FIRST ANNUAL REPORT

OF THE

NEW YORK STATE DAIRY COMMISSIONER.

1885.

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New York State Dairy Commissioner,

WITH

ACCOMPANYING DOCUMENTS.

TRANSMITTED TO THE LEGISLATURE JANUARY 15, 1885.

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STATE OF NEW YORK.

No. 27.

IN SENATE,

JANUARY 15, 1885.

FIRST ANNUAL REPORT

OF THE NEW YORK STATE DAIRY COMMISSIONER.

To the Legislature of the State of New York:

The New York State Dairy Commissioner, in obedience to the requirements of chapter 202 of the Laws of 1884, respectfully submits the following report:

The undersigned filed his oath of office on the 14th day of May, 1884, and immediately entered upon the discharge of his duties as "New York State Dairy Commissioner."

This being a new department it became necessary to organize a force of assistants by the selection of such persons as possessed qualifications adapted to the special duties contemplated in the law. This was attended with considerable difficulty, for the reason that persons who were experts and competent to detect oleomargarine, or the presence of any oleaginous substance, the manufacture and sale of which is prohibited, and whose services could be obtained, were comparatively few.

Geo. L. Flanders, of Hopkinton, St. Lawrence county, N. Y., and Benjamin F. Van Valkenburg, of Brooklyn, N. Y., were appointed assistant commissioners.

The former entered the service June 1, has charge of the affairs of the office at Albany, and receives a salary of $1,200 per year; the latter entered the service July 11, has his office at his place of business, No. 350 Washington street, New York city, and receives a salary of $2,000 per year.

The following is a list of the persons employed as chemists, experts and agents, who have received certificates of employment, together with the date of entering service and the rate of compensation:

Date.	Name.		Salary.	Period.
June 1.	Edward W. Martin...	Chemist	Paid for	analyses made.
June 1.	Walter Moeller	Chemist	$100 00	per month.
June 1.	E. S. Wilson	Expert and agent ..	105 00	per month.
June 28.	D. A. Ottman	Expert and agent ..	60 00	per month.
July 1.	William G. Spence...	Expert and agent ..	60 00	per month.
July 1.	R. D. Clark..... ...	Chemist	100 00	per month.
July 16.	J. J. Sorogan	Expert and agent ..	60 00	per month.
Aug. 21.	Chas. Sears.....	Expert and agent ..	60 00	per month.
Aug. 21.	Geo. B. Fellows.....	Expert and agent ..	100 00	per month.
Aug. 22.	Wm. W. Meeteer	Expert	80 00	per month.
Sept. 1.	Thos. R. Gray	Expert	80 00	per month.
Oct. 4.	Chas. S. Kellogg.....	Expert and agent ..	3 00	per day.
Oct. 4.	Philo E. Eysaman	Expert and agent ..	3 00	per day.
Nov. 11.	Jedediah R. Wheeler..	Expert and agent ..	80 00	per month.
Dec. 1.	Marcus A. Perry.....	Expert and agent .	100 00	per month.
Dec. 10.	Samuel J. White.....	Expert and agent ..	60 00	per month.

Hon. William K. Newton, State Milk Inspector of New Jersey, requested that he be authorized by this department to act as chemist, that he might be enabled to inspect milk shipped to the New Jersey markets, while en route through the State of New York.

His request was complied with, and a certificate of employment, dated July 17, 1884, was issued to him, with the condition expressed therein that services performed by him should be without compensation and without any expense whatever to the State of New York.

The commissioner of health of Brooklyn, N. Y., requested that certain officials connected with the "Department of Health" of that city be given certificates of employment in order that they might be clothed with the additional power and authority which is conferred by chapter 202 of the Laws of 1884. Accordingly certificates bearing date July 17, 1884, were issued to Dr. E. H. Bartley, as chemist, W. A. DeLong, L. McLean and W. J. Hobday, as experts, upon the same conditions and terms as to compensation and expense as expressed in the certificate to Mr. Newton.

At the request of the municipal authorities of Albany, N. Y., a similar certificate of employment as expert was issued, July 24, 1884, to Lawrence Cary, city milk inspector.

From time to time I have found it necessary to employ persons for specific work to whom no certificates of employment were issued, because the services to be rendered were not continuous, in most cases occupying but a few days.

The names of such persons with the amounts paid them for compensation and disbursements will appear further on in this report.

In organizing the force of this department, I was at first inclined to appoint assistant commissioners in different portions of the State; this I found, upon making an estimate of the probable cost, to be

impracticable, and so concluded for the present to appoint but two, and devote as much of my own time as possible to visiting the different sections of the State to ascertain the condition of the dairy interests, to learn the views of and to receive suggestions from practical dairymen. I accordingly employed more experts, and by this means was enabled to place nearly every man in the service where he was actively engaged in detecting those who were violating the provisions of this act. As a result of my investigations and inquiries, I believe that a larger force of experts should be employed, and so distributed through the State as to bring the dairymen and this commission in closer relation; they should report directly to the office at Albany, and be the medium through which the complaints and requirements of the people come to the notice of the Commissioner. By this course the office work would be greatly increased, but it would necessitate fewer assistant commissioners, make the work more direct and simple, and secure better results for the money expended than any other plan yet considered.

The investigation of the committee of public health of the Senate revealed the fact that large quantities of imitation butter, known as oleomargarine, butterine, etc., were annually sold in the cities of New York and Brooklyn as genuine dairy butter. I became satisfied that, although limited quantities of these goods were sold in different parts of the State, yet by far the greater portion was handled and sold in these two cities, and therefore as soon as practicable commenced and continued prosecutions against those engaged in this unlawful traffic at points where the violations were most numerous, and the dealers strongest.

I had very little, if any, doubt that all of the artificial butter which was made before and on hand on the first day of June was property which might be sold by its owners, without violating the law. A few weeks of hot summer weather would suffice to drive all such goods from the market, and enable us to organize our forces so as to be all ready for effective work by the time violations of this statute would be likely to become at all frequent or serious.

The attempt to bring the offenders to justice has been attended with many difficulties, perplexities and delays. In order to secure the evidence necessary to a conviction, some one of our force has himself made a purchase of the prohibited article and taken it to a chemist for analysis.

An affidavit of the facts was then made, upon which an application for a warrant of arrest was made to some one of the police magistrates of the city.

Upon the return of the warrant, it was necessary that all our witnesses should be present, because the accused might choose to proceed with the examination immediately.

In almost every instance, however, the hearing was adjourned by the defendant, which made it necessary for all the witnesses to be present on the adjourned day; frequently other adjournments were obtained, so that our witnesses were necessarily in court several different times in each case.

to be enforced so that there will be a steady market for State goods, have ceased to deal in the spurious article, thereby largely increasing the demand for genuine butter.

It appears from his report that there have been sixty-seven arrests made and eleven convictions secured. Forty-two are under indictment, or have elected to be tried by Special Sessions. Ten cases are still in police court awaiting examination, and four defendants have been discharged.

By the courtesy of the district attorneys I have been able to render some assistance in forwarding these prosecutions by furnishing extra counsel to some extent in certain stages of the proceedings.

All violations of this law are misdemeanors, and of course it is the duty and privilege of the local district attorney to take entire charge of all prosecutions, especially after proceedings have gone so far as to result in indictments being found. In the counties of New York and Kings there is always a vast amount of business in the criminal courts, and the district attorneys there will probably pursue the usual course of trying indictments in their order, giving those precedence which are found against persons who cannot give bail and are in confinement.

I am assured by many merchants who are dealers in butter, and competent to speak upon this subject, that as a result of these arrests and prosecutions, at least eighty per cent of this unlawful traffic has been broken up. Quite recently large amounts of oleomargarine have been shipped to the interior cities and towns of this State by manufacturers in other States, and I am now engaged in augmenting the force of experts so as to try to prevent the sale of these goods. It is no offense to ship oleomargarine into or through the State, if it is not sold or offered for sale here. I think, however, that our interests would be promoted by some legislation regulating this business and providing for checks of some kind to guard against and prevent sales of such goods within the State. There are a large number of boarding-house keepers who purchase artificial butter, presumably because it is cheaper, and furnish their boarders with this rather than genuine butter. It is not probable that in such cases these goods are offered for sale or sold by the proprietors within the meaning of the statute. So long as this bogus butter can be made at about half the price of the genuine article and such a market remains to be supplied, the temptation will continue to clandestinely manufacture such goods within the State, or purchase them from manufacturers outside the State, in order to meet the wants of such customers. In fact, such consumer may himself order these goods from factories outside the State, and probably be guilty of no offense against the present law. There is also a class of restaurants, whose proprietors have upon their tables bills of fare stating the different articles of food to be obtained there by their customers, and the price to be paid for each ; the article butter, however, is not named at all, nor any price fixed for it, but the practice is to set on a small plate of this artificial butter in addition to the articles called for, no

specific charge being made for it; it is claimed that this is no sale of the article, therefore no violation of the statute. I suppose upon any trial of such a case in which all this was made to appear it would be a question of fact for the jury whether it was not an attempt to evade the statute, and in fact a sale of the prohibited article. All violations of this statute, however, are misdemeanors and for the second offense the guilty party must be imprisoned, and it is not at all certain the courts would not so strictly construe this law as to declare that such a transaction was not a violation of its provisions.

No complaint has been made that adulterated cheese was being manufactured or sold, and I have no knowledge or information that violations of this law have occurred by manufacturing, selling or offering for sale within this State any article of imitation cheese, prohibited by section 6, of the act.

The business of furnishing milk to the inhabitants of the cities of New York, Brooklyn, and vicinity, is an immense industry; the product of over 100,000 cows being shipped daily for this purpose over the following railroads, viz.

New York, Lake Erie and Western; New York, Ontario and Western; New York, Susquehanna and Western; New York Central; New York and Northern; Long Island; Harlem; and by boat from Newburgh, in summer.

To provide an adequate force of suitable inspectors and agents to examine and test all such milk, to inspect the barns and stables where the cows are kept and fed, in order to fairly enforce the plain provisions of this law would require an expenditure of not less than $12,000 per year.

In view of the alarming fact that the cholera scourge may and probably will reach and afflict our people the coming year it would doubtless be well worth all it would cost to organize and maintain an efficient force for that purpose. That which is so important to the people of these great cities is also essential to the welfare of the residents of all other cities and villages within the State who are dependent for their milk supply upon those who make it their business to furnish them with that article of food. Every quart of water that is mixed with milk and sold to consumers takes the place of a quart of pure milk, which otherwise would have been needed, so that the dairy farmer is very greatly interested in having the law enforced. It is quite apparent that the appropriation now at the disposal of the Dairy Commissioner is altogether too small to justify the attempt to fully accomplish his work of milk inspection, however desirable or necessary it may appear to be. In the localities of the State from which the milk is taken to supply the demands of the people of New York city, Brooklyn and vicinity, about one-tenth of the dairy interest of the whole State is represented, and the amount of money required to maintain the present service there is not less than one-fifth the entire appropriation. All that can be done in the field now under consideration, in justice to the people of other portions of the State and to the other interests to be cared for and served, will be to distribute our forces so as to guard, as well as possible,

those points where the danger may appear to be greatest, and rely upon local authorities to supply whatever of effort we may be unable to make.

Prof. Edward W. Martin, of the School of Mines, Columbia College, New York city, has had charge of the force of milk inspectors and experts which was employed in the milk producing districts supplying the cities of New York and Brooklyn. A full account of his work has been submitted to me, which I have annexed and made a part of this report.

The report of Mr. Martin will show that the amount of work performed by chemists, experts, etc., in inspecting milk in that section of the State where milk is produced for shipment to New York, Brooklyn and vicinity, is as follows: Number of inspections, 9,685; number of specimens of milk examined, 25,270; number of creameries inspected, 52; number of dairy farms inspected, 36; number of condensaries, 6; the milk of 3,527 producers has been examined; 27 complaints have been made for violation of the law and the offenders have been prosecuted. There have also been 107 analyses of milk made; 11 of condensed milk; 10 examinations for the detection of impure water added to milk; 1 analysis of milk for the detection of arsenic; 5 for soda and borax; 1 cow's stomach analyzed for arsenic, making a total of 135 analyses. The chemist has spent twenty days in court in expert work.

The average amount of milk which should be examined from this section daily is as follows: 12,630 cans of milk; 194 cans condensed milk, and 519 cans of cream, or yearly 4,136,111 cans of milk, 75,670 cans of condensed milk, 99,260 cans of cream; or calculating to milk, viz., 1 can of condensed milk equals 4 cans of milk, and 1 can of cream equals 4 cans of milk, we have as the total amount of milk which should be inspected every year, in this section alone, 4,835,683 40-quart cans, which equals 193,425,240 quarts.

With the present force employed only a small portion of this can be inspected, but the mere fact of determining whether water has been added, or cream removed, is the least that should be done.

Cleanliness in handling the milk should be insisted upon, as well as the most rigid inspection of the cows producing it, the manner in which they are housed, treated and fed, as well as the condition of the water supplied them, and also that used to clean the various vessels and utensils used on the farms, or at the creameries and condensaries.

The quality of the milk has been greatly improved, the producers sending much better milk. The creameries from which large quantities of skimmed and skimmed and watered milk have heretofore been shipped have, with a few exceptions, stopped this fraudulent practice, and the quality of the milk shipped from creameries from June 1st of the past year was excellent. The condensaries have also shipped condensed milk of good quality, and the practice of condensing partly skimmed milk has been abandoned.

The following letters from Dr. White, chief inspector of milk, New York city, Dr. Bartley, chemist to the Brooklyn health depart-

that the quality of the milk sent to New York, and the adjacent cities is uniformly excellent; adulterated or skimmed milk being almost unknown.

Allow me to congratulate you upon the results obtained by you in your endeavors to check the shipment of impure milk from stations in your State.

Yours very truly,
WILLIAM K. NEWTON,
N. J. State Inspector of Milk.

The report of milk and its adulterations, submitted to me by Edward W. Martin, assisted by Walter Moeller, Ph. B., is a very valuable contribution to the literature of milk, and is the result of much labor and experience and an extended inquiry into all the authorities upon the subject.

This report shows the great importance of a pure milk supply. Commencing with a short historical account of milk, the composition of milk of various animals and plants is discussed and given. The physical and chemical difference between cow's and human milk is thoroughly entered into. The composition of cow's milk is then taken up and its various constituents discussed and explained. The percentage of the constituents in average milk is thoroughly gone into. The results of analyses of milk made by all the recognized authorities, some forty in number, are here tabulated, together with the results of the analyses of milk from herds from various sections of this State. The result of this conclusively shows that in healthy normal cow's milk there should not be more than 87.5 per cent of water, nor less than 12.5 per cent of milk solids, and of these milk solids at least 3.2 per cent should consist of fat and 9.3 per cent of solids not fat.

It can thus be seen that the standard created by the present law is actually below that of average milk. The average specific gravity of milk is also thoroughly gone into, and it is conclusively shown as the result of experiments by many authorities; and the result of inspections of cows at many dairy farms in this State shows conclusively that the average specific gravity of milk never falls as low as 1.029, which equals one hundred degrees at sixty Fahr. on the lactometer generally used. This point is of great importance, as it enables the inspector to ascertain at once if water has been added to any considerable amount. The subject of abnormal milk is then taken up and many curious and interesting facts are given, including a complete list of all the plants which impart an odor and color to milk. The fact that abnormal milk is unwholesome is also shown here; watery milk, sour milk, blue milk, stringy milk, red milk, colostrum in milk, and the so-called sandy milk, and milk stones are also discussed. The churning of cream is also spoken of, and causes are mentioned which produce unsatisfactory results, among which is the use of milk containing colostrum, milk from pregnant cows and milk from old milkers; prominent among these is the fact that much trouble arises from laxity in the management of the dairy,

number of epidemics of typhoid fever, the infection of which was conveyed through milk contaminated with foul water. He states that there is strong suspicion that milk supplies the conditions for rapid development of disease germs.

He shows that improper food given to cows deleteriously modifies their milk as food for infants.

He speaks of the effects of sanitary conditions of the cow upon her milk. He shows how unfavorable sanitary conditions produce disease of the cow and that the milk from such cows is unwholesome. Several instances are given in which the milk of diseased cows has communicated the disease to mankind. He gives the results of some of the chemical and microscopical examinations of diseased milk.

He states the results of experiments which show an alarming probability that milk from a consumptive cow will produce the same disease in man.

He shows that milk is used by physicians as the basis of diet in sickness, and the importance of diet in the treatment of all exhaustive diseases.

For the purpose of putting the department in communication with the representatives of butter and cheese factories and the various other manufacturers of dairy goods, and the manufacturers of package vessels, eleven hundred and sixteen circular letters, accompanied by a copy of the law, were issued to the supervisors of the towns and wards of the State. The following is a copy of the circular:

OFFICE OF NEW YORK STATE DAIRY COMMISSIONER,
NEW CAPITOL, ALBANY, *August* 2, 1884.

DEAR SIR—Your attention is respectfully called to the inclosed sections of chapter 202 of the Laws of 1884.

In pursuance of the duties imposed by said law, and in order to have data upon which to base official action, I most respectfully ask that you will, at your earliest convenience, fill the inclosed blanks for the town or ward of which you are supervisor. Promptness will materially aid the department in the work to be done.

The Commissioner desires to obtain the name and location of every manufactory of butter, oleomargarine, butterine, suine, condensed milk, of vessels for the package of the same, with the name and post-office address of the person owning or operating the same; also the names of persons or associations dealing in milk, with the post-office address of each. Hoping to be favored by an early reply.

I am, very truly yours,

J. K. BROWN,
Commissioner.

In compliance with the request, over eight hundred replies were received. These reports furnished the department with the names and location of twelve hundred and eighty-eight cheese and butter factories, and the names and post-office address of the director or proprietor of each, this being about three-fourths the number of

all the factories in the State. They also report eleven hundred and ten persons, firms and associations dealing in milk, and three hundred and twenty-seven persons and firms manufacturing packages for butter, and seven condensed milk factories.

Upon receipt of replies from the supervisors, circulars were sent to the several proprietors of butter and cheese factories referred to therein, for a more detailed statement.

From these reports much valuable information was obtained. Upon the subject of food given to milch cows, they show that various kinds are used, of which the following is an enumeration, given in the order of preponderance:

In summer, fodder corn, ensilage, soiling with grass, rye, oats and millet, and in one case prickley comfrey, with additions of brewer's grains, barley sprouts, corn starch refuse, glucose refuse, corn meal, oil meal, wheat bran or shorts and middlings, cotton seed meal, pumpkins and mixed mill feed; and in some cases sour milk and whey. In winter, hay, corn stalks, ensilage and straw supplemented with corn meal, shorts, brewer's grains, middlings, corn starch refuse, glucose refuse, barley sprouts and roots of various kinds.

In the vicinity of cities where breweries and malt-houses are mostly located, large quantities of brewer's grains and barley sprou are fed.

Refuse from starch and glucose factories is shipped to all parts of the State.

Some of these reports state the effect certain foods have on the milk, and its product as follows: Belfast, Allegany county, and Hinsdale, Chautauqua county; in the former that "potatoes are not good for milch cows, causing the milk to be poor and thin, and produces sticky cheese;" in the latter, "they produce slimy curd." A report from the town of Russia, Herkimer county, and the town of Hamburg, Lewis county, says, "potatoes are not good for milch cows."

A report from the city of Newburg, Orange county, says, "In my opinion, brewer's grains and sprouts make a very inferior and poor article of milk, unless corn meal is fed heavily at the same time;" and further adds, "I do not regard milk made from brewer's grains as being a healthful article of food."

A report from the town of Byron, Genesee county, says: "As far as our experience goes, the seventh milking after parturition is saved for use; sometimes the fifth and the ninth; but we know of none that wait five days."

A report from the town of Paris, Oneida county, says: "I think there is no violation of the law here, except section 13, and only using the milk too soon after parturition."

From Monroe, Orange county, says: "We think 'sprouts' are bad for our manufacture. It makes our cheese ferment, and gives it a bad smell. In many instances, we were unable to cure cheese made with milk from cows fed on sprouts, and had to throw it away. During the winter, when hay got to be scarce, sprouts were fed

very liberally. After a few days we noticed that our cheese was turning out bad. In the mean time, the cows got to be sick — all taken with dysentery. Some of them so bad that they were actually passing blood. We stopped the sprouts and got the cows well again."

From Amsterdam, Montgomery county, "The glucose waste that a few years ago was so much used as fodder is now put aside. The milk from cows fed upon this is known to cause diarrheal diseases when consumed by children, but yet no sanitary law seemed capable of ridding us of the evident nuisance. Time, however, effectually evaded it; for it was soon observed by the dairymen, that while, at first, the quantity was increased, in about a year's time the cow became diseased and worthless if kept upon the food in question."

Letters and documents of various kinds were received from individuals and corporations intended to show that brewer's grains, "sprouts," starch feed, and other refuse materials, were valuable and wholesome food for milch cows. There were such wide differences of opinion with reference to this subject and the interests involved were of such magnitude that I desired, if possible, to have such a series of careful and practical experiments made with these several articles of cattle food, to be fed to milch cows, for such length of time and under such conditions, carefully and faithfully observing and recording all the influence and effect upon the cattle, the milk and the products, as that when the results were all published, these conflicting opinions might be harmonized and this vexed feed question definitely settled. Accordingly application was made to the proper authorities of the New York Agricultural Station at Geneva, to undertake this work. This request was cheerfully and promptly complied with and such experiments were commenced as soon as suitable preparations could be made.

Dr. Sturtevant, the director in charge of that institution, published a bulletin on the 22d day of November last, which he says was "intended to inform the public of progress at the station, rather than to give complete results." This bulletin has been widely published and all the facts, figures and data obtained will doubtless appear in full in the annual report of that institution to your honorable body. In a communication to the Commissioner, Dr. Sturtevant, speaking of this experiment, says: "In giving the results of this experiment to the public, we must call attention to the fact that a negative experiment is by no means conclusive, especially in the face of positive claims to the contrary. The director and his chemist at the station both feel that this experiment requires a repetition, and that it is not safe to generalize from the facts obtained. Until the experiment has been tried with cows fresh in milk and for a period far more extended, this experiment will simply stand by itself for what it is worth, as but recording the results obtained with cows of the Jersey breed, of far above the average quality, at a distance from calving, and yielding but little milk and for but a limited period."

Other experiments are now in progress at the "station," and will

Date.			Compensation.	Expenses.
Oct. 3.	Chas. Sears	Expert	$60 00	$0 50
Oct. 3.	Thos. R. Gray	Expert	80 00	56 49
Oct. 3.	Elwyn Waller	Chemist	205 00	
Oct. 3.	E. G. Love	Expert	45 00	
Oct. 3.	Stillwell & Gladding	Chemists	96 00	
Oct. 3.	William Doyle	Expert	65 00	33 97
Oct. 4.	B. F. Van Valkenburg	Assistant commission'r	166 66	67 20
Oct. 18.	D. P. & H. Gedney	Counsel	10 00	
Oct. 22.	G. C. Hodges	Chemist	50 00	
Oct. 22.	E. S. Wilson	Expert	105 00	8 50
Oct. 31.	R. D. Clark	Chemist	100 00	
Nov. 1.	William W. Meeteer	Expert	80 00	21 80
Nov. 10.	Edward W. Martin	Chemist	160 00	
Nov. 10.	Walter Moeller	Chemist	100 00	
Nov. 10.	E. G. Love	Chemist	80 00	
Nov. 10.	Chas. Sears	Expert	60 00	16 74
Nov. 10.	Elwyn Waller	Chemist	75 00	
Nov. 11.	Edward W. Martin	Chemist	.....	23 87
Nov. 11.	Geo. L. Flanders	Assistant commission'r	100 00	
Nov. 11.	Geo. B. Fellows	Expert and agent	100 00	5 19
Nov. 11.	E. S. Wilson	Expert	105 00	5 53
Nov. 11.	B. F. Van Valkenburg	Assistant commission'r	166 33	51 14
Nov. 11.	Thos. R. Gray	Expert	80 00	25 86
Nov. 11.	Stillwell & Gladding	Chemists	150 11	
Nov. 11.	W. G. Spence	Expert	60 00	18 29
Nov. 11.	J. J. Sorogan	Expert	60 00	39 84
Nov. 11.	P. E. Eysaman	Expert and agent	45 00	36 20
Nov. 13.	R. D. Clark	Chemist	.....	13 12
Nov. 13.	William P. Quin	Counsel	200 00	3 30
Nov. 13.	Chas. S. Kellogg	Expert	48 00	28 25
Nov. 25.	Geo. L. Flanders	Assistant commission'r	100 00	
Nov. 25.	Geo. B. Fellows	Expert and agent	100 00	
Dec. 4.	B. F. Van Valkenburg	Assistant commission'r	166 66	24 90
Dec. 4.	P. E. Eysaman	Agent	57 00	43 70
Dec. 4.	Chas. S. Kellogg	Agent	75 00	33 00
Dec. 4.	Edward W. Martin	Chemist	112 00	16 59
Dec. 4.	J. J. Sorogan	Expert	60 00	13 69
Dec. 4.	Chas. Sears	Expert	60 00	12 00
Dec. 8.	R. D. Clark	Chemist	100 00	20 75
Dec. 8.	E. G. Love	Chemist	95 00	
Dec. 8.	W. W. Meeteer	Expert	80 00	41 61
Dec. 8.	Walter Moeller	Chemist	100 00	
Dec. 8.	F. V. S. Oliver	Counsel	660 00	
Dec. 8.	W. G. Spence	Expert	60 00	16 76
Dec. 8.	Stillwell & Gladding	Chemists	188 47	
Dec. 8.	Elwyn Waller	Chemist	105 00	
Dec. 12.	E. S. Wilson	Expert and agent	105 00	17 31
Dec. 12.	J. R. Wheeler	Expert and agent	36 92	9 28
Dec. 12.	Thomas R. Gray	Expert and agent	80 00	49 21
Dec. 24.	Geo. L. Flanders	Assistant commission'r	100 00	
Dec. 24	Geo. B. Fellows	Expert and agent	100 00	
Jan. 8.	Thomas R. Gray	Expert	80 00	37 49
Jan. 8.	J. J. Sorogan	Expert	60 00	17 35
Jan. 8.	M. A. Perry	Expert	100 00	7 61
Jan. 8.	A. C. Salmon	Counsel	275 00	6 95
Jan. 8.	Walter Moeller	Chemist	100 00	
Jan. 8.	F. V. S. Oliver	Counsel	420 00	

APPENDICES ACCOMPANYING THE REPORT.

1. Copy of chapter 202, Laws of 1884.
2. Report by B. F. Van Valkenburg of his work and proceedings as Assistant Commissioner.
3. Report by Edward W. Martin of the work performed by the Chemist and Milk Inspectors.
4. Report by Edward W. Martin, assisted by Walter Moeller, Ph. B., on Methods of Testing Milk.
5. Report of R. D. Clark, M. D., on "Cow's Milk in Reference to its Medical Bearings."

CHAP. 202.

AN ACT to prevent deception in sales of dairy products.

PASSED April 24, 1884; three-fifths being present.

The People of the State of New York, represented in Senate and Assembly, do enact as follows:

SECTION 1. No person or persons shall sell or exchange, or expose for sale or exchange, any unclean, impure, unhealthy, adulterated, or unwholesome milk, or shall offer for sale any article of food made from the same or of cream from the same. This provision shall not apply to pure skim cheese made from milk which is clean, pure, healthy, wholesome and unadulterated, except by skimming. Whoever violates the provisions of this section is guilty of a misdemeanor and shall be punished by a fine of not less than twenty-five nor more than two hundred dollars, or by imprisonment of not less than one or more than six months, or both such fine and imprisonment for the first offense, and by six months' imprisonment for each subsequent offense.

§ 2. No person shall keep cows for the production of millk for market, or for sale or exchange, or for manufacturing the same, or cream from the same, into articles of food, in a crowded or unhealthy condition, or feed the cows on food that is unhealthy, or that produces impure, unhealthy, diseased or unwholesome milk. No person shall manufacture from impure, unhealthy, diseased, or unwholesome milk, or of cream from the same, any article of food. Whoever violates the provisions of this section is guilty of a misdemeanor and shall be punished by a fine of not less than twenty-five nor more than two hundred dollars, or by imprisonment of not less than one or more than four months, or by both such fine and imprisonment for the first offense, and by four months' imprisonment for each subsequent offense.

§ 3. No person or persons shall sell, supply, or bring to be manufactured to any butter or cheese manufactory, any milk diluted with water, or any unclean, impure, unhealthy, adulterated, or unwholesome milk, or milk from which any cream has been taken (except pure skim milk to skim cheese factories), or shall keep back any part of the milk commonly known as "strippings," or shall bring or supply milk to any butter or cheese manufactory that is sour (except pure skim milk to skim cheese factories). No butter or cheese manufactories, except those who buy all the milk they use, shall use for their own benefit, or allow any of their employees or any other person to use, for their own benefit, any milk, or cream from the milk, or the product thereof brought to said manufactories, without the consent of the owners thereof. Every butter or cheese manufacturer, except those who buy all the milk they use, shall keep a correct account of all the milk daily received, and of the number of pounds and packages of butter, the number and aggregate weight of

cheese made each day, the number of packages of cheese and butter disposed of, which shall be open to inspection to any person who delivers milk to such manufacturer. Whoever violates the provisions of this section shall be guilty of a misdemeanor and shall be punished for each offense by a fine of not less than twenty-five or more than two hundred dollars, or not less than one or more than six months' imprisonment, or both such fine and imprisonment.

§ 4. No manufacturer of vessels for the package of butter shall sell or dispose of any such vessels without branding his name and the true weight of the vessel or vessels on the same with legible letters or figures not less than one-fourth of an inch in length. Whoever violates the provisions of this section is guilty of a misdemeanor and shall be punished for each offense by a fine of not less than fifty nor more than one hundred dollars, or by imprisonment of not less than thirty or more than sixty days, or by both such fine and imprisonment.

§ 5. No person shall sell or offer or expose for sale any milk except in the county from which the same is produced, unless each can, vessel or package containing such milk shall be distinctly and durably branded with letters not less than one inch in length, on the outside, above the center, on every can, vessel or package containing such milk, the name of the county from which the same is produced, and the same mark shall be branded or painted in a conspicuous place on the carriage or vehicle in which the milk is drawn to be sold, and such milk can only be sold in or retailed out of a can, vessel, package or carriage so marked. Whoever violates the provisions of this section shall be guilty of a misdemeanor, and shall be punished by a fine of not less than twenty-five nor more than two hundred dollars, or not less than two months' or more than four months' imprisonment, or both such fine and imprisonment for the first offense, and by four months' imprisonment for each subsequent offense.

§ 6. No person shall manufacture out of any oleaginous substance or substances, or any compound of the same, other than that produced from unadulterated milk, or of cream from the same, any article designed to take the place of butter or cheese produced from pure, unadulterated milk or cream of the same, or shall sell, or offer for sale, the same as an article of food. This provision shall not apply to pure skim-milk cheese made from pure skim milk. Whoever violates the provisions of this section shall be guilty of a misdemeanor, and be punished by a fine of not less than one hundred nor more than five hundred dollars, or not less than six months' or more than one year's imprisonment, or by both such fine and imprisonment, for the first offense, and by imprisonment for one year for each subsequent offense.

§ 7. No person shall offer, sell or expose for sale in full packages, butter or cheese branded or labeled with a false brand or label as to county or state in which the article is made. Whoever violates the provisions of this section is guilty of a misdemeanor, and shall be punished by a fine of not less than twenty-five or more than fifty dollars, or imprisonment of not less than fifteen or more than thirty

days, for the first offense, and fifty dollars or thirty days' imprisonment for each subsequent offense.

§ 8. No person shall manufacture, sell, or offer for sale, any condensed milk unless the same shall be put up in packages, upon which shall be distinctly labeled or stamped the name or brand by whom or under which the same is made. No condensed milk shall be made or offered for sale unless the same is manufactured from pure, clean, healthy, fresh, unadulterated and wholesome milk, from which the cream has not been removed; or unless the proportion of milk solids contained in the condensed milk shall be in amount the equivalent of twelve per centum of milk solids in crude milk, and of such solids twenty-five per centum shall be fat. When condensed milk shall be sold from cans or packages not hermetically sealed, the vendor shall brand or label such cans or packages with the name of the county or counties from which the same was produced, and the name of the vendor. Whoever violates the provisions of this section shall be guilty of a misdemeanor, and be punished by a fine of not less than fifty or more than five hundred dollars, or by imprisonment of not more than six months, or both such fine and imprisonment for the first offense, and by six months' imprisonment for each subsequent offense.

§ 9. The Governor, by and with the advice and consent of the Senate, shall appoint a Commissioner, who shall be known as the New York State Dairy Commissioner, who shall be a citizen of this State, and who shall hold his office for the term of two years, or until his successor is appointed, and shall receive a salary of three thousand dollars per annum and his necessary expenses incurred in the discharge of his official duties under this act; said Commissioner shall be appointed within ten days after the passage of this act, and shall be charged, under the direction of the Governor, with the enforcement of the various provisions thereof. Said Commissioner may be removed from office at the pleasure of the Governor, and his successor appointed as above provided for.

The said Commissioner is hereby authorized and empowered to appoint such assistant commissioners and to employ such experts, chemists, agents and such counsel as may be deemed by him necessary for the proper enforcement of this law. Their compensation to be fixed by the Commissioner.

The said Commissioner is also authorized to employ a clerk at an annual salary of not to exceed twelve hundred dollars.

The sum of thirty thousand dollars is hereby appropriated to be paid for such purpose out of any moneys in the treasury not otherwise appropriated. All charges, accounts and expenses authorized by this act shall be paid by the Treasurer of the State, upon the warrant of the Comptroller. The entire expenses of said Commissioner shall not exceed the sum appropriated for the purposes of this act.

The said Commissioner shall make annual reports to the Legislature, not later than the fifteenth day of January of each year, of his work and proceedings, and shall report in detail the number of

ASSISTANT COMMISSIONER'S REPORT.

[By B. F. Van Valkenburg.]

New York, *December* 31, 1884.

Hon. Josiah K. Brown, *New York State Dairy Commissioner, New Capitol, Albany, N. Y.:*

Dear Sir — I have the honor to submit the following report:

I received my commission July 11, 1884. During the months of July and August there was, as usual during the heated term, a very small amount of imitation butter used, owing to the fact that the flavors of the animal, vegetable and nut oils, now used in the making of this spurious butter, are, under high temperature, so readily detected by the consumer as to render the article unsalable or nearly so.

During the above-mentioned months, by reason of this and other facts in a conference with you, it was deemed best to defer making arrests until about September 1, 1884.

In the intervening time, I confined myself to selecting experts, counsel, chemists and proper agents, who were duly appointed by you, and taking a general survey of the field.

On September 1st, after a careful preparation in this office and frequent consultations with the district attorney, and upon his advice and instruction, we began to make arrests for violations of chapter 202, Laws of 1884.

The violators of this law, whether manufacturer, wholesale dealer or retailer, have moved with secrecy; we have met with many obstacles, and it has required a vast amount of labor to watch the different dealers and obtain sufficient evidence to warrant making arrests.

Believing the public suffers more from the dealer or his agents who knowingly, willfully and fraudulently sells the consumer a spurious article representing it to be butter, and that the evil could sooner be eradicated by commencing at the root, I accordingly proceeded first against the retail dealer who buys this "oleaginous compound" with full knowledge of what it is, thereby encouraging the manufacture of the same.

A profit nearly double that made from the sale of pure dairy butter tempted the retail dealer to continue to impose this bastard upon the consumer who would not knowingly use it. He could buy the goods at from thirteen to fifteen cents and sell at from twenty-five to thirty-two cents per pound, the price advancing or declining with

for butter, except that obtained from pure milk and cream, and whenever the question is discussed the sale of bogus butter is condemned.

I am fully convinced, from all the information that I can obtain upon the subject, that the enforcement of the law has reduced the sale of counterfeit butter fully 50,000 pounds daily, as compared with last year, which is equivalent to protecting 400,000 persons from being defrauded into the use of these goods on their tables daily as an article of food.

The dairy farmers of this State have been incidentally benefited to a large amount through the effect of this law, although all other products of the farm, as well as all classes of manufactured goods, have sold in the market at a reduction in value, amounting to from ten to thirty per cent as compared with 1883, State dairy butter has held its own price, with a largely increased production over last year, amounting in receipts in New York alone to 5,600,000 pounds more from May 1st to December 1st than during the same period of last year; also during the same period of this year the exports were 1,260,000 pounds less than in 1883, showing that the market has had a surplus of 6,860,000 pounds for home consumption during the same period.

Sales of State butter to parties who formerly handled spurious goods, and the great confidence of the dealers in the continued enforcement of the law, prohibiting the sale of all kinds of counterfeits of genuine butter thereby keeping the market open to dairy butter during the winter months, is, in my opinion, the reason State goods have held up in price while nearly every other class of farm products and manufactured goods have declined to a lower price than for years past.

There have been sixty-seven arrests made; eleven convictions secured; forty-two are under indictment, or have elected to be tried by Special Sessions; ten are still in police court awaiting examination, and four have been discharged. Prosecutions have been delayed in many cases by the system of rotation of the police judges from one district to another, no judge sitting two consecutive weeks in the same district.

The actions brought by this department have received prompt attention in every instance from the judges of the courts in which the actions were brought.

The district attorneys of New York and Kings counties have given the business of the department prompt attention, and brought every case to as speedy a trial as the business of their respective offices would permit.

In conclusion, I am pleased to be able to say that all the employees appointed by you for this department have done their full duty, and have greatly assisted me in accomplishing what I have the honor to report.

Respectfully submitted,

B. F. VAN VALKENBURG,

Assistant State Dairy Commissioner.

REPORT OF WORK PERFORMED BY THE CHEMIST AND MILK INSPECTORS.

By Edward W. Martin.

New York, *January* 1, 1885.

Hon. J. K. Brown, *State Dairy Commissioner, Albany, N. Y.:*

Sir — I have the honor to make the following report of the work performed by the chemist and milk inspectors from June 1, 1884, to December 31, 1884, inclusive:

(A.)

Walter Moeller, Ph. B., employed from June 1, 1884, to December 31, 1884, inclusive.

Number of inspections	2,824
Number of specimens examined	9,000
Number of creameries inspected	7
Number of dairy farms inspected	2
Number of condensaries inspected	1
Number of producers' milk inspected	858
Number of complaints	15

(B.)

De Witt C. Ottman, employed from July 1, 1884, to July 28, 1884, inclusive:

Number of inspections	735
Number of specimens examined	985
Number of creameries inspected	5
Number of dairy farms inspected	3
Number of condensaries inspected	1
Number of producers' milk inspected	340
Number of complaints	...

(B.)

Charles Sears, employed from Aug. 21, 1884, to December 31, 1884, inclusive:

Number of inspections	2,277
Number of specimens examined	2,955
Number of creameries inspected	11
Number of dairy farms inspected	22
Number of condensaries inspected	..

Number of producers' milk inspected	597
Number of complaints	5

(C.)

William G. Spence, employed from July 1, 1884, to December 31, 1884, inclusive:

Number of inspections	1,865
Number of specimens examined	6,199
Number of creameries inspected	19
Number of dairy farms inspected	2
Number of condensaries inspected	2
Number of producers' milk inspected	891
Number of complaints	3

(D.)

Joseph J. Sorogan, employed from July 16, 1884, to December 31, 1884, inclusive:

Number of inspections	1,833
Number of specimens examined	6,000
Number of creameries inspected	13
Number of dairy farms inspected	7
Number of condensaries inspected	2
Number of producers' milk inspected	841
Number of complaints	2

(E.)

Samuel J. White, employed from December 11, 1884, to December 31, 1884, inclusive:

Number of inspections	151
Number of specimens examined	131
Number of creameries inspected	...
Number of dairy farms inspected	20
Number of condensaries inspected	1
Number of producers' milk inspected	131
Number of complaints	...

Total.

Number of inspections	9,685
Number of specimens examined	25,270
Number of creameries inspected	52
Number of dairy farms inspected	36
Number of condensaries inspected	6
Number of producers' milk inspected	3,527
Number of complaints	25

The work performed by me as chemist has been as follows, from June 1, 1884, to December 31, 1884, inclusive:

Number of analyses of milk	107
Number of analyses of condensed milk	11
Number of analyses for impure water	10
Number of analyses of milk for arsenic	1
Number of analyses for soda and borax	5
Number of analyses for arsenic	1
Total	135

Number of days at courts, twenty, and some 10,000 miles have been traveled. Some 200 samples were brought by the inspectors for analysis besides the samples analyzed, but upon examination were found to be so near the standard that conviction would not have been possible, or the proper kind of evidence was lacking.

The following tables show the amount of milk which should be examined daily, besides that received at creameries, etc.:

Daily Average per Week of Cans of Forty Quarts each of Milk, Condensed Milk and Cream.

RAILROADS.	Week Ending June 5.			Week Ending June 12.			Week Ending June 19.			Week Ending June 26.		
	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.
Harlem and New York Central	2,148	169	....	2,093	157	....	2,084	196	....	2,055	150	....
Lake Erie and Western	3,675	25	285	3,741	28	300	3,979	27	306	3,874	27	245
Ontario and Western	1,975	....	145	1,950	....	140	2,113	....	167	2,030	....	191
New York, Susquehanna and Western	1,387	....	62	1,366	....	81	1,362	....	67	1,270	....	94
New Jersey Central	300	....	15	385	....	15	385	....	10	385	....	12
New York, New Haven and Hartford	1,192	....	....	1,200	....	....	1,267	....	....	1,282	....	....
New York City and Northern	1,279	....	....	1,285	....	....	1,290	....	...	1,259	..	....
Miscellaneous	600	....	12	600	....	12	600	...	15	600	....	10
Total	12,556	194	519	12,620	185	548	13,080	223	565	12,755	177	652
Surplus disposed of on platform, per 40-qt. can	$1 25			$1 30			$1 25			$1 30		

Daily Average per Week of Cans of Forty Quarts each of Milk, Condensed Milk and Cream.

RAILROADS.	Week Ending July 31.			Week Ending August 7.			Week Ending August 14.			Week Ending August 21.		
	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.
Harlem and New York Central	1,744	141	. .	1,715	143	....	1,692	113	....	1,675	134	....
Lake Erie and Western	3,851	30	201	3,766	28	141	3,738	56	166	3,780	36	165
Ontario and Western	1,952	....	173	1,960	....	141	1,950	....	140	1,883	....	149
New York, Susquehanna and Western	1,300	....	50	1,311	....	69	1,264	....	58	1,254	....	62
New Jersey Central	360	....	10	355	....	10	355	....	10	350	....	10
New York, New Haven and Hartford	1,175	...	....	1,175	....	....	1,160	....	....	1,160	....	....
New York City and Northern	1,143	....	....	1,140	....	....	1,141	....	....	1,150	....	....
Miscellaneous	525	....	14	575	....	12	575	....	10	500	....	10
Total	12,050	171	448	11,997	171	373	11,875	169	384	11,752	170	396
Surplus disposed of on platform per 40-qt. can.	$1 40			$1 30			$1 30			$1 30		

Daily Average per Week of Cans of Forty Quarts each of Milk, Condensed Milk and Cream.

RAILROADS.	Week Ending September 25.			Week Ending October 2.			Week Ending October 9.			Week Ending October 16.		
	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.
Harlem and New York Central	1,799	154	....	1,882	132	...	1,888	159	....	1,924	165	....
Lake Erie and Western	3,200	25	250	3,225	27	225	3,635	37	75	3,775	35	101
Ontario and Western	2,088	....	106	1,928	....	79	2,075	....	100	1,979	....	83
New York, Susquehanna and Western	1,229	....	13	1,196	....	32	1,196	....	32	1,156	....	30
New Jersey Central	355	....	8	355	....	8	355	....	8	355	....	8
New York, New Haven and Hartford	1,200	....	...	1,180	....	....	1,055	90	....	1,019	101	....
New York City and Northern	1,150	....	...	1,179	....	....	1,164	....	....	1,178	...	....
Miscellaneous	525	....	10	525	....	10	500	....	10	500	....	10
Total	11,546	179	387	11,470	159	354	11,868	286	225	11,886	301	232
Surplus disposed of on platform per 40-qt. can.	$1 40			$1 40			$1 45			$1 50		

Daily Average per Week of Cans of Forty Quarts each of Milk, Condensed Milk and Cream.

RAILROADS.	Week Ending November 20.			Week Ending November 27.			Week Ending December 4.			Week Ending December 11.		
	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.	Milk.	Condensed Milk.	Cream.
Harlem and New York Central	1,951	170	....	1,960	169	....	1,958	167	....	1,966	170	....
Lake Erie and Western	2,565	....	90	2,690	...	80	2,940	....	74	3,300	35	70
Ontario and Western	1,724	....	56	1,700	....	62	1,682	....	60	1,675	. .	50
New York, Susquehanna and Western	1,018	....	18	1,026	...	17	1,032	....	15	1,050	....	15
New Jersey Central	350	....	10	350	....	8	350	....	8	350	....	10
New York, New Haven and Hartford	1,075	35	...	1,040	52	....	1,002	72	....	950	106	....
New York City and Northern	1,090	....	....	1,000	....	....	1,040	....	...	1,007	....	...
Miscellaneous	400	...	8	425	....	12	500	....	10	525	....	8
Total	10,173	205	182	10,191	221	179	10,504	239	167	10,823	311	153
Surplus disposed of on platform per 40-qt. can.	$1 55			$1 60			$1 65			$1 80		

SUMMARY.

Total number of cans of milk..... 4,136,111
Total number of cans of condensed milk..... 75,670
Total number of cans of cream..... 99,260

or calculating to milk, viz.: 1 can of condensed milk equals 4 cans of milk, and 1 can of cream equals 4 cans of milk, we have as the total amount of milk which should be inspected every year in this section alone, 4,835,831 cans, equals 193,425,240 quarts.

Now although the work performed by the chemist and inspectors is large still much remains to be done.

The force employed is inadequate to cope with the evil, for as can be seen, only a small proportion can be inspected daily, even to determine whether the milk is adulterated; but this is the least that should be done.

Cleanliness in handling the milk should be insisted upon as well as a most rigid inspection of the cows producing it, the manner in which they are housed, treated, and fed, as well as the condition of the water supplied them, and also that used to clean the various vessels and utensils used on the farms or at the creameries and condensaries.

These matters are of the highest importance in the coming year, for it is conceded by all sanitary authorities that the cholera will be with us with the first warm weather, and a producer or creamery man might, by the use of impure water, spread this disease to an alarming extent.

It must be remembered that only producers' milk, with one or two exceptions, has been examined. Inspection has been asked for in many small towns and villages, but this it was impossible to do in every instance on account of the small force employed. Twenty inspectors would be barely enough for this district alone.

The quality of the milk has been greatly improved even with the small force at work; but it must be acknowledged that the cold weather during the past summer had considerable to do with the excellence of the milk.

For the reason that the supply being greater than the demand, no incentive was offered to adulterate.

Again the creameries, from which large quantities of skimmed and skimmed and watered milk have heretofore been shipped, have with a few exceptions stopped this fraudulent practice.

The quality of the milk shipped from creameries from June 1 of the past year was excellent.

The condensaries have also shipped preserved milk of good quality, and the practice of condensing skimmed milk has ceased.

The following tables show the results of the analyses of the various brands of condensed milk made and sold in this section:

There is still considerable to be done in order to bring the standard up to where it should be.

More has been done to improve the condition of stables in this vicinity during the last year than during any two previous years within my knowledge.

The feeding of "swill" on Long Island during the last six months has been practiced less than at any time during the last ten years, and but few milkmen have dared to feed it.

Very respectfully yours,
E. H. BARTLEY, M. D.

941 MADISON AVE.,
NEW YORK, *Jan'y* 5, 1885.

Mr. EDWARD W. MARTIN, *Chief Inspector, State Dairy Commissioner:*

DEAR SIR—In reply to your favor of this date relative to what influence the supervision of the milk supply of New York State, under the auspices of the State Dairy Commission, may have had upon the quality of the milk shipped to this city, I would state, that in my opinion, such supervision has very materially aided in excluding unlawful milk from this market. It has afforded me much gratification to note in my official rounds how much improved in quality the general average of the milk supply has been since we have had the benfit of such intelligent inspection out of the city as was afforded within the past six months by the department you represent. The inspection of dairies, as well as the cattle, and the milk supplied by them before shipment, is, in my estimation, a matter of too much importance to be overlooked, and when attended to, as I am confident it will be under your direction, the results cannot but prove advantageous to the public.

Believe me, very truly yours,
J. BLAKE WHITE, M. D.

PATERSON, N. J., *Jan'y* 5, 1885.

EDWARD W. MARTIN, Esq., *Chemist, New York Dairy Commissioner:*

MY DEAR SIR—After making my final inspection for 1884 of the milk shipped to New York city, I am in the position to express an opinion respecting its quality. It gives me great pleasure to say that the work of the past five years has been crowned with success, and that the quality of the milk sent to New York and the adjacent cities is uniformly excellent, adulterated or skimmed milk being almost unknown.

Allow me to congratulate you upon the results obtained by you in your endeavors to check the shipment of impure milk from stations in your State.

Yours very truly,
WM. K. NEWTON, M. D.,
New Jersey State Inspector of Milk.

REPORT ON MILK AND ITS ADULTERATIONS.

By Edward W. Martin, assisted by Walter Moeller, Ph. B.

Historical Part.

As far back as history goes we find milk spoken of as a most important and palatable article of food, and in ancient times it was considered to contain many hidden virtues.

Hippocrates, in his account of the Scythians, describes with great minuteness their process of making butter and commends milk as the most healthy and nourishing kind of food for human consumption.

Aristotle, who may be considered the father of natural history, describes many curious particulars relating to milk and from the high esteem in which he held it, it may be inferred that its importance, as an article of human sustenance, was in his age duly appreciated.

According to Pliny many eastern nations of his time subsisted almost entirely upon milk and the spontaneous productions of the earth. The early Germans and other European nations lived largely on milk as indeed also did the early Britons, as related by Cæsar in his Commentaries. It is curious to note that the Indian legends state that a cow was among the first of created animals, and the traditions of every Celtic nation, it is said, place the cow among the earliest productions and represent it as a kind of divinity. In ancient Rome baths of warm milk were recommended as most beneficial in many diseases and, in fact, at all times milk has been considered a most important and necessary article of diet.

Up to the seventeenth century only three of the constituents of milk had been discovered, viz.: Butter, Cheese, and Whey.

Bartoletus, an Italian physician, and who was a professor at Bologna (wrote a work entitled "Encyclopædia Hermetico Dogmatica sive orbis Doctrinarum, Physiologicæ Semioticæ et Therapeuticæ, 1619 ") seems to have been the first one to have discovered a fourth principle or constituent, viz.: Sugar.

Ludovico Testi seems to have been the first to have written about milk sugar in his Relazione concemente il Zucchero di Latte, 1698.

Leeuwenhoek was the first to notice the microscopical characteristics of milk. A. Donné published in his book Comus Microscopie, Paris, 1844, drawings from the microscope, showing the fat globules in fresh and sour human and animal milk.

Boerhave appears to have been the first to have made a qualitative examination of milk, and speaks at some length on the danger of using milk from diseased or improperly fed animals.

Geoffrey, in his Commercium Liberarium ad Re Medicæ et

FIG. 1. CREAM. X 420.

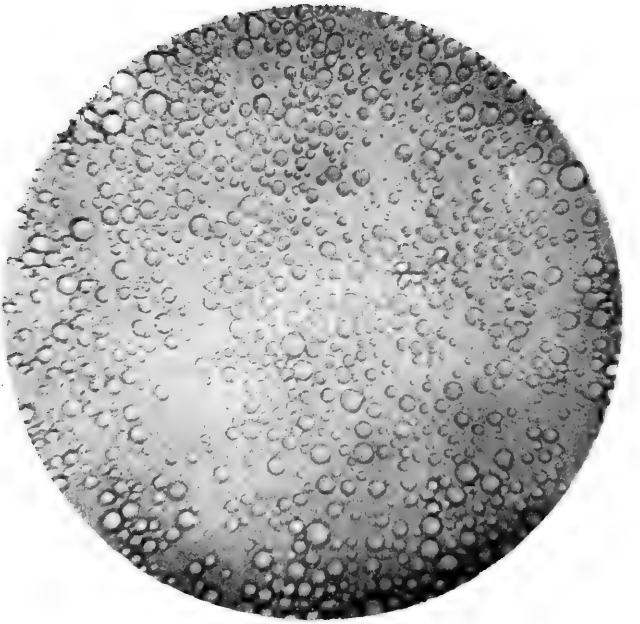


FIG. 2. COW'S MILK. X 420.

ARTOTYPE. E. BIERSTADT, N. Y.

Scientiæ Naturalis Incumentum Institutium, 1737, describes a quantitative analysis of milk, twelve pounds of milk were coagulated, heated gently and filtered. The coagulated mass and the filtered portion or serum were each weighed. The serum eight pounds, the coagulated mass two pounds, seven ounces. The serum was dried and the residue weighed seven ounces, twenty-four grains. This is one of the earliest quantitative analyses of milk known.

Scheele, in 1780, discovered lactic acid, and proved that phosphate of lime was always present in human casein, and considered that a true combination was formed between them in the proportion of one to one and a half parts of phosphate of lime to one hundred parts of dry casein.

It is only at a comparatively recent date, however, that the question of regulating the milk supply by stringent laws began to be taken up and such laws made. Now, however, the great importance of a pure milk supply is universally recognized in all civilized countries.

Nearly all civilized people have some law in relation to this subject, and as the great centers of population increase and become more and more crowded, the importance of pure milk becomes more and more necessary.

It has been my unpleasant duty to see poverty and misery in every form in the city of New York, and the necessity of a nourishing article of food for infants reared under the most disadvantageous circumstances, as far as their sanitary surroundings go, is exceedingly necessary, and this may be said of all large cities.

It is universally conceded that the adulterator of milk may be just as much a murderer as if he deliberately poisoned the consumer. It is of interest to note, under the head of unhealthy milks, how epidemics of typhoid fever, etc., etc., are produced by carelessness in handling milk.

Too rigid laws cannot be made in order to first, protect the health of the consumer, and secondly, to assist those producers of milk who really desire to produce an article fit for human consumption. The second reason, because if adulteration is allowed to go on, the honest producer is driven to commit the crime in order to compete with the dishonest one.

Composition of Milk.

Milk is a fluid secreted by the mammary glands of animals for the support and nourishment of their young, and consists of an emulsion of fats in a solution of casein and sugar, together with certain inorganic salts. The color of milk is due to the fat globules, which can be readily seen with the aid of a microscope.

These fat globules have a yellowish blue color and a pearly gloss and vary in size. (See Photomicrograph of milk, plate 1, figure 2.)

Thus M. E. Bouchut found that in different samples of cows' milk there are from 1,102,500 to 3,700,000 globules to the cubic millimetre (6-1000 of an inch).

By some it is thought that each globule is surrounded by an envelope or thin membrane. An attempt to prove this has been made by attempting to show that scarcely any of the fat is dissolved upon shaking the milk with ether unless a little acetic acid is first added, which is supposed to dissolve this membrane. There is great diversity of opinion on this subject; one authority, Moleschott, claims to have pressed out the fat and filled up the membrane with colored liquids; Hoppe-Seyler endeavors to prove the existence of a membrane by estimating the proportion existing between the water and casein in cream.

I have examined milk with the microscope, magnifying up to 4,000 diameters, but could not, by any of the numerous methods suggested, see this supposititious membrane. The milk of different animals varies greatly in the amounts of water, fat, etc., as will be seen on reference to the following table:

	Water.	Fat.	Sugar.	Albumin & Casein.	Salts.	Specific gravity.
Human	86.78	3.38	7.50	1.72	0.56	1.032
Cow	86.80	3.80	4.50	4.20	0.70	1.031
Goat	84.49	5.68	3.69	3.51	0.61	1.03353
Ass	89.00	1.85	5.05	3.56	0.54	1.03457
Mare	88.80	2.50	5.50	2.70	0.50	1.03374
Elephant	79.30	9.10	8.59	2.51	0.50	1.03132
Bitch	76.60	9.57	3.19	9.91	0.73	1.035
Cat	81.62	3.33	4.91	9.55	0.58	.....
Sheep	82.27	5.30	4.20	7.23	1.00	1.040
Llama	89.55	3.15	5.60	0.9	0.8	1.034
Sow	84.04	4.55	3.13	7.23	1.05	1.038
Hippopotamus	90.98	4.51	4.40	....	0.11	.. ..
Camel	86.94	2.90	5.66	3.84	0.66	1.042

Even birds and plants secrete a fluid similar in composition to milk. Pigeons secrete a fatty albuminous fluid in the crop with which they are supposed to feed their young. An analysis by Le-Compte shows the secretion to contain:

Water 66.30
Fat 10.47
Casein and salts 66.30

Jonge, in the Zeitschrift for Physiol. Chemie. Strasburg, 1879, gives the following analysis of a substance analogous to milk, which he found in the glands at the tail of the goose:

	1		2	
Water	60.807		58.466	
Albumen and nuclein	17.966		12.763	
Compounds insol. in absolute ether	18.677		24.708	
Alcoholic extract	1.090		1.831	
Water extract	0.753		1.131	
Ash	0.707	Sol. 0.371 / Insol. 0.336	1.101	Sol. 7.71 / Insol. 3.36

The ether extract contained:

Cetyl alcohol	7.423	10.402
Oleic acid	0.648	
Lower acids	0.373	1.484
Leuthin	0.233	

Many plants, such as the well-known milk weed, yield a white liquid called milk, but which is decidedly different in its composition from milk.

In Central America the famous cow tree or milk tree (Brosnium Utile Palo de Vaca).

When the trunk of this tree is pierced there flows a stream of sweet and nourishing milk, flowing most freely at sunrise. It has a pleasant odor, becomes yellow after a short time, and a cream rises on the surface, which gradually thickens, becoming of a cheesy consistency. It has a viscidity differing from the milk of animals.

It consists of

Water	45 per cent
Wax, fat and albumen	54 " "
Sugar	0.5 " "
Salts	0.5 " "

During the siege of Paris in 1870, a substitute for milk was prepared as follows:

Water	87 parts
Olive oil or horse fat	4 "
Sugar	4 "
Egg albumen or gelatine	4 "
Salt	½ "
Carbonate of soda	½ "

These were mixed by violent shaking, and the resulting compound had the appearance of milk, and having all of its constituents, could be used as a food for the young.

In civilized countries, cows' milk is principally consumed; in Africa, that of the camel; in Tartary and Siberia, that of the mare; in India, the buffalo's; in Lapland, the reindeer's; in China, until a comparatively recent date, sows' milk was generally consumed.

Milk is especially adapted for the support of the young of animals

because it contains all the components of a mixed food; for it has been found by experiment that a mixed diet is the best. An examination of the needs of the body, shows that definite amounts of carbon, hydrogen, nitrogen and oxygen are required daily, depending on the amount lost by the body and the organs used. An excess beyond this is needed by the young animal to furnish material for growth. In milk, casein supplies the nitrogen, sugar and fat in a great measure the carbon, the salts the mineral constituents, and the water the water needed by the body.

It is for this reason that cows' milk must be diluted before being given to infants, as the percentage of casein is too large. Should it not be diluted then the infant has to digest the excess of casein, and so giving its digestive organs more work to do thus permanently injure them.

In this, as in many other countries cows' milk is the one used almost entirely, and when we consider that two-thirds of our infant population are brought up on other than human milk, viz.: cows,' and that nearly all children partake more or less largely of cows' milk, to say nothing of its general use, we can at once see the necessity of a pure milk supply.

This is particularly necessary when milk is used as a substitute for mothers' milk; for cows' milk, although the best substitute we can get, is still different in its chemical properties and amount of its constituents, and any adulteration only tends to make this difference, and consequently its indigestability, greater.

As for instance, in skimmed milk the per cent of fat is too small while the per cent of casein is too large, or by adulteration with water, the per cent of the solid constituents is lowered, and more of such milk must be digested in order that the body may obtain sufficient nourishment.

Chemistry points out the following differences between human and cows' milk. Human milk generally has a strong alkaline reaction, sometimes neutral, but never acid when fresh; the milk of cows has a much weaker alkaline reaction, and, in fact, is sometimes acid. The more careful analyses have shown that cows' milk contains larger quantities of salt and a smaller quantity of milk sugar. The difference considered to be of greatest importance by physicians lies in the larger quantities of casein in cows' milk; human milk contains 1.5 to 2 per cent, while cows' milk contains 4 to 5 per cent.

Kuhne (Lehrb. der physiol. Chem. 1868, 565) believes casein to be a potassium albuminate, and though as yet elementary analyses have shown no difference in the composition of the casein of human milk and that of cows, still it is highly probable that such is the case.

If to one-half c. c. of human milk, two drops of artificial gastric juice be added, an immediate precipitation takes place, consisting of numerous, very fine, pliable, flat coagula mingled with some of medium size. The same quantity of gastric juice added to cows' milk

produces a large, lumpy, coarse coagulum which adheres to the sides of the vessel and leaves but little clear serum.

These differences between human and cows' milk are those which cause serious difficulties in the digestive organs and are of great importance when cows' milk is used as a substitute for human milk.

The physical differences existing between the coagula formed on the addition of gastric juice to human and to cows' milk may be due to one of the following causes:

1st. The difference in the amounts of casein in human and in cows' milk.

2nd. The larger quantity of free alkali in human milk.

3d. Differences in the chemical composition of the casein of the two varieties of milk.

To test the first hypothesis, cows' milk was diluted so as to reduce the amount of casein to that of human milk; on adding the gastric juice to this diluted milk the same heavy coagulum was formed.

The excess of alkali in human milk was neutralized with hydrochloric acid in very slight excess. Gastric juice, added to this acid milk produced the same fine coagula as the natural alkaline milk. Chloride of sodium and chloride of potassium were then added to cows' milk but of no avail, the same heavy coagulum was precipitated.

It, therefore, seems that the difference existing between the coagula produced in human and in cows' milk by the addition of gastric juice is due to a difference in the chemical composition of the casein. This theory is well supported by the fact that different reactions take place on the addition of the same reagent to these varieties of milk.

The reactions produced by various reagents are here tabulated:

TABLE of Reactions produced by various Reagents.

REAGENT.	Human Milk.		Cows' Milk.	
	In the cold.	In the warm.	In the cold.	In the warm.
Artificial gastric juice.... In excess.....	Coagula. Exceed	Insoluble, ingly fine granules.	Coagula. Heavy Cg.	Insoluble. Cg. remains.
Boiled gastric juice.....	None.	None.	A few large Cg. Coagulation is incomplete.	Cg. forms lump.
Boiled gastric juice in excess	do	do	Complete Cg.	Cg. lumps or separates into several smaller lumps.

Table of Reactions, etc. — (Continued).

REAGENT.	Human Milk.		Cows' Milk.	
	In the cold.	In the warm.	In the cold.	In the warm.
Glacial acetic acid	None.	None.	Large Cg.	Cg. remains.
In excess	do	do	Cg. dissolves.	None.
Nitric acid	do	Numerous fine yellow Cg.	Large Cg.	Cg. firmer and yellow.
In excess	do	Larger Cg.	Insoluble.	Soluble to yellow liquid.
Phosph'c acid	do	None.	Large white Cg.	Cg. remains.
Sulphuric acid	do	Fine Cg. milk turns brown.	Large Cg.	Cg. separates into very fine hard particles.
In excess	do	Heavier Cg. The sample turns brown.	Cg. dissolves. Solution red-brown.	Greasy black liquid.
Conc. tartaric acid	do	None.	Large Cg.	Cg. dissolves and separates out again on cooling.
In excess	d	do	Cg. dissolves.	None.
Alcohol in excess	Very fine grains.	Dissolve on cooling medium size and small Cg. are formed.	Large soft Cg.	Cg. dissolve, separate on cooling first as fine grains then as a soft Cg.
Corrosive sublimate	None.	None.	Numerous fine grains.	Coarse Cg.
In excess	Numerous fine grains.	Numerous thicker Cg.	None.	Coarse Cg., adhering partially to the sides.
Chloride of lime	None.	None.	do	Large coarse Cg.
In excess	do	do	do	Large Cg.
Sulphate of aluminium	do	do	Large soft Cg.	Coarse Cg.
In excess	do	do	A few flocks adhering to the sides. Insoluble in x. s.	Dissolve, but on cooling smaller and larger Cg., separate out.
Tanin	Medium and fine Cg.	Very fine grains.	Numerous and very fine Cg.	Soluble.
In excess	Numerous fine Cg.	Very fine grains.	Numerous fine Cg.	Form Cg., and clear yellow liquid.
Sugar of lead	None.	Very fine Cg.	Large soft Cg.	Coarse Cg.
In excess	do	None.	Large soft Cg.	Numerous isolated hard Cg.
Sulphate of magnesia	do	do	None.	Large Cg.
In excess	do	do	do	None.

of the fatty acids, stearic, palmitic, oleic, arachadic and myristic, called insoluble fatty acids, they not being soluble in water, and of the glycerides of butyric, caproic, caprilic and capric or rutic, these are called the soluble fatty acids, they being soluble in water.

Tristearin or Stearin ($C_3 H_5 (C_{18} H_{35} O_2)_3$ is a white solid fat. Its melting point is about 66° c. (150.8° F.)

By saponifying and then decomposing the soap with a suitable acid, as sulphuric or hydrochloric, we obtain 95.73 per cent of stearic acid. Stearin enters in the composition of all fats which have a high melting point.

Stearic acid ($C_{18} H_{36} O_2$) is always found in animal fats, with but few exceptions. It is also found in some of the vegetable fats. Of late years this acid has been largely used, particularly in the manufacture of stearine candles, so well known and so universally used at the present day. To make the stearic acid for this purpose, slaked lime $Ca (O H)_2$ and any of the animal fats are boiled in suitable vessels until saponification takes place.

The resulting lime-soap is then decomposed by means of sulphuric acid. The resulting acids consisting of oleic, palmitic and stearic acids are put in bags, these are placed in powerful presses and the oleic acid is pressed out. What remains in the bag is commercially known as stearin; it consists of a mixture of stearic and palmitic acids. Pure stearic acid may be obtained from this compound, by dissolving commercial stearin in alcohol and precipitating the stearic acid by means of acetate of lead. This is then to be decomposed by means of sulphuric acid.

The stearic acid is then dissolved in alcohol (boiling); on cooling the solution, the stearic acid crystallizes out in needles.

Under the microscope they have the form of elongated lozenge-shaped plates.

Stearic acid melts at 69.4° C. (157° Fahr.), is odorless and tasteless, has no greasy feeling. It is soluble in all proportions, in boiling alcohol and ether.

Tripalmitin or palmitin $(C_3 H_5 (C_{16} H_{31} O)_3$ This is a white solid fat. Soluble in hot alcohol and ether, but nearly insoluble in cold.

Margarin, once considered a definite compound, was found to be a mixture of palmitin and stearin. This crystallizes in needle-like tufts. Palmitin upon being saponified, and subsequently decomposed by a suitable acid, gives 95.28 per cent of palmitic acid.

Palmitic acid ($C_{16} H_{32} O_2$) melts at 62° C. (143.6° Fahr.) and is obtained largely from palm oil, and can be produced by saponifying spermacetti.

It may be purified by repeatedly crystallizing it from alcohol. It is white, tasteless and crystallizes in needle-like tufts.

Triolein or olein $(C_3 H_5 (C_{18} H_{33} O_2)_3$ It is solid at 5° C. (41° Fahr.) and when pure is colorless, becoming yellow by absorbing oxygen. It dissolves stearin and palmitin readily. It is soluble in absolute alcohol or ether. It is the principal constituent of almost

all the vegetable oils. Pure olein contains 95.70 per cent of oleic acid.

Oleic acid (C_{18} H_{34} O_2), when pure, is a fluid odorless, tasteless and colorless at 4° C. (39.2° Fahr.) It crystallizes in needles. Upon oxidation it becomes yellow, and then has a strong odor. It forms two classes of salts, normal and acid.

Normal salts of the alkalies are soluble in water.

All the acid salts are insoluble in water. Oleate of copper and lead are soluble in ether or absolute alcohol and may be separated from the stearates and palmitates by taking advantage of this property. Upon destructive distillation a great variety of compounds are formed, among which is sebacic acid (C_{10} H_{18} O_4).

Butyrin C_3 H_5 (C_4 H_7 O. O)$_3$ Caproin (C_6 H_{11} O_2)$_3$ C_2 H_5), caprilin (C_8 H_{15} O_2)$_3$ C_2 H_5, and rutin (C_{10} H_{19} O_2)$_3$ C_2 H_5, yield on saponification and subsequent decomposition, butyric, caproic, caprilic, and rutic acids, respectively. They have not, as yet, been separated in a pure state.

Butyric acid (C_4 H_8 O_2).

Two butyric acids exist: Normal C_3, H_7, C O O H, boiling point 163. 4° C. (326° Fahr.), specific gravity 0.9817 at 0° C. (32° (Fahr.), and isobutyric acid (C H_3)$_2$H. C O O H, boiling point 154° C. (309.2° Fahr.) specific gravity 0.8598 at 0 C (32° Fahr.); the latter has a less offensive odor than the first named.

Butyric acid is found in the fruits of the following plants:

Botanical name.	Common name.
Sapindus saponaria.	Locust bean.
Tanorandus indica.	
Anthemis nobilis.	Feverfew.
Tancentum vulgare.	Tansy.
Arnica montana.	Arnica.
Gingko viloba.	Gingko.

Butyric acid is found in a very much larger quantity in butter than in any other fat, and is indeed the distinguishing characteristic of it, amounting to nearly seven per cent.

Butyric acid is volatile and may be distilled unaltered in its composition. It is soluble in alcohol, ether, or in water, in all proportions. Nearly all of its salts are soluble.

Butyric acid, when treated with alcohol and sulphuric acid, forms butyric ether. This reaction is very characteristic. Butyric ether has a strong odor resembling that of pine-apples. Rancid butter when heated with alcohol produces butyric ether. It has a specific gravity of .902 at 0° C. (32° Fahr.), boiling point 119° C. (246.2° Fahr.)

Caproic acid C_6 H_{12} O_2 forms two acids, normal C_5 H_{11} C O O H, boiling point 205° C. (401 Fahr,), and Isocaproic C_3 (C H_3)$_2$ H_5 C O O H, boiling point 199.5° C. (390.2° Fahr.)

Caproic acid is found in a vast number of plants in human perspiration and in cheese. Nearly insoluble in water. Is distilled unchanged.

Caprilic acid $C_8 H_{16} O_2$ melting point, boiling point 236° C,. the amount of caprilic acid in milk fat is very small. It is nearly insoluble in boiling water.

Rutic acid $C_{10} H_{20} O_2$. Less soluble than caprilic acid in boiling water, occurs in very minute quantities in milk fat. It is a solid, white and crystalline. Arachadine and mynstine are present in butter fat but in too small quantities to be estimated.

Milk sugar or lactose, $C_{12} H_{22} O_{11} H_2 O$. As far as is known milk sugar is found only in human milk, that of the bitch and in all herbivora or plant-eating animals, Specific gravity 1.53.

It turns a ray of polarized light to the right, according to the following authorities:

Blythe, 58.2°. Fownes, 58.3° [a]. Biot, 60.28°.

It is insoluble in absolute alcohol or in ether; one part is soluble in six parts of cold and two and one-half parts of boiling water, and it is of course slightly soluble in ether or alcohol, which contain water, and is soluble in acetic acid.

At 150° C. it loses one molecule of water without being decomposed.

The watery solution is neutral and has a sweet taste, but far less than cane sugar.

It easily undergoes lactic acid fermentation as in the ordinary souring of milk, but undergoes alcoholic fermentation with difficulty.

It is precipitated by acetate of lead but not by the neutral acetate of lead. Potash, soda, ammonia and oxide of lead form with it compounds. Strong acids decompose it as do also oxydizing agents.

It reduces the oxides of bismuth and silver, from their solutions and copper from an alkaline solution of that metal.

Distilled with sulphuric acid it yields formic acid and with nitric acid, mucic, saccharic, tartaric, racimic and oxalic acids.

By boiling milk sugar for three to four hours with four parts of water and two per cent of sulphuric acid, neutralizing with carbonate of lime and evaporating the liquid to a syrup, a different sugar is formed.

This altered milk sugar is called galactose. It is dextro-rotatory 83.22 at 15° C. (60° Fahr.) and is fermentable, and with nitric acid twice as much mucic acid as milk sugar.

Galactose has the formula, $C_{12} H_6 O_6$.

The Albumenoids of Milk.

These are usually classed under the head of casein and include casein, albumen, nuclein and galactine.

Casein, when pure, is a white, brittle, transparent substance and exists in milk in combination with phosphate of soda, from which combination it may be precipitated by the addition of an acid, as when milk sours, the lactic acid formed causes the casein to separate. Casein may be considered to be an alkali albuminate.

It is precipitated by a great variety of substances, as acetate of lead, sulphate of copper, chloride and nitrate of mercury, the various acids, mineral and vegetable, except carbonic acid, which re-dissolves it in excess. None of these, however, precipitate it in a pure state, but together with fat, nuclein and phosphate of lime. A solution of casein free from fat and in combination with sulphate of magnesia in strong alkaline solution turns the ray — 91°, in a dilute — 87°.

Rennet causes a precipitation of casein even in an alkaline solution.

Hammersten considers that the precipitation of casein by rennet is caused by the splitting up of the casein into two bodies, one of which is precipitated together with the fat, etc., and the other an albumenoid remaining in solution. This latter is not precipitated by boiling nor by acetic or nitric acid.

Albumen, as it occurs in milk, is in no respect different from that found in blood.

In the milk the amount of casein is usually five times that of the albumen. It is not precipitated by acetic, carbonic, phosphoric or tartaric acids. Mineral acids precipitate it.

NUCLEIN.

Nuclein (C_{29} H_{49} N_9 P_5 O_{22}) is found not only in milk but in blood, pus, yolk of eggs, yeast cells and in the liver cells.

It is a white, amorphous substance, soluble in ammonia, soda and phosphate of soda.

Nuclein is distinguished from other albumenoids from the fact that it contains phosphorus.

Milk, besides these, contains, or is supposed to contain, a variety of substances, which each discoverer calls by a new name, leading to endless confusion. Galactine is obtained by decomposing the lead salt by hydrogen sulphide. It is soluble in water and is a brittle, white, tasteless, no crystalline mass.

Lactochrome (the coloring matter of butter) was discovered by Blythe.

Kreatinine and urea are always present in minute quantities.

The peculiar odor of milk may be separated out by shaking it with petroleum ether. (Blythe.)

Blythe found that, when the gas existing in milk was pumped out by means of a suitable apparatus this gas consisted of

Carbon dioxide	3.27 per cent.
Nitrogen	77.60 per cent.
Oxygen	19.13 per cent.

Milk, when tested fresh from the cow, has a peculiar reaction, which is called the "amphoroteric reaction," as it turns tumeric paper brown and litmus paper blue.

MINERAL CONSTITUENTS.

The investigation of these constituents has been fully made and I copy from Blythe the following, which may be considered as accurate:

Potassium oxide	(K_2O)
Sodium oxide	(Na_2O)
Calcium oxide	(CAO)
Ferric oxide	(F_2O_3)
Magnesium oxide	(Mg O)
Phosphoric pent-oxide	(P_2O_5)

also a minute quantity of sulphuric acid.

The following table from Blythe gives the composition of milk (average).

Milk fat	Olein	1.477	3.50
	Stearin, Palmitin	1.750	
	Butyrin	0.270	
	Caproin, Caprylin, Rutin	0.003	
Casein			3.98
Albumen			0.77
Milk sugar			4.00
Galactine			0.17
Lactochrome			traces
Bitter principle precipitated by tannin			0.01
Odorous principle			traces
Urea			0.0001
Kreatinine			traces
Ash	K_2O	0.1228	0.7
	Na_2O	0.0868	
	CaO	0.1608	
	Fe_2O_3	0.0005	
	P_2O_5	0.1922	
	Cl	0.1146	
	Mg O	0.0243	
Flurine.			Traces.
Sulphuric acid in combination			0.005
Water			86.87
Sulphocynates			(?)

Cream is that part which rises when milk is allowed to remain at rest for sometime.

And in its composition is about the same as milk, except of course the per cent of fat is greater, and that it contains relatively a larger proportion of casein and albumen than milk.

The following table shows the result of analyses of cream:

	No. 1.	No. 2.
Water	50.02	65.75
Fat	41.81	26.60
Sugar	2.80	2.00
Casein	5.06	4.21
Salts	0.31	0.44

No. 1 was cream carefully separated from the milk by letting the cream rise and drawing off the skimmed milk from underneath.

No. 2 is the average of twenty analyses of commercial cream.

An analysis of the cream and skimmed milk from the milk separator described below showed the following results:

	Cream.	Skimmed milk.
Water	52.21	90.34
Fat	41.16	0.15
Sugar	3.11	3.98
Casein	3.40	4.80
Salts	0.12	0.78
Sp. grav.	60° F. 0.9900	1.0338

The appearance of cream under the microscope is shown in Plate 1, Fig. 1.

This is the cream No. 1. Analysis given above.

A very ingenious method of separating the cream from the milk is by means of the "milk separator," which consists of a rapidly revolving vessel. The cream, having a less specific gravity than that of the milk, approaches nearer the center of the revolving vessel, while the skimmed milk, having a greater specific gravity, tends toward the outside. Tubes or outlets are arranged for drawing off the cream and skimmed milk, while whole milk is being run in, so that the action of the machine is continuous.

BUTTER-MILK.

The average composition of butter-milk is as follows:

Water	90.50
Fat	1.30
Sugar	3.20
Casein	4.00
Lactic acid	.35
Ash	.65

As will be seen, it contains all of the constituents of milk, except a part of the sugar has been changed into lactic acid.

KOUMISS

is fermented milk, and was first prepared by the Tartars from mares' milk.

Its preparation consists in adding fresh warm milk to sour milk to which a little sugar has been added. This is stirred from time to time, and at the end of a few hours the operation is completed. During this time the following chemical changes take place. The sugar is partly changed into lactic acid, alcohol and carbonic acid, while peptones are produced from the albumenoids.

The following analyses show the changes:

	Wanklyn.	Fleischman Cows' milk.	Fleischman Mares' milk.
Water	87.32	88.93	91.53
Fat	.68	.85	1.27
Sugar	6.60	3.11	1.25
Lactic acid	....	.79	1.01
Alcohol	1.00	2.65	1.85
Carbonic acid	.90	1.03	.88
Casein	2.84	2.03	1.91
Ash	.66	.44	.29

It is claimed that koumiss is easily digested by persons with weak stomachs. If made from cows' milk, the milk should be previously skimmed. Ten parts of skimmed milk as fresh as possible are added to one part of sour milk and one-tenth part of sugar is then mixed with this and the mixture stirred from time to time, care being taken to keep it at a temperature of about 75° Fahr. for about four and a half hours. At the end of this time it may be bottled, and is ready for use.

Percentage of Constituents in Average Milk.

In order to detect the adulteration of milk by the addition of water or by the removal of cream, it becomes of great importance to determine whether the constituents of average milk vary between certain limits, and what these limits are.

The constituents vary, and more especially the fatty matter according to age, breed, time before or after calving, the quality of the food, condition of the animal, etc. But even taking into consideration these facts, we find that nature, in its endeavor to produce a healthy food for the young, will in a great measure overcome surroundings which are most antagonistic to the production of healthy normal milk.

So much has been done to determine what the standard is, below which pure, healthy milk never falls, that we know now with absolute certainty that the variation in the constituents of average milk is between certain well-defined limits.

The following tables, prepared from analyses of many investigations, and, as will be seen, from a very large number of cows, and from all parts of the world, show most conclusively what the limit or standard of purity is:

The following table will show the result of the analyses of milk from herds in various sections of this State. All of the samples were milked in the presence of an inspector and delivered to me in the same condition as when taken from the cow:

No. of cows.	Water.	Fat.	Casein and sugar.	Salts.	Solids not fat.	Total solids.	No. of inspection and analysis.
40	87.47	3.29	8.57	0.67	9.24	12.53	D 1504
28	87.34	3.33	8.56	0.67	9.23	12.66	D 1513
10	86.98	3.62	8.72	0.68	9.40	13.02	B 2561
1	87.05	3 40	8.92	0.63	9.55	12.95	B 2526
27	87.03	3.80	8.48	0.69	9.17	12.97	D 1585
1	84.71	3.79	10.81	0.69	11.50	15.29	B 2690
10	86.85	3.58	8.89	0.68	9.57	13.15	B 2694
11	87.34	3.44	8.52	0.70	9.22	12.66	D 1595
27	86.97	3.33	8.90	0.80	9.70	13.03	D 1666
1	84.47	6.24	8.48	0.71	9.29	15.53	B 2762
24	85.82	4.80	8.66	0.72	9.38	14.18	B 2772
14	86.67	3.49	9.12	0.72	9.84	13.33	B 2788
20	86.38	4.45	8.56	0.71	9.27	13.62	E 5
20	82.10	8.31	8.80	0.79	9.59	17.90	D 1703
*31	86.19	4.64	8.40	0.77	9.17	13.81	C 1854
†31	86.88	3.90	8.45	0.77	9.22	13.12	C 1855

*Morning's milk. †Evening's milk.

If then we assume that in healthy normal cows' milk, there should be not more than 87.5 per cent of water, 3.2 per cent of fat, 9.3 per cent of solids, not fat, and 12.5 per cent of total solids, we are certainly well within the limits.

Average Specific Gravity of Milk.

This subject is of the greatest importance in connection with the inspection of milk, for having once determined this point, the detection of the adulteration of milk with water can readily be made. The many tests made to determine this point show conclusively that the specific gravity of milk from healthy cows varies between certain well-defined limits.

The following tables show the variations in the specific gravity of milk from single cows:

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
A 975	Dutch.	C.	4	2	April	4	114	12
976	H. Horn.	C.	4	2	April	4	108	20
977	Largest.	C.	7	5	April	6	103	18
978	Woman.	C.	4	2	May	6	109	18
979	Coney.	Half Ald.	8	6	April	5	105	20
980	Old Speck.	Half Ald.	10	8	May	6	102	22
981	Boney.	C.	6	4	May	7	112	16
982	Black.	C.	6	4	May	6	113	16
983	Morley.	Half Ayr.	5	3	May	4	111	16
984	Alderney.	Alderney.	6	4	May	4	111	30
985	Heifer.	C.	2	1	May	3	112	20
986	O. White.	C.	4	2	April	5	112	16
987	F. White.	C.	6	4	Feb.	4	111	20
988	Hamden.	C.	5	3	Jan.	4	110	8
989	Holstein.	Half Hol.	4	2	April	3	113	25
990	Shoem.	C.	7	5	March	6	110	25
991	Sp. Horn.	C.	7	5	May	4	112	16
Average ..	.....	.....	..	..	.....	..	110	19

Morning of August 12, 1884; Liberty, Sullivan Co.; farm of Abel Gregory; cows in herd, twenty-two; treatment, kind; housing, good; food, pasture.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent
A 992	Dutch.	C.	4	2	April	4	114	9
993	H. Horn.	C.	4	2	April	4	110	13
994	Largest.	C.	7	5	April	6	105	20
995	Woman.	C.	4	2	May	6	106	21
996	Coney.	Half Ald.	8	6	April	5	105	20
997	Old Speck.	Half Ald.	10	8	May	6	104	20
998	Boney.	C.	6	4	May	7	112	16
999	Black.	C.	6	4	May	6	106	16
1000	Morley.	Half Ayr.	5	3	May	4	108	12
1001	Alderney.	Alderney.	6	4	May	4	114	36
1002	Heifer.	C.	2	1	May	3	107	16
1003	O. White.	C.	4	2	April	5	112	17
1004	F. White.	C.	6	4	Feb.	4	111	19
1005	Hamden.	C.	5	3	Jan.	4	110	10
1006	Holstein.	Half Hol.	4	2	April	3	110	18
1007	Shoem.	C.	7	5	March	6	108	18
1008	Sp. Horn.	C.	7	5	May	4	110	12
Average ..	.....	.....	..	..	.....	..	109	17

Morning of December 3; Montgomery, Orange Co.; farm of Moses R. Shafer, 250 acres; cows in herd, forty milkers and twenty-four strippers; treatment, stabled and fed on feed named; housing, cows kept in stable, nights; well out of yard and on elevation from the yard; cow stables well ventilated, not crowded; large yard well protected from north and west winds, attached to stables; cattle look well; food, ground corn middlings and hay.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			
B 2490	1	C.	11	8	13 days.	5	110	
2491	2	C.	8	5	11 "	7	108	
2492	3	C.	4	2	2 months.	6	112	
2493	4	C.	9	7	2 "	6	110	
2494	5	C.	7	4	5 "	4	116	
2495	6	C.	7	5	3 "	5	108	
2496	7	C.	7	5	2 "	8	102	
2497	8	C.	8	6	3 "	4	104	
2498	9	C.	5	2	3 "	6	112	
2499	10	C.	5	3	5 "	4	110	
2500	11	C.	8	6	3 "	6	114	
2501	12	C.	7	5	3 "	4	108	
2502	13	C.	3	1	4 "	3	104	
2503	14	C.	5	2	2 "	5	110	
Average....	..	..	..	..	.....	..	110	

Evening of December 3; Montgomery, Orange Co; farm of Moses R. Shafer, 250 acres; cows in herd, forty milkers and twenty-four strippers; treatment, stabled and fed on feed named; housing, cows kept in stables, nights; food, ground corn middlings and hay.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2504	1	C.	11	8	13 days.	5	110	12
2505	2	C.	8	5	11 "	5	108	14
2506	3	C.	4	2	2 months.	4	110	16
2507	4	C.	9	7	2 "	4	110	16
2508	5	C.	7	4	5 "	4	114	20
2509	6	C.	7	5	3 "	4	110	16
2510	7	C.	7	5	2 "	4	102	10
2511	8	C.	8	6	3 "	3	104	12
2512	9	C.	5	2	3 "	3	112	14
2513	10	C.	5	3	5 "	3	108	12
2514	11	C.	8	6	3 "	5	112	16
2515	12	C.	7	5	3 "	3	108	10
2516	13	C.	3	1	4 "	2	104	24
2517	14	C.	5	2	2 "	5	110	16
Average	..	..	..	..	.....	..	109	15

Morning of December 3, 1884; Montgomery, Orange Co.; farm of John B. Mould, 102 acres; cows in herd, twenty-one milkers and twelve strippers; treatment, fed twice a day on feed named; housing, cows kept in stables, nights; well on elevation on the upper side of barn-yard; cows get water from this well; stables large and well ventilated; barn-yard fronting east and south, well protected from north and west winds; cattle in fine order; mostly bred on the farm; food, sprouts eight quarts and middlings three quarts and hay.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			
B 2518	Lill.	C.	9	7	6 weeks.	12	106	
2519	Nell.	C.	7	5	1 month.	12	104	
2520	Susie.	C.	4	2	2 months.	9	110	
2521	Dollie.	C.	6	4	5 "	6	114	
2522	Mary.	C.	7	5	2 "	8	104	
2523	Mollie.	C.	6	4	2 "	6	114	
Average	.....	..	..	..	.....	..	109	

Evening of December 3, 1884; Montgomery, Orange Co.; farm of John B. Mould, 102 acres; cows in herd, twenty-one milkers and twelve strippers; treatment, fed twice a day on feed named; housing, cows kept in stables, nights; food, sprouts eight quarts and middlings three quarts and hay.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2524	Lill.	C.	9	7	6 weeks.	8	106	14
2525	Nell.	C.	4	2	1 month.	4	110	14
2526	Susie.	C.	7	5	2 months.	10	104	8
2527	Mary.	C.	7	5	2 "	7	102	6
2528	Dollie.	C.	6	4	5 "	6	114	16
2529	Mollie.	C.	6	4	2 "	6	114	16
Average	.....	..	..	..	.....	..	108	13

December 4; Hamptonburgh, Orange Co.; farm of Samuel W. Eager, 200 acres; cows in herd, forty-five milkers and thirty strippers; treatment, cows are fed twice a day of the feed stated; housing, stabled nights and fed on hay; underground stables, large and well ventilated; well in stables, not been used in five years; cows get water from running brook five hundred yards from stables; large yard adjoining stables fronting south and east; cattle look well; food, corn cobs, meal and grains.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2530	1	C.	8	5	3 months.	10	118	16
2531	2	C.	6	4	6 weeks.	8	108	14
2532	3	C.	7	4	3 months.	5	110	18
2533	4	C.	10	7	4 "	6	110	16
2534	5	C.	7	5	3 "	7	108	14
2535	6	Hol.	7	5	5 "	4	120	22
2536	7	C.	8	5	3 "	9	112	31
2537	8	C.	3	1	4 "	4	116	14
2538	9	C.	7	6	3 "	5	110	14
2539	10	C.	8	6	3 "	6	112	14
2540	11	C.	7	5	3 "	5	112	16
Average	..	....	..	..	.....	..	112	17

December 5; Montgomery, Orange Co.; farm of Robert A. Fisher, seventy-six acres; cows in herd, twelve milkers and seven strippers; treatment, fed twice a day on feed named; housing, stabled nights and bad weather; Lucy of Lee, cost $250; Hatty French, cost $275; Young Rosett, cost $400; large, roomy stalls, well ventilated; cattle in very fine order, look healthy; food, corn on cobs, oats ground, cotton seed meal.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2541	Lucy of Lee.	Ald.	6	4	6 months.	3	118	20
2542	Hatty French.	Ald.	3	2	4 "	4	110	22
2543	Young Rosett.	Ald.	3	2	7 "	6	112	28
2544	Alphenia.....	Ald.	6	4	8 "	4	106	42
Average	.....	....	..	..	.....	..	113	28

December 6; Montgomery, Orange Co.; farm of Thomas Wait, 245 acres; cows in herd, fifty-six strippers and forty-one milkers; treatment, fed twice a day on feed stated; housing, stabled nights and cold and wet days; has cows that have been fed grains for fifteen years and are healthy now; stables partly underground, well ventilated; cattle get water from spring outside of barn-yard; cattle look well and appear healthy; food, middlings and grains.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2545	1	C.	12		3 weeks.	6	112	18
2546	2	C.	9		4 months.	4	118	12
2547	3	C.	7		2 "	6	118	10
2548	4	C.	15		½ "	4	110	10
2549	5	C.	12		1 "	5	116	28
2550	6	C.	10		10 days.	5	114	16
2551	7	C.	7		2 months.	6	108	10
2552	8	C.	10		3 "	5	112	14
2553	9	C.	6		1 "	4	114	20
2554	10	C.	9		4 "	4	104	8
2555	11	C.	12		6 "	3	110	8
2556	12	C.	16		10 days.	5	114	14
2557	13	C.	7		2 months.	4	112	12
2558	14	C.	7		3 "	4	110	8
2559	15	C.	7		3 "	3	118	18
Average	..	..	..		.....	..	114	13

December 6; Montgomery, Orange Co.; farm of J. Egan; cow in herd, one; treatment, fed twice a day, four quarts; housing, stabled nights; food, wheat, middlings and hay each day.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2560	Dasie.	Ald.	4	3	7 months.	5	114	32

December 9, 1884; Hamptonburgh, Orange Co.; farm of R. J. McVoy, 219 acres; cows in herd, forty-three milkers and thirty-nine strippers; treatment, fed on hay and feed named; housing, stabled nights and rainy days; large, airy stables underground; no well in stables or yard; cows young, large, fine condition; food, grains and corn ground, four quarts grain and three quarts meal.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2562	1	C.	5	3	2 months.	8	114	14
2563	2	C.	6	4	20 days.	10	112	22
2564	3	C.	11	9	1 month.	8	118	12
2565	4	C.	5	3	3 "	6	110	18
2566	5	C.	5	3	1 "	10	104	22
2567	6	C.	6	4	2 "	8	110	20
2568	7	C.	5	3	3 "	6	110	14
2569	8	C.	5	3	3 "	9	108	16
2570	9	C.	6	4	1 "	9	112	14
2571	10	C.	6	4	2 "	6	110	22
2572	11	C.	6	3	1 "	10	112	12
2573	12	Aysh.	3	2	2 "	8	108	14
2574	13	C.	3	2	2 "	5	114	14
2575	14	C.	6	4	3 "	7	116	18
2576	15	Dutch.	8	5	5 "	7	106	20
2577	16	C.	3	1	2 "	5	108	14
2578	17	C.	8	5	2 "	7	110	10
2579	18	C.	8	6	1 "	6	114	16
2580	19	C.	10	7	1 "	5	118	14
2581	20	C.	6	4	3 "	7	110	10
2582	21	C.	9	7	3 "	6	108	24
2583	22	C.	8	..	3 "	4	110	20
Average ..	..	.....	..	..	.....	..	110	15

December 10, 1884; Crawford, Orange Co.; farm of John McKornachan, 110 acres; cows in herd, seventeen milkers and twelve strippers; treatment, fed on hay and corn fodder; housing, stabled nights and rainy days; good buildings on gentle slope; well under barn not affected by drainage from yard; cows in good condition and look healthy; stable above ground; food, wheat, bran and middlings, ten quarts per day.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2585	1	C.	10	7	1 month.	6	110	20
2586	2	C.	7	5	3 "	3	108	18
2587	3	C.	12	9	2 "	6	102	14
2588	4	C.	6	4	4 "	3	104	22
2589	5	C.	5	3	2 "	5	106	20
2590	6	C.	4	2	2 "	4	110	18
2591	7	C.	12	4	3 "	4	104	20
2592	8	C.	9	6	1½ "	6	102	16
2593	9	C.	6	6	1½ "	5	104	14
Average ..	..	..	..	..	.....	..	106	18

December 13, 1884; Montgomery, Orange Co.; farm of S. J. Morris, ninety acres; cows in herd, twenty milkers and eight strippers; treatment, fed on hay and feed named; housing, stabled nights and rainy days; good stables, well ventilated; stables above ground; yard adjoining stables well protected from north and west winds; well out of cow-yard; cattle look well and healthy; food, wheat, cotton seed meal.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2688	1	C.	8	6	1 month.	8	114	12
2689	2	C.	8	5	3 "	4	118	14
2690	3	C.	6	4	3 "	5	128	20
2691	4	C.	7	5	3 "	6	110	22
2692	5	C.	5	3	3 "	5	116	24
2693	6	C.	7	4	2 "	5	114	22
Av. 2694	..	..	..	..	.....	..	114	20

December 16, 1884; Montgomery, Orange county; farm of Abner Bookstaver, 180 acres; cows in herd, twenty milkers, fifteen strippers; treatment, fed on hay and feed named; housing, stabled nights and rainy days; stables above ground, well ventilated; water brought to yard by wind-mill; cattle look well; food, grains and corn meal ground.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2695	Sleepy Beet.	C.	12	..	2 months.	7	108	12
2696	Bodine.	C.	11	..	7 "	5	114	16
2697	Wooley.	C.	11	..	5 "	5	112	14
2698	Cherry.	C.	5	..	4 "	6	114	22
2699	O. Brindle.	C.	8	..	2 "	6	116	12
2700	Spud.	C.	6	4	4 "	5	120	20
2701	O. Black.	C.	8	..	1 "	8	110	10
2702	N. Brindle.	C.	5	..	1 "	6	110	14
2703	Spot.	C.	9	..	4 "	4	112	10
2704	G. Black.	C.	5	..	2 "	5	116	14
2705	Wide Horn.	C.	7	..	3 "	5	118	16
2706	Browne.	C.	5	..	5 "	6	110	22
2707	Red Heifer.	C.	5	..	5 "	4	108	18
2708	White.	C.	6	..	2 "	4	114	18
2709	Spotted.	C.	4	..	3 "	5	116	14
2710	Sue.	C.	7	..	3 "	4	112	16
2711	Blue.	C.	10	..	4 "	4	112	16
Av. 2712	.....	..	..	..	.....	..	112	18

December 17, 1884; Montgomery, Orange county; farm of W. E. Hasbrouck, 300 acres; cows in herd, forty milkers, twenty-one strippers; treatment, fed on corn stalks, on feed named; housing, stabled nights and rainy days; stables above ground; no well in yard; cattle look fair; food, corn, ground, bran and grain.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2713	Yellow.	C.	4	2	3 months.	4	112	16
2714	White Face.	H.	4	2	4 "	4	110	14
2715	Olley.	C.	12	..	5 "	3	110	16
2716	Peggy.	C.	9	6	1 "	7	112	26
2717	Blind.	C.	12	..	4 "	3	104	10
2718	Reed.	C.	6	4	4 "	4	112	8
2719	Bates.	C.	8	5	5 "	4	120	26
2720	Topsy.	C.	5	3	2 "	5	110	12
2721	Boss.	C.	6	3	1 "	5	104	12
2722	Baby.	C.	5	3	2 "	6	106	14
2723	Betsy.	C.	12	..	1 "	6	108	12
2724	Brindle.	C.	9	6	2 "	6	110	8
2725	Sarah B.	C.	4	2	2 "	5	112	12
2726	Dine.	C.	11	8	3 "	5	106	10
2727	Dolly.	C.	7	5	2 "	5	114	14
2728	White.	C.	8	6	2 "	6	104	8
2729	Lucy.	C.	4	2	2 "	3	106	8
2730	Sally.	C.	7	5	3 "	4	114	12
2731	Rosie.	C.	9	6	3 "	4	110	16
2732	Susie.	C.	5	3	2 "	3	108	14
Av. 2733	.....	..	..	..	.....	..	108	16

December 19, 1884; Montgomery, Orange Co.; farm, John I. Van Kensen, 107 acres; cows in herd, twenty-four milkers, nineteen strippers; treatment, fed on hay and feed named; housing, stabled nights and cold weather; stables above ground, large and well ventilated; no well in yard, cattle get water from spring in adjoining lot; cattle look well; food, cotton seed, meal and wheat bran.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of time calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
B 2752	Brindle.	C.	7	....	5 months.	5	108	18
2753	Black.	C.	4	....	4 "	5	108	20
2754	Kent.	C.	4	....	2 "	7	110	20
2755	Ashton.	C.	6	....	4 "	6	106	22
2756	Yellow.	C.	12	....	1 "	7	112	14
2757	Buffalo.	C.	10	....	3 "	6	108	26
2758	Hasbrouck.	C.	4	....	2 "	7	110	14
2759	Little Red.	C.	14	....	2 "	7	104	24
2760	Fool.	C.	6	....	1 "	8	102	14
2761	George.	C.	8	....	5 "	3	114	12
2762	Jumbo.	C.	8	....	3 "	9	100	34
2763	Line Back.	C.	8	....	3 "	5	110	18
2764	Jen.	Ald.	5	....	6 "	5	118	42
2765	Cristy.	C.	6	...	5 "	4	112	12
2766	Cat Bird.	C.	4	....	4 "	6	120	18
2767	Susie.	C.	5	....	2 "	6	114	16
2768	Lill.	C.	6	....	2 "	7	110	18
2769	Shafer.	C.	8	....	3 "	5	110	20
2770	Mary.	C.	9	....	"	6	112	16
2771	Nell.	C.	7	....	2 "	6	112	20
Av. 2772	.....	....	..	....	.....	..	110	20

January 5 and 6, 1885; Hamden, Delaware Co.; farm, A. Shaw; cows in herd, fifty; treatment, ground millett, oats, etc.; housing, wheat middlings, equal parts; food, four quarts each after hay in the morning.

	No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
				yrs.		1884.			per cent.
C	1866	Lucy.	N.	5	3	Oct.	8	110	13
	1867	Betsey.	N.	11	8	Oct.	7	112	14
	1868	Nancy.	N.	6	4	Oct.	5	109	11
	1869	Alderney.	A.	8	6	May.	3	120	23
	1870	Loombs.	N.	9	7	Oct.	6	119	21
	1871	Mate.	N.	11	9	June.	4	120	22
	1872	Hurlbert.	N.	7	5	Nov.	7	120	23
	1873	Meg.	N.	10	8	June.	4	114	17
	1874	Pease.	N.	5	3	Nov.	7	112	13
	1875	Fan.	N.	5	3	Oct.	7	116	18
	1876	Star.	N.	5	3	Oct.	7	113	14
	1877	Spot.	N.	10	7	Oct.	9	119	22
	1878	Maud.	N.	7	5	Oct.	6	110	12
	1879	Spec.	N.	8	6	Oct.	5	108	11
	1880	Lily.	N.	8	6	Oct.	6	114	12
	1881	Nell.	N.	6	4	Oct.	7	116	17
	1882	White.	N.	8	6	Oct.	5	112	10
	1883	Average Morning's Milk						117	21
	1884	Average Evening's Milk						113	17

A. Shaw has kept an average of thirty-five cows for twenty years, and has had only two abort in that time.

Afternoon of December 2, 1884; New Windsor; farm of James W. Morrison, Glensmere; cows in herd, forty; treatment, curried once and fed three times per day; housing, stabled; food, wheat, bran, meal and hay.

	No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
				yrs.		1884.			per cent.
D	1489	Sherman.	C.	4	2	Oct. 1.	8	110	14
	1490	Clara.	Jersey.	5	3	Sept.	10	112	14
	1491	Lila.	A. G.	6	4	Sept.	10	108	
	1492	Susie.	D. G.	6	4	Oct.	11	108	
	1493	Ferry.	G. D.	4	2	Oct.	8	110	
	1494	Beauty.	D. G.	6	4	Oct.	10	106	14
	1495	Blossom.	G. A.	7	5	Aug.	10	108	
	1496	Rosa.	G. J.	3	1	June	8	110	17
	1497	Maud.	G. D.	7	5	July	12	106	16
	1498	Hattie.	G. A.	6	4	Aug.	10	106	16
	1499	Vail No. 6.	D.	7	5	Oct.	10	108	14
	1500	Vail No. 8.	G. D	8	6	Sept	10	106	15
	1501	Vail No. 1	D.	6	4	Sept.	9	105	
	1502	Vail No. 2.	D.	7	5	Oct.	9	107	
	1503	Vail No. 3.	D.	7	5	Oct.	9½	106	
	1504 Av.	.....	... ..	..	..	... ..	..	108	

Evening of December 4, 1884; Walkill; farm of A. Crans; cows in herd, twenty-seven; treatment, ordinary; housing, stabled; food, bran, corn, meal and hay.

	No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
				yrs.		1884.			per cent.
D	1505	Jennie.	C.	10	8	March	8	104	13
	1506	Stierre.	G. D.	6	4	June	8	100	13
	1507	Cherry.	C.	6	4	Aug.	5	112	14
	1508	Deer.	C.	7	5	Sept.	3	112	
						1883.			
	1509	Reck.	C.	10	8	Feb.	4	113	12
	1510	Brindle.	C.	9	7	July	8	108	
	1511	White.	G. H. G.	6	4	Sept.	10	106	14
	1512	Pet.	C.	7	5	April	6	101	14
	1513 Av.	.....	.....	..	..	.....	..	106	14

Evening of December 11, 1884; Walkill; farm of S. M. Slaughter; cows in herd, twenty-seven; treatment, ordinary; housing, stabled; food, cotton seed meal and hay.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
D 1576	No. 1.	Aysh.	5	3	April	8	112	18
1577	Lidy.	Aysh.	4	2	Oct.	7	102	20
1578	No. 2.	Aysh.	4	2	March	8	104	22
1579	Mat.	Aysh.	6	4	May	8	100	12
1580	Sally.	Aysh.	5	3	July	9	104	32
1581	Strawb'y.	Aysh.	6	4	Aug.	8	106	18
1582	Short.	O. G.	8	6	Oct.	12	102	20
1583	Sue.	O. G.	8	5	Sept.	8	110	
1584	Jane.	C.	10	8	Sept.	10	111	14
1585 Av.	.....	.....	..	..	.....	..	104	13

Evening of December 13, 1884; Hamptonburgh; farm of Frank Slaughter; cows in herd, eleven; treatment, ordinary; housing, stabled; food, bran and corn meal.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs.		1884.			per cent.
D 1586	No. 1.	Durham.	6	4	Dec.	10	120	24
1587	No. 2.	Durham.	5	3	Nov.	8	110	14
1588	No. 3.	Durham.	5	3	Oct.	18	101	22
1589	No. 4.	Durham.	4	2	Nov.	8	106	14
1590	No. 5.	Durham.	5	3	June	8	110	22
1591	No. 6.	Durham.	6	4	April	2½	108	16
1592	No. 7.	G.	6	4	April	4	102	6
1593	No. 8.	G. D.	2	1	March	3	104	16
1594	No. 9.	Durham.	7	4	Apr., '83.	3	104	
1595 Av.	.....	.....	..	..	.....	..	108	13

Evening of December 18, 1884; Hamptonburgh; farm of James H. Jackson; cows in herd, seventy-seven; treatment, ordinary; housing, stabled; food, grains and ensilage.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream
			yrs.		1884.			per cent.
D 1655	No. 1.	G. D.	4	2	Aug.	4	106	10
1656	No. 2.	C.	7	4	Sept.	5	108	22
1657	No. 3.	G. D.	4	2	Sept.	5	101	20
1658	No. 4.	C.	12	10	Oct.	7	100	18
1659	No. 5.	C.	12	10	Oct.	5	102	
1660	No. 6.	C.	10	8	Oct.	9	107	20
1661	No. 7.	C.	12	10	Aug.	6	104	18
1662	No. 8.	C.	9	7	Sept.	5	105	18
1663	No. 9.	C.	8	6	June	10	106	24
1664	No. 10.	C.	7	5	Feb.	2	108	
1665	No. 11.	C.	8	6	Oct.	5	105	22
1666 Av.	.....	.. ...	..	..	.....	..	106	13

The average lactometric standing of all the milk as given, the result of testing some 20,000 specimens is 110° at 60°=1.0319. If, then, the average specific gravity of milk is placed at 1.029 it certainly is at its lowest possible limits.

UNHEALTHY MILKS.

Abnormal Milk.

By this is meant milk differing from the natural secretion in regard to the proportions of its constituents, or having an unusual odor, taste or appearance, while the animal producing it is in a perfect state of health.

Instances of healthy cows giving milk differing as regards the proportions of its constituents from the average milk are but few.

Pattison gives the following analysis of milk from a healthy cow. The milk had a decided salty taste: Water, 90.15; fat, 3.00; casein, 2.00; sugar, 3.90; ash, 0.95; sodium chloride (common salt) in ash, .44.

I recently analyzed a sample of milk taken from a heifer before she had had connection with a bull, with the following results: Water, 94.68; fat, .75; casein and albumen, 3.00; sugar, 1.06; salts, .50.

This last fact is a peculiar one, but it is well known that even many male animals secrete milk. The newly-born infant nearly always secretes a fluid in the mammæ.

Humboldt mentions the case of a man whom he saw, and upon carefully investigating the case found that he secreted enough milk or nutrient fluid to support his infant son for some months. ("Humboldt, Voyage aux Regions Equinoxiales du Nouveau Continent.")

Robert, Bishop of Cork, wrote a letter concerning a man who gave suck to a child. (Phil. Trans. 1741, No. 461, vol. XLI, p. 813.)

The following persons also speak of this: Franklyn, Narrative of a Journey to the Shores of the Polar Sea, 1819, p. 157. Cobbold, Milk from Male Mamma, Monthly Journal of Medical Science, 1854, vol. XVIII, p. 271. Morgagni (Adversaria Anatomica Omnia V. Animadversio, p. 31).

The following analysis of milk taken from the breast of a newly-born infant may be of interest:

Water	95.705
Fat	1.456
Sugar	0.956
Casein	0.557
Albumen	0.490
Salts	0.826
Total solids	4.295

—(From Jahrb. F. Kinderkrankheiten N. F. Bd. IX, S. 160.)

In the Recherchès sur le Lait. III Bruxelle, 1856, is recorded the case of an old lady of seventy-five years of age, who suckled her grandchild.

Jolly and Filhol record a case of milk taken from a bitch who had had no connection with a male: Water, 71.00; fat, 2.20; sugar, 0.32; casein and albumen, 23.20. The specific gravity was 1.069 at 60° Fahr.

The ash or salts were analyzed, and gave: Chloride of sodium, 65.10; chloride of potassium, 3.88; phosphate of lime, 27.75; phosphate of soda, 1.40; carbonate of soda, 1.87.

In the Annalen der Chemie u Pharmacie, 1844, Schlossberger gives the following analysis of milk taken from a he goat: Water, 61.30, fat, 26.50; casein and salts, 9.60; sugar and salts, 2.60.

Plants will impart an odor, taste and color to milk.

The following list are said to impart a peculiar color to milk, after being eaten by cows:

1st. Reddish —

Botanical name.	Common name.
Galium verum.	E. Yellow bedstraw.
Rubium tinctorum.	E. Madder.
Carex.	Sedge.
Scirpus.	Sedge.
Equisteum.	Scouring rush
Ranunculus.	Buttercup.
Euphorbia.	Spurge.

Botanical name.	Common name.
2d. Yellowish —	
Dancus carota.	Wild carrot.
Rheum palmatum.	E. Rhubarb.
3d. Blueish —	
Anchusa tinctoria.	E. Alkault.
Butomus umbellatus.	E. Water violet.
Melampyrum arrense.	E. Purple cow wheat.
Mercurialis perennis.	E. Perennial mercury.
Polygonum aviculare.	Common knot grass.
Fagopyrum esculentum.	Buckwheat.
Rhinanthus crista galli.	E. Yellow rattle.

E. more generally found in Europe.

Many plants do impart a decided taste and odor to milk. The following is a list:

Botanical name.	Common name.
Allium ursinum.	E. Ramsons.
Artemisia absinthium.	Wormwood.
Raphamus raphanistrum.	Rape.
Euphorbia cyparissias.	Cypress spurge.
Gratiola officinalis.	E. Hedge hyssop.
Helleborus niger.	Black hellebore.
Matricaria chamomilla.	German chamomile.

Wild onions will impart a very strong odor to the milk as well as a taste; this fact is undoubtedly familiar to all.

Various kinds of unhealthy foods will produce milk not only abnormal in the proportions of its constituents, but in its reactions, and such milk must be considered unhealthy, although produced by an apparently healthy animal.

As for instance, the use of distillery swill. A case where the use of such milk was followed by the death of the child to whom it was given, is shown here by the following letter from Dr. Bartley:

BROOKLYN, *February* 6, 1884.

EDWARD W. MARTIN:

DEAR SIR — Your card is received. The following is a copy of the record of the autopsy filed in the county clerk's office, of the child you refer to: I made an autopsy on the body of Stanlie F. Heyden, of No. 281 Bergen street, August 1, 1882. I found the stomach exceedingly soft and delicate, and filled with coagulated milk, forming quite a firm lump over three inches in diameter. The stomach was also reddened. The intestines were very pale and entirely bloodless, and contained a pale, slimy material characteristic of inflammation. The membrane of the intestines was also closely studded with little whitish specks, which were enlarged glands. All the other organs of the body were normal, except the marked paleness. In my opinion death resulted from exhaustion; (collapse)

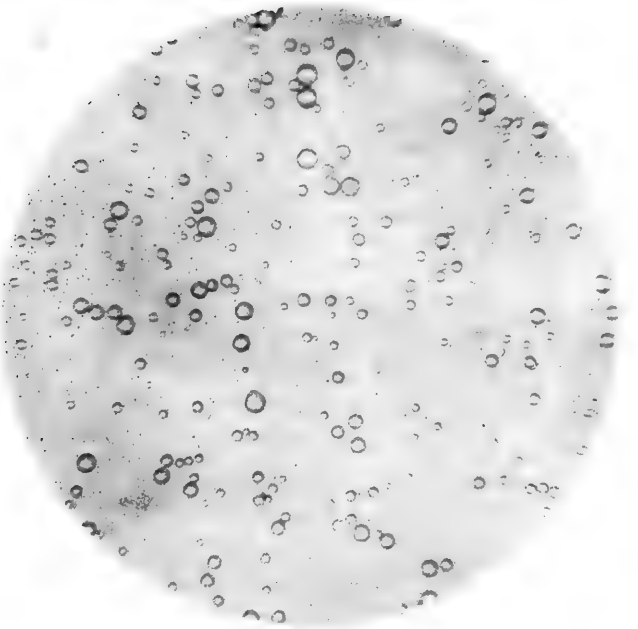


FIG. 1. SKIMMED COW'S MILK. X 420.

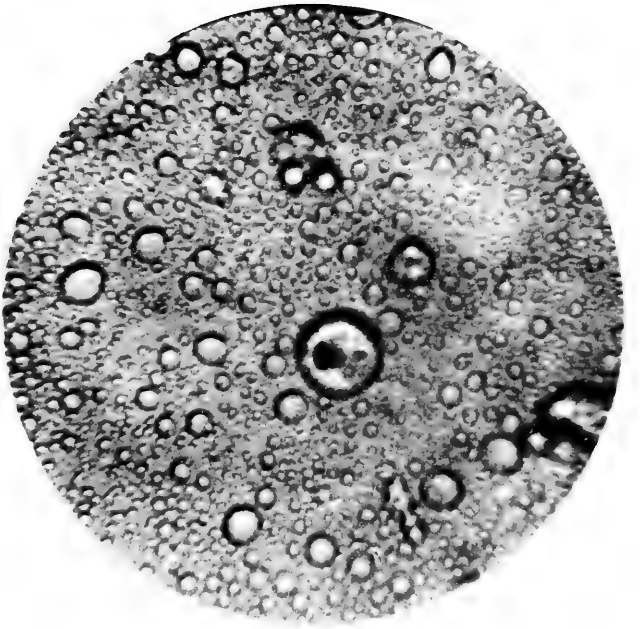


FIG. 2. COLOSTRUM IN COW'S MILK. X 420.

due to gastro-entro-colitis; augmented by the presence in the stomach of the firm clot of coagulated milk, which was too firm for the child to vomit up or pass down into the gut, and therefore acted as a foreign body and irritant.

(Signed) A. H. P. LEUF, M. D.

Appended, I find the mother's statement as follows: "I am the mother of the child. He was four months old. He took sick on the same day, and we went to the druggist and got some medicine. The child died soon afterward. We sent for Dr. Bartley, but he arrived just after the child died. He was fed on one cow's milk."

The mother gave me some of the milk, which, on analysis, I believed to be "swill" milk, and the man when accused of it, at first denied it, but afterward admitted that he "fed grains." The curd formed from the milk was exceedingly tough, and could be shaken to pieces with difficulty. This was especially seen in the estimation of the fat with the lactobutyrometer; after adding ether, it required very long shaking to break up the clots of casein. The fat was deficient in quantity. The curd very abundant. The specific gravity 1.030. Sugar not estimated.

Hoping this will be satisfactory, I am,

Very truly yours,

E. H. BARTLEY.

The analysis of this milk was made by Dr. Bartley, with the following results: Water, 89.46; fat, 2.03; sugar, 2.83; casein and salts, 5.74.

As has been before stated, abnormal milk should be considered unwholesome, even if the animal is not suffering with any disease, because the more abnormal the milk the greater is the difference between it and human milk.

There is only one period at which a healthy cow will secrete unhealthy milk, and that is after the birth of the calf. Such milk contains colostrum (see Fig. 2, plate 2), and such milk taken by the young or by invalids might produce very harmful results.

The colostrum is in the milk at that time for the purpose of purging the calf, and its results on the young or sickly can readily be imagined.

The lacteal gland in its healthy, normal condition is a very sensitive organ, affected by every change in the general health of the system. It is, therefore, not surprising that the quality and quantity of the milk should be greatly influenced by a general unhealthy condition of the system as well as by some local disturbance in the gland. In one case indigestion has the effect of causing milk to become stringy either immediately or after some time, and it is to coagulate. In another case the same cause increases the tendency of the milk to become sour and to coagulate. Blue and yellow milk have been perplexing phenomena for many years. It is due to a peculiar decomposition of the casein, brought about by

digestive disturbances. Red milk is also frequently a symptom of disease, caused by the decomposition of the blood, the coloring material of which is absorbed by the capillaries and carried into the milk glands.

Watery milk contains a large amount of water, a small amount of total solids, especially fat, it yields but little cream, and has an abnormal specific gravity of 1.027 to 1.029. Milk of this kind is characteristic of cows whose digestive organs are naturally weak, or which have been weakened by unwholesome food and by bad treatment.

Sour milk. In dairies where cleanliness is the rule and the general health of the cows good, it sometimes occurs that the milk will coagulate after standing a short time. This trouble is met with in the summer if the cows are kept in a crowded condition, and is apparently caused by the weakening effect of heat on the general system, and especially on the digestive organs. In airy, well-ventilated stables the trouble is due to indigestion affecting some of the cows, and can be remedied by regulating the diet or by medicine. The milk, however, can be prevented from souring if it is cooled at once with ice water. It is usually considered necessary to allow at least 1,000 cubic feet of air space to each cow.

Blue milk. As has been said before, it is a well-known fact that some plants if eaten by cows will impart a color to the milk. "Blue milk," however, is not colored in this way. When freshly milked it does not betray its abnormal character, and it is only after standing for twenty-four to seventy-two hours at a temperature of 70° Fahr. that the cream which will have risen begins to turn yellow, and scattered through it are numerous indigo-blue, orange or red specks of the size of a pin's head. The blue specks soon begin to enlarge, and at the end of six to eight hours are an inch or more in diameter. The orange and red spots grow more slowly. The blue spots soon cease to grow, and on careful examination they are found to be covered with fungi. With the aid of the microscope, however, numerous vibrio and monads can be distinguished before the growth of the spots cease.

It is believed that this peculiar blue milk owes its color to the presence of aniline blue — tri-phenyl-ros-aniline $C_{20}H_{16}(C_6H_5)_3N_3$— which has been produced by a curious decomposition of the casein. Haubner has shown that of the other constituents of the milk the sugar alone assists indirectly in the formation of this color by being converted into lactic acid. This acid precipitates the casein, which, while in solution, could not produce aniline blue. When an excess of lactic acid has been formed it acts on the casein, rendering it more compact, and thus checking the formation of the coloring material. Haubner also has demonstrated that this phenomenon is accompanied with the formation of an alkali, and this explains why the color gradually turns yellow, why the coagulum maintains a soft consistency for a long time, and why a small portion of the casein is re-dissolved.

"Blue milk" does impart this fungoid growth to healthy milk by the blue portions of the abnormal milk. Blue cream communicates the color readily, serum slowly, while buttermilk will not communicate it at all. The germ will remain active for weeks, even in water. Hence the necessity of being very careful with water which has been used to clean vessels in which blue milk was contained. It is injurious to the health of those who drink it. It churns with great difficulty, and the butter has a bad taste and odor.

It is generally believed that this germ only occurs when the condition of the milk is specially favorable to it. This condition is brought about by digestive disturbances, as is shown by the fact that a regulation of the diet of cows affected with it is an immediate remedy. Should the disease affect a whole dairy the utensils and the stable must be thoroughly disinfected by means of burning sulphur (about half a pound to each cubic yard of capacity), keeping all the doors and windows closed for four to five hours. Pails should be scoured with water containing chloride of lime, and clothes washed with strong lye. If it is true that the milk cannot turn "blue" until casein begins to separate out, it is advisable to cool the milk immediately, and to keep it cool while the cream rises, and removing the latter before the milk turns sour.

Stringy milk is so called because it runs in strings when poured from one vessel to another. A large percentage of albumen seems to be characteristic of this variety of abnormal milk. It may be stringy as it comes out of the udder, or it may become stringy after standing a short time. It churns with difficulty, and this property can easily be communicated to normal milk.

The cause of this is also to be found in digestive disturbances, brought on by a cold, or bad treatment and reckless feeding.

In Norway and Sweden, milk is made stringy to preserve it. This is effected by means of a plant known as Pinguicula vulgaris. But since stringy milk thus prepared will keep for months, there must be a difference in the constitution of this milk and the abnormal variety above described.

Sandy milk contains small, solid particles of the size of grains of sand, which frequently obstruct the milk channels in the tit. Fuerstenberg, who has studied this disease most carefully, distinguishes three varieties of milk stones, viz., milk stones proper, pseudo-milk stones and concrements.

Milk stones proper consist of a solid granule, around which salts are deposited in concentric layers. They weigh from 0.01 to 1.72 grams, and have specific gravity of 2.186. Their chemical composition is as follows, omitting traces of alkalies, magnesia and oxide of iron:

Water	1.00 per cent.
Fat	1.11 "
Phosphate	1.95 "
Organic	4.27 "
Carbonate of lime	91.67 "

Casein forms the cementing material of these stones.

Pseudo milk stones have the same external appearance as milk stones proper. They do not, however, have a nucleus of salts but of casein, which is surrounded by a salt crust.

Concrements are amorphous masses, the salts are not arranged in layers, and they contain a large amount of organic matter. Their composition is as follows:

Fat	2.69	per cent.
Water, traces of alkalies and oxide of iron	5.33	"
Carbonate of lime	17.45	"
Organic	18.55	"
Phosphate of lime and magnesia	59.98	"

From these analyses, which show the milk stones to consist largely of mineral matter, specially carbonate of lime, it can be inferred that they are the result of introducing large quantities of mineral matter into the system. This may either be contained in the food or in the water. If the milk charged with mineral matter deposits some of its salts in the udder in the form of a fine precipitate, a large part of the latter will pass out in milking, but some will remain in the recesses of the udder. Here they enlarge by concentric growth, and finally, either by their own weight or otherwise, they find their way into the milk channels.

As for the pseudo and the concrements, some casein must separate out of milk in the udder, in addition to large quantities of mineral matter.

Whether the milk stones are due to an excess of lime salts derived from the food, or whether they are abnormally concentrated in the milk, at the expense of the bony structure of the cow, is not known.

It frequently occurs that cream churns with great difficulty, and it is often the case that the churn is finally filled with froth, having a bad taste and odor. It cannot be denied that this is sometimes due to the decomposed food, which has been given to the cattle. It has also been observed that when healthy normal milk is mixed with milk containing colostrum, or with the milk of pregnant cows, or of old milkers, a cream will be produced which churns with difficulty. In the majority of cases, however, the trouble arises from a laxity in the management of the dairy. Either the utensils have not been thoroughly scoured or the milk or cream has been allowed to stand too long before churning.

Bitter milk. Old milkers frequently give milk which has a bitter taste. The milk glands of such cows are gradually losing their activity, and it is quite natural that they should fail to produce normal milk.

Bitter milk gives rise to serious troubles, for it imparts its taste to all its products, as cream, cheese and butter. Immediately after milking, nothing suspicious can be noticed, but after standing a

short time the abnormal taste is developed, fat separates out and bubbles of gas are noticed to rise in the milk. Nothing definite is known about this difficulty, though it never occurs in dairies where cleanliness is strictly practiced. The presence of bubbles of gas indicates decomposition, and it may be that this abnormal milk is only a variety of *milk which decomposes rapidly.*

This milk possesses the abnormal property of beginning to decompose after standing twenty-four to forty-eight hours. The layer of cream is decolorized and broken by the rising of bubbles of gas, it emits an odor of rotten eggs and the coagulum presents a loose, slimy, abnormal consistency.

Want of cleanliness, together with carelessness in the management of the dairy, are the only causes of this premature decomposition. In well-constructed dairies, well ventilated and clear, neither this nor the preceding abnormal condition of the milk will occur.

Red milk may be due either to the coloring material of certain plants which the cow may have eaten or to the presence of blood. The latter occurs when the udder is diseased or injured and the blood finds its way into the milk glands. On standing for some time a heavy sediment is formed in the milk. The secretion of bloody milk may also be due to some disease of the kidneys.

Unhealthy milk may be divided into two classes.

First. Unhealthy because secreted by an unhealthy cow.

Second. By the absorption of disease from the atmosphere or by becoming contaminated from the addition of impure water, etc.

Unhealthy Because Secreted by an Unhealthy Cow.

Much has been written on this subject, and a great diversity of opinion, in regard to what diseases cause the milk to become unhealthy, exists. It is, however, much better to prohibit the sale or use of milk taken from an unhealthy cow, no matter whether such doubt exists or not, because so little has been done or can be done in the way of absolutely proving this fact.

Chemical analysis, beyond showing that the milk is abnormal, can do but little. All it can do is to show the proportions of the constituents and not what is really the cause of the transmission of disease.

To illustrate: A physician gives a dose of castor oil, should he consider it necessary, for the infant; not to the infant but to the mother, and chemical analysis will fail to detect any of the properties of the medicine in the milk; and the same way with a large number of drugs of vegetable origin.

A case came under my notice, where strychnine, administered to a nursing mother, caused involuntary twitching of the muscles of the child before the mother was in the slightest degree affected.

Turnips, onions and a host of other vegetables or plants, will produce their characteristic odor in the milk. Again, some plants impart a color to the milk, others a peculiar taste. (See "Abnormal milk.") And yet chemical analysis fails to detect the active principles which produce these effects.

In connection with the effect of drugs or poisons upon milk the following very interesting fact came under my notice:

A farmer in Delaware county had a number of his cows poisoned with arsenic, during the month of October, 1884. Some of the cows died, others recovered. I examined the stomach of one of the cows that died and found large quantities of arsenic present. I also obtained some of the milk taken from one of the herd, who had partly recovered, and could not discover even the slightest trace of arsenic in this milk.

The milk was taken from the cow thirty days after she had been poisoned. An analysis of the milk from one of the cows who recovered, but was still very sick, was made as well as the average of the herd, with the following result:

	C. 1781 sick cow.	C. 1782 average.
Water	82.62	85.44
Fat	5.37	4.66
Sugar casein	11.21	9.24
Salts	0.80	0.76
Specific gravity		

An inspection was made of the milk from each cow by Mr. Spence, with the following result:

It will be observed that the effect of the arsenic was to increase the per cent of fat.

December 15, 1884; Hamden, Delaware Co.; farm, Kelley, George W. Kelly; cows in herd, twenty-one milkers; treatment, yard open square surrounded; housing, by sheds and buildings; food, millet and oats ground.

No. of inspection.	Name of cow.	Breed.	Age of cow.	No. of times calved.	Time of last calving.	No. of quarts given.	Lactometer at 60° Fahr.	Cream.
			yrs		1884.			per cent.
C 1783	Brindle.	C.	7	5	March	3	106	17
1784	Jennie.	C.	10	7	March	4	109	18
1785	Fannie.	C.	10	7	March	3	112	14
1786	Lib.	C.	11	7	March	3	107	20
1787	Spunk.	C.	8	6	March	4	110	16
1788	White Heifer.	C.	5	3	March	4	110	14

Pleuro-pneumonia is a disease which has long been known in this country, and much discussion has ensued as to whether milk drawn from cows so affected is capable of transmitting such disease or some modification of it to human beings.

I have had the fact stated to me by men of undoubted reputation, that they have drank milk drawn from cows suffering with pleuro-pneumonia, with impunity.

But as I have said before, so little has been done in the way of experiment on mankind and particularly on infants, that probably no data can be had from which to draw absolute conclusions. And again, whether the milk as drawn from the cow is contaminated or whether it absorbs such contaminations from the air, remains in many instances cited, yet to be solved.

J. Blake White made the following analysis of milk from cows suffering with pleuro-pneumonia:

	Cow No. 1.	Cow No. 2.
Water	89.80	89.18
Fat	1.18	1.30
Sugar	4.20	4.50
Casein	4.16	4.30
Salts	0.66	0.64

Many experiments have been made as to the transmission of tubercular diseases by milk; sometimes the results are positive, sometimes negative.

Blythe says: A disease similar, if not identical with tuberculosis, may be propagated from animal to animal by means of milk derived from a diseased cow.

That, therefore, such milk should not be used for human consumption. That nothing definite is known with regard to the propagation of tubercule from the lower animals to man.

Husson says in speaking of milk from cows having contagious typhus, "that although the milk cannot transmit the typhus to man, still it should not be given to young children, even before the disease has produced a decrease in the flow, in consequence of a change in its constitution, which is at the outset of the disease, a decrease in the carbonaceous elements (fat and sugar), and an increase in the nitrogenous elements (albumen and casein)."

II.

By Absorption of Disease from the Atmosphere, or by becoming Contaminated from the addition of Impure Water, etc.

There is no doubt, under this head, as to the effects from the use of such milk. And the ease with which milk can and does become contaminated will be shown.

Mr. Ernest Hart, of London, in an article read by him before the International Medicine Congress in 1881, sums up as follows:

"The number of epidemics of typhoid fever, recorded in the abstract as due to milk, is fifty; scarletina, fifteen; of diphtheria,

seven. The total number of cases occurring during epidemics traced to the use of infected milk may be reckoned in round numbers as 3,500 of typhoid fever, 800 of scarlet fever, and 500 of diphtheria. When it is remembered that it was only ten years ago we were utterly ignorant of milk being a carrier of infection, and that consequently these epidemics have all occurred within one short decade, it will be seen how vitally important is the safeguarding of our milk supplies from contamination.

In the *Lancet* for October, 1883 (No. 88, p. 652), records an epidemic of typhoid fever at St. Pancras. There were 431 cases in 276 houses, and 220 cases were traced to the dairy supplying the houses with milk.

In Scotland, at Dundee, thirty cases occurred among the customers of one milkman, and upon investigation it was found that three of the man's children were suffering with this disease in adjoining rooms. (*Lancet*, January, 1884.)

At Aberdeen, sixteen cases of typhoid fever in nine families were caused by polluted milk from a dairy, where this disease was at the time. (*Lancet*, January, 1884.)

At Penzance, England, more than thirty cases of typhoid fever were found to originate in a case in the family of the milkman.

In Port Jervis, Orange county, N. Y., Dr. F. C. Curtis investigated the cause of an outbreak of enteric fever by order of the State Board of Health, and says in conclusion:

"The epidemic was one of true enteric fever. It made its appearance in a previously healthy locality. It arose suddenly and ended suddenly. It exhibited no local foci of infection. It affected several members of a large proportion of the affected families. Eighty-seven per cent of the cases occurred among persons using milk supplied by one milk vender. The possibility of the milk becoming infected from the cases of the disease at the dairy farm is established. I would report, therefore, that the epidemic was caused and spread through the medium of infected milk." (Fourth Annual Report, State Board of Health of New York.)

In Alleghany City an epidemic of typhoid fever occurred, and I am indebted to Dr. Newton for the following letter, which he kindly allows to be used:

November 21, 1883.

TYPHOID EPIDEMIC IN ALLEGHANY, PENNSYLVANIA.

The first cases of typhoid fever in Alleghany, Pa., occurred in June, 1883, among the servants living in three adjacent houses on Ridge avenue. These dwellings are among the very best in the city, and are fully provided with approved sanitary apparatus and perfect drainage. The avenue and the cross streets have excellent surface drainage and good public sewerage. At intervals following June, six of the servants in these houses, and five members of the families, were attacked with fever. I live on Ridge avenue, at the

corner of Alleghany avenue, four doors below the houses mentioned, on opposite side.

On July 10, two cases of fever occurred in a house three doors below my house, then two in a house adjoining, then two in a house in the rear. On July 16, my son, in his twenty-first year, was attacked, and, in the week following, my housekeeper. My son had been home from school in Massachusetts four weeks. He used no tea nor coffee, but drank two or three glasses of milk at breakfast and at six o'clock dinner. He did not relish beef tea; but as he liked milk, the physicians allowed him as much as he desired. He drank a gallon each twenty-four hours, and took very little other nourishment. A thorough examination of sewerage and plumbing of my house was made by the physicians and experts, and all found to be in excellent condition. All the houses mentioned, like my own, are of the best character, well located on high ground, with large lots, plenty of trees and grass, in a suburban locality.

On July 28, Dr. Jones, an old, experienced physician, suggested that the milk might be the cause of the epidemic, as the families where fever first appeared had recommended the milkman who had served me for more than a year. I at once made inquiry, and learned that in my neighborhood, embracing, say eight large blocks, there were no cases of fever excepting in families supplied by the one milkman. One of my neighbors, who had four cases in his family, reported the facts to the physician of the health board, who at once visited the dairy and made an examination of the premises. His report to me was substantially as follows: The stables were on a hill-side just within the limits of the city. The stable was large, airy and clean; the cows of very fine quality, nicely kept and apparently healthy. A few feet from the upper door of the stable was a well which furnished all the water used on the premises. A short distance above this well, on the hill-side, there was a large, deep privy, filled to the surface drainage, as well as the soaking through the earth, led directly to the water-well lower down the hill-side. It was also discovered that a son of the milkman (whose dwelling was very near the spring) had been sick with typhoid since third week in June. As there was no dairy building on the premises, it is supposed that the milk from which cream was gathered was kept in the house where the sick boy lay.

Some efforts were made to follow the delivery cart and get a list of all the families supplied, and then inquire if there were cases of fever, but my neighbor and I were too busy in our stricken households to follow the investigation diligently and promptly. However, we obtained the names and residences of *forty-eight* cases of fever in families served by this milkman. Of these, four we know were fatal. Several left the city, and of others we could get no facts as to the final result.

My son died August 2d, four days after the cause was suspected and the milk changed. My wife was attacked two days before my son's death.

During the month the epidemic was prevalent, there were (as reported at the health office) only *five* cases in the city other than those using the infected milk. These forty-eight cases were scattered all through the city, between points two miles distant. The prevalence of the fever on Ridge avenue and adjoining streets gave rise to the suspicion that there was some local cause, but the subsequent investigation showed that in that entire large section of the city there was but *a single* case of typhoid not served with this milk.

Among the victims was Rev. S. I. Wilson, D. D., Professor in Theological Seminary, and (I think) one of his servant girls.

From all I can learn, the case of my son was by far the most violent in symptoms of all, and I think he used much more of the milk than any other person.

The ages of the cases ranged from three to sixty-five years.

We had the water from the well analyzed by a competent chemist, which I give you:

ANALYTICAL LABORATORY, PITTSBURGH, PA.,
September 18, 1883.

I have carefully examined a sample of water from a well, received from you. I find that it is abundantly charged with nitrates and nitrites, proving it to be contaminated with organic matter of animal origin. The water also contains ammonia in the volatile state, and as non-volatile salts—that is to say—salts which are not volatile at common temperature. On boiling the water during concentration it evolves a very marked urinous odor. Examined by the microscope immediately when received, I found that every drop was swarming with living and active bacteria. To sum up, I consider this an extremely bad and dangerous water, whether to be used as a potable water or to cleanse vessels used to contain food of any kind.

I am, yours,
GEORGE HAY, M. D.,
Analytical Chemist.

The chemist, in conclusion, says that he has examined many waters, both in Europe and America, and that this is the worst he has ever analyzed, except one specimen in Scotland.

Such cases might be given "*ad infinitum.*" It can readily be seen, then, how important it is to control the sale of milk and rigidly inspect the same. For, as has been before stated, no chemical analysis or examination of any kind, except a careful inspection of the premises of milkmen and producers, can prevent epidemics of the kind mentioned.

It is for this reason that when milk shows something abnormal in its characteristics that suspicion is excited, and the sale of such milk should be prohibited.

METHODS OF TESTING MILK.

The most satisfactory manner of examining milk is to make a

chemical analysis of it, and this requires much time, experience, expensive apparatus and chemicals. In many cases it would be of great interest to determine certain constituents of the milk by some easy and rapid method, as on the dairy farm to determine the relative quality of the milk of the various cows, or the effect of certain kinds of feed on the quality of the milk, etc., and especially so for police duty, in which latter case hundreds of samples must be examined in a very short time, and each sample must be pronounced to be above or below the standard fixed by law.

The adulterations most commonly practiced are the addition of water, the partial removal of cream, or both; and since the determination of water and of cream are also most desirable on the farm, many ingenious methods and kinds of apparatus have been devised to determine rapidly and easily one or the other of these ingredients.

Methods for Determining the Amount of Cream or Fat.

The Cream-gauge or creamometer, is a graduated tube in which the milk is allowed to stand until the cream has risen, the volume per cent of which can then be read. Normal milk contains about fourteen per cent of cream. This, however, fluctuates considerably, and the cream-gauge should be considered, at best, a most unreliable guide.

Another variety of cream-gauge was invented by Krocker, and differs but little from one previously invented by Bouchardat and Quevenne. (Bouchardat Du Lait. Paris, 1857, II, p. 10.)

This apparatus, Fig. 1, consists of three funnel-shaped glass vessels, each of which rests in an iron ring supported by a wooden frame. Besides this, there is a measuring cylinder of glass graduated from below into one hundred equal parts. The opening in the bottom of each glass dish is closed with a long glass stopper.

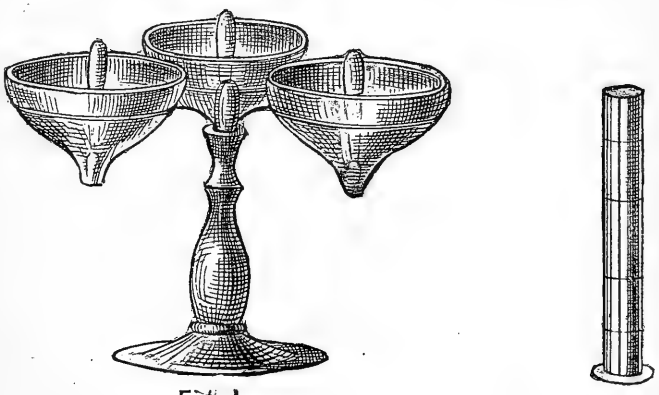


Fig. 1

One hundred parts of milk are measured out in the cylinder and transferred into each dish, and after standing twenty-four hours the skimmed milk is drawn off into the measuring cylinder by carefully raising the glass stopper. By subtracting the quantity of skimmed milk from 100, the volume per cent of cream can be ascertained. (Fresenius, Zeitschr. f. anal. chem., 1874, p. 336.)

OPTICAL METHODS.

Most of the modifications of the optical test may be divided into two groups. In the first, milk is added to water placed in a vessel having parallel glass walls, until a candle flame can no longer be seen through the liquid. From the quantity of milk employed to render the water opaque, the percentage of fat in the milk can be calculated. In the second, whole milk or milk of known dilution is introduced into a vessel having parallel glass walls, or wedged-shaped with glass walls. A candle flame is viewed through the liquid and the thickness of the layer of the liquid through which the flame can no longer be seen is noted, and from this the amount of fat in the milk can be estimated. These instruments are constructed on the principle that the transparency of the tested layer of liquid is inversely as the quantity of fat in the milk.

DONNÉ'S LACTOSCOPE.

Donné is to be credited for the discovery of the principle of the optical method for testing milk, and for bringing the same into practical use. His instrument, fig. 2, consists of two hollow cylinders made to slide one into the other, the outer extremity of each capped with a glass plate, so that by means of a screw, finely divided into fifty equal parts, one plate can be made to approach, or to recede from the other. The cylindrical cavity is now filled with the milk to be tested and the screw is set at zero. The observer looks through the liquid at a lighted candle. The glass walls are then brought together until the flame just disappears. The degree indicated by the number of revolutions made by the screw is read and the percentage of fat corresponding to this number is found on a table specially prepared for this instrument by means of chemical analysis. These instruments are difficult to construct, and it is a hard matter to find two different instruments giving the same results, hence it is necessary to prepare a separate table for each instrument. Besides this, the

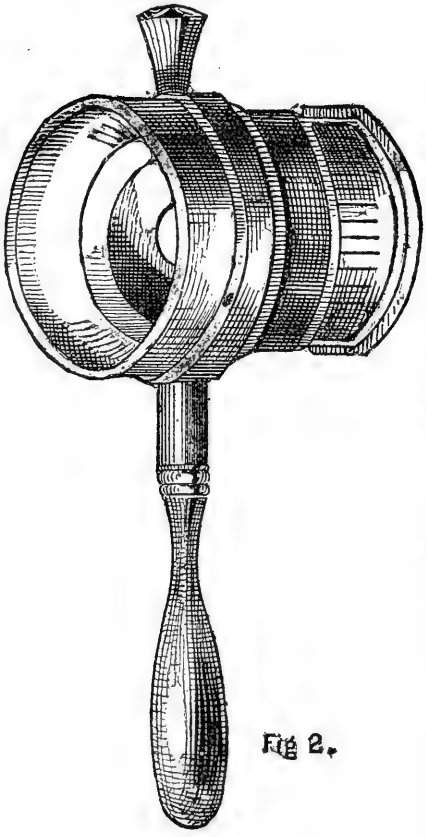


Fig 2.

screw is a very delicate piece of mechanism, difficult to manipulate very expensive, and the thickness of the layers of milk varying within a m. m., the results cannot be accurate. The Donné instrument is of historic interest but has, to-day, no significance either in science or in practice.

Vogel's Lactoscope.

Vogel has made a very ingenious application of Donné's principle. He constructed an apparatus consisting of a very simple Lactoscope, a measuring cylinder, a small pipette and a candle.

This lactoscope, Fig. 3, consists of two semi-circular plates of glass, 5 m. m. apart, held in position by a suitable frame and intended

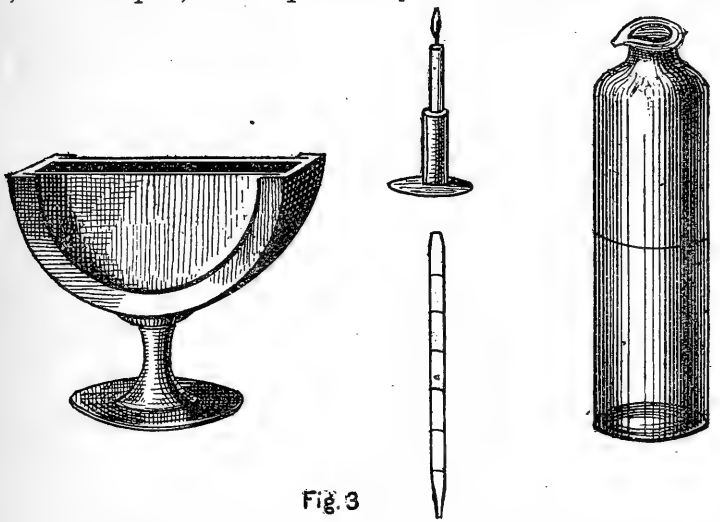


Fig. 3

to hold a mixture of milk and water. To test a sample of milk, the cylinder is filled with water up to the 100 mark, the candle is lighted, and three c. c. of milk are added from the pipette to the water, thoroughly mixed with it and poured into the lactoscope, when the observer endeavors to see the flame through the liquid. If he cannot see it he has used too much milk, and must repeat the test with less than three c. c. If he does see it, the liquid is poured back into the cylinder, another small quantity of milk is added, the test repeated and so on until the liquid is of such an opacity that the flame just disappears. The eye must be placed close up to the lactoscope and the flame placed from fifty to sixty c. m. (17 to 20 inches) from the Lactoscope. Behind the flame is placed a dark background. It is best to experiment in a dark room. From the number of c. c. of milk employed – m., which the observer must exactly note, the per cent of fat – x., in the milk can be computed form the following formula:

$$x = \frac{23.2}{m} + 0.23$$

The derivation of this formula is very simple. Suppose a sample of normal milk gave on analysis, a per cent of fat, and it requires

$n.$ c. c. of milk to render 100 c. c. of water opaque. If $s.$ be the specific gravity of the normal milk, 1 c. c. will weigh $s.$ grms and since 1 grm. contains $\frac{a}{100}$ grms fat, $s.$ grms or 1 c. c. must contain $\frac{s.\ a.}{100}$ grams fat; since $n.$ c. c. of milk are added to 100 c. c. of water $(100 + n.)$ c. c. of liquid contain $\frac{n.\ a.\ s.}{100}$ grams of fat, or 1 c. c. will contain $\frac{n.\ a.\ s.}{100\ (100 + n.)}$ grams.

Suppose we have another sample of milk having a sp. gr. of s'. it contains x per cent of fat and 100 c. c. of water are rendered opaque by $m.$ c. c. of milk, then 1 c. c. of the liquid contains $\frac{m.\ x.\ s'.}{100\ (100 + m.)}$ grams fat. If we suppose that equal volumes of mixtures of water and milk which are just opaque, contain equal quantities of fat, then

$$\frac{\text{m. x. } s'.}{100\ (100 + \text{m.})} = \frac{\text{n. a. s.}}{100\ (100 + \text{n.})}$$

Solve this equation for x, letting s. = s′.

$$\text{x} = \frac{\text{n. a. } 100}{\text{m.}\ (100 + \text{n.})} + \frac{\text{n. a.}}{100 + \text{n.}} \text{ or}$$

$$\text{x} = \frac{1}{\text{m.}}\ \frac{\text{n. a. } 100}{100 + \text{n.}} + \frac{1}{100}\ \frac{\text{n. a. } 100}{100 + \text{n.}}$$

$$\text{For simplicity let } \frac{\text{n. a. } 100}{100 + \text{n.}} = \text{e.} \qquad \text{(I)}$$

$$\text{then x} = \frac{\text{e.}}{\text{m.}} + \frac{\text{e.}}{100}$$

By actual experiment and analysis, Vogel found in one sample $n.$ = 4; $a.$ = 5.993, and in another, $n.$ = 8.8; $a.$ = 2.890. Substituting these values in I., then

$$e = 23.212$$

$$\text{x} = \frac{23.212}{\text{m}} + \frac{23.212}{100} \text{ or}$$

$$\text{x} = \frac{23.2}{\text{m}} + 0.23.$$

This is known as Seidel's formula.

Dr. Vogel has prepared a table by means of which the per cent of fat in the milk can be determined from the quantity of milk employed. (Dr. Alfr. Vogel. Eine neue Milchprobe — Erlangen, 1862.)

Hoppe Seyler (Arch. f. pathol. Anat., etc., 1863, Bd. 27, p. 394), modified Vogel's process materially. He mixes in a beaker 5 c. c. of milk with 95 c. c. of water, and puts 5 c. c. of this mixture into the lactoscope, the glass walls of which are 1 c. m. apart, and adds water from a burette until the flame which is placed at a distance of 1 m. just disappears. A few analyses having been made, a formula might easily be calculated.

Feser (Der Werth der bestehenden Milchproben für die Milchpolizei, München, 1866, p. 32) suggested another modification. He made a box, having two of the opposite parallel sides made of glass 2 m. m. thick, 16 c. m. square, and 4.5 m. m. apart. In one corner of

this box is a small opening 1 c. m. in length. The box is painted with shellac, except in two places 4.5 m. m. square each, exactly opposite each other, one on each glass plate; 25 c. c. of water are introduced through the opening, this fills the box about three-quarters full. The candle is lit, the box held in one hand and with the other milk is introduced drop by drop until the flame just disappears. A formula could also be calculated to suit this method.

Trommer of Eldena (Landw. Wochenerschr. des Balt. Vereines-Greifswald, 1867, No. 13, p. 204 — Martiny, Die, Milch, I, p. 162) supplements Feser's modification by having a lactoscope whose walls are 5 m. m. and will hold 100 c. c. of milk liquid. The milk is introduced carefully from a burette. Seidel's formula can of course be employed in this case.

The Wedge-Shaped or Prismatic Lactoscope.

Seidlitz' instrument, Fig. 4 (Balt. Wochenschr. Dorpat, 1867 — Vol. 5, No. 13 and Milchzt. 1873, No. 37, p. 458) consists of two glass plates, so fitted into a woden frame that their lower, smaller edges come together, and the upper ones are just 15 m. m. apart. Across the middle of one of the plates a narrow strip of black varnished paper is pasted, having thirty holes, equidistant the one from the other, and each one is numbered. In testing, 95 c. c. of water are mixed with 5 c. c. of milk, and introduced into the instrument. The candle flame is looked at through the openings in the paper, and that one is noted at which the flame just disappears or just becomes visible.

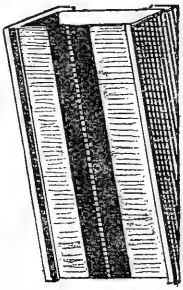


Fig. 4.

Th. Behrmann has published, in the Balt. Wochenschr., a table giving the per cent of fat in the sample of milk corresponding to the hole at which the flame disappears. From this table Fleischmann has computed the following formula for all prismatic lactoscopes.

$$x = \frac{r}{2.\,m.} - \frac{35.228}{n.}$$

in which n = the number of the hole, m = the thickness in m. m. of the liquid at the uppermost hole, r = the number of holes, x = the per cent of fat in the tested liquid. It is understood that the numbers continue from the lowest, thinnest part to the uppermost, thickest part, and the ratio of water to milk is as nineteen to one.

For Seidlitz's instrument.

$$r = 30,\ m = 15$$

$$\therefore\ x = \frac{30}{2.15} \cdot \frac{35.228}{n} \text{ or } x = \frac{35.223}{n}.$$

In 1867, Alf. Vogel of Dorpat (Balt. Wochenbl. 1867, V. Jahrg.

No. 15, p. 237) encased the glass plates of the wedge-shaped lactoscope in a tin frame, and laid the instrument on its side instead of standing it upon edge. An instrument of this kind was afterward made by Reischauer, and is now known as the Reischauer lactoscope, Fig. 5. One of the glass walls of this instrument is divided into five spaces, respectively, 2.3, 2.8, 3.2, 4.0 and 3 c. m. in width. This vessel is filled with a mixture of 1 part milk and 25 parts water, the observer looks through the liquid at the flame of a candle, and according to that division on the glass plate through which he can no longer see the flame, the milk is considered to be:

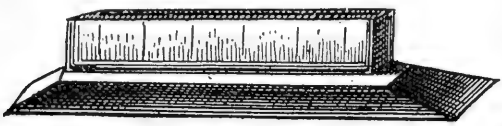


Fig. 5.

1. Extraordinarily rich,
2. Very rich,
3. Rich,
4. Normal,
5. Poor.

(Bayer Indust. and Gewerbbl. — 1871, p. 163 — also Schweiz. Landw. Zt. Zurich, 1874, p. 4, p. 21.)

Dr. Heinrich has invented an instrument similar to the one just described but differing somewhat in details of construction and manipulation. He places his long, narrow, wedge-shaped instrument on a graduated board. Vertical to this board is another, in which a narrow slit is made and behind which the lighted candle is placed. The lactoscope is filled with a mixture of water and milk, moved back and forth until the point has been found at which the candle flame disappears from view; this point is read off on the graduated board and is compared with a table prepared on the basis of numerous chemical analyses. In this manner the percentage of fat is estimated. The specific gravity of the milk is next determined and compared, together with the amount of fat previously found, with another table, and thus he arrives at the amount of total solids in the milk.

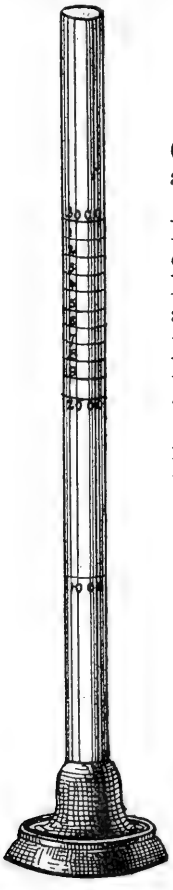


Fig. 6.

LACTOBUTYROMETER.

This instrument, Fig. 6, was first constructed by Marchand de Fécamp, and was afterward modified by Calleron, Schmidt, Tollens, Mehu and others (Martiny-Die Milch, p. 169, Schweiz. Landw. Z. Zurich, 1875, p. 209, Jab. Techn., 1878, p. 740, 1879, p. 128, 1877, p. 47). Marchand determines the fat directly by introducing 10 c. c. of milk to which 1 or 2 drops

of caustic alkali have been added, into a graduated tube, the "butyrometer."

This is shaken with 10 c. c. of ether; then 10 c. c. of alcohol are added and again shaken. The instrument is then placed in a water bath heated to 40° C until the layer of fat which rises to the top no longer increases in bulk. The quantity of fat is then read off, and by means of an empirical formula he calculates the amount of butter fat in 1000 grams of milk. This formula is (*n.* c. m. m. × 2.23), + 12.6. M. claims to have discovered that the extraction of the fat by means of ether is not complete. Each c. c. of the ethereal solution contains 0.223 grams of butter, and 10 c. c. of milk retains 0.126 grams of butter which the ether does not dissolve.

The solubility of the fat in ether, however, depends on the age of the milk, and we may also admit that it varies in different samples of milk. Experiments have shown that the solvent power of the ether in different samples is not rendered uniform by the addition of caustic alkali and alcohol, and hence Marchand's attempt to find a constant factor for this undissolved portion of the fat cannot be considered successful.

Feser's Lactoscope.

Feser's lactoscope, fig. 7, consists of a hollow glass cylinder doubly graduated, one scale giving the number of c. c. and the other the percentage of fat. In the lower part of the cylinder a cylindrical body of milk glass is fixed which is graduated with black lines. In testing a sample of milk 4 c. c. are transferred by means of a pipette into the instrument. Water is then gradually added, and the mixture thoroughly shaken after each addition, until all the black lines on the small cylinder can be read. The c. c. scale then indicates how much water was necessary to effect the desired dilution, and the per cent scale indicates the corresponding percentage of fat in the milk.

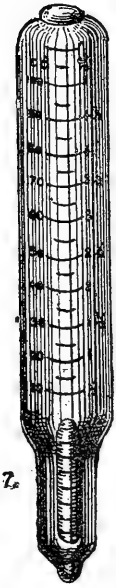


Fig 7.

The Butyroscope patented by Prof. Leeds of Hoboken is essentially the same as the lactoscope just described. The only difference between these two instruments is this: in the lactoscope of Feser, water is added to milk until it has attained a certain degree of transparency, while in the butyroscope of Leeds, an invariable quantity of water is added to the milk, and the degree of transparency effected by this dilution is noted.

The Pioscope.

The Pioscope consists of a disc of black gutta-percha three inches in diameter, having a raised center surrounded by a circular groove, and a piece of glass of the same shape and size as the disc, and which is colored with various shades of blue. In the center of the glass plate a place is left blank, corresponding in size and shape to the raised center of the rubber disc. A few drops of milk are placed on the center of the disc and covered with

the unpainted center of the glass plate. The color assumed by the thin film of milk is now compared with the colors of the plate, and according to the one to which it corresponds, the milk is declared to be rich, normal, poor or skimmed.

Alex. Muller (Journal prak. Chem., 1861–83, 13 and 1862–86, 380) claims to facilitate the determination of fat by extracting the same directly from the milk by means of a mixture of three parts absolute ether and one part alcohol.

G. Hoyermann (Archiv der phar., 116–127, Milchzt., 1872, No. 7, p. 78) advises to heat milk to boiling, cool to 12° R., and shake it at that temperature until the butter comes. The butter is filtered off on a gauze, washed with cold water and weighed.

Prof. C. J. Fuchs of Carlshruhe (Wilda, Landw, Centralbl. f. D't Berl., 1859, II, S. p. 408), constructed a small centrifugal machine for determining the amount of cream in milk. The cream rapidly separates in a small glass tube, and, from its volume, the amount of cream in milk can be ascertained.

2. METHODS FOR DETERMINING THE AMOUNT OF WATER.

The Hydrometer is an instrument which, when floated in a liquid at a certain temperature, shows the difference in weight between this liquid and an equal bulk of water; or, in other words, determines its specific gravity at a given temperature.

The Lactometer is a hydrometer, which indicates a specific gravity at a temperature of 60° Fahr. beteween 1.000 (the specific gravity of water) and 1.03480.

On the scale, the specific gravity of water is indicated by 0, the specific gravity of 1.03480 by 120, and the space between 0 and 120 is divided into 120 equal parts. The 100 mark indicates a specific gravity of 1.029, and is so taken from the fact that the average milk, as has been shown, has a specific gravity greater than 1.029.

The 100° is used merely to indicate 100 per cent of pure milk.

The space between 0 and 100 being divided into 100 parts, each part indicates per cent. If, therefore, the milk tested has a specific gravity indicated by 90; or, in other words, if the lactometer floats at 90, then we can safely assume that at least 10 per cent of water has been added; if at 85, 15 per cent of water; if at 80, 20 per cent of water has been added, and so on.

The method of using it is as follows:

The milk to be tested should be warmed or cooled, as the case may be, to a temperature of 60° Fahr.

The lactometer is placed in it, care being taken not to wet that part of the stem above the milk. The mark at which it floats is now noted. Now take the lactometer out of the milk, and observe whether the thin film adhering to it runs rapidly off, and whether the milk appears thin and bluish, and the taste of the milk is flat and watery; if such is the case, and the lactometer floats at some point less than 100 — as, for instance, 90 — we are reasonably certain that water has been added. If the appearance and taste are as before

stated, and it floats at some point greater than 100, it may be skimmed, or skimmed and watered milk.

It can be readily understood that skimmed milk has a greater specific gravity than pure milk; for the cream, the constituent having the least specific gravity, has been removed. If the lactometer floats at some point greater than 100, and the appearance is whitish, and the taste creamy, then we may assume that the milk is pure. If these directions are followed out, no mistake can occur.

All that has been claimed for this instrument is this: that, with a certain degree of accuracy, it can detect milk adulterated with water alone, and also indicate the removal of the cream. There is no instrument that has done so much to prevent and detect the adulteration of milk with water.

It is stated over and over again that cream has a specific gravity less than pure milk, and, therefore, the lactometer when placed into cream would indicate watered milk. This is undoubtedly the case, but certainly it does not require much experience to determine the difference between milk and cream, and still less, watered milk and cream.

It has been said that many healthy cows give milk which has a less specific gravity than 1.029.

This I have failed to verify either from my own or the tests of others, as will be seen by reference to the tables of the specific gravity of milk; and when such a statement is made, it will be well to determine the following facts:

1st. Whether the milk in question was taken from strippers or unhealthy cows, or from cows which have just calved.

2d. Whether the milk was tested at a temperature of 60° Fahr.

3d. Whether on the lactometer used the 100 mark indicated a specific gravity of 1.029.

4th. Whether the milk was stirred while cooling or allowed to rest for a period sufficient to allow the air mechanically mixed with it to escape.

The first, because strippers, unhealthy cows and cows having just calved often give milk of a very low specific gravity, but such milk must be called abnormal or unhealthy.

The second, for the reason that a great many using the lactometer, take no account of the temperature, nor consider the fact that a liquid expanded by heat has a much less specific gravity than when at a lower temperature.

The third, for the reason that a lactometer was at one time extensively sold whose 100 point indicated, not a specific gravity of 1.029, but of 1.0319, or 110 on the lactometer. In other words, when the lactometer, whose 100 mark = 1.029, floated at 110, this lactometer, whose 100 mark = 1.0319, would float at 100.

The fourth, because the milk becomes thoroughly mixed with air during the milking. This air tends of course to decrease the specific gravity.

A case in point may be cited:

Having occasion to test and examine the skimmed milk drawn from a milk separator, I placed a portion taken directly from it into the testing glass, inserted the lactometer (the temperature of the milk being 65° Fahr.) and found it floated at 5. It commenced to rise, however, at the end of 25 minutes, floated at 115, and after twenty-four hours, at 125, the temperature of the milk being then at 59.

These results came from the fact that the milk, rotating at the rate of 4,000 revolutions a minute in the separator, became thoroughly mixed with air. This air rose out of the milk after standing.

I have also tested the milk taken from cows and cooled rapidly in a closed vessel. Three of such tests are given below.

Temperature.	Lactometer.	Lactometer after 24 hours at 60° Fahr
60	104	109
60	108	110
58	112	114

Should the temperature of the milk be above or below 60° Fahr. a calculation may be made which will show very nearly where it would float at 60° Fahr.

It has been found by experiment that a difference of 3° in temperature (Fahr.) produces a difference of about 1° in the lactometer. This seems to hold good, however, only between 40° and 75°.

Hence the following rule:

Find the difference between the indicated temperature and 60°; divide this by 3, and the quotient, if the temperature was above 60° add to, and if below 60° subtract from the degree at which the lactometer floats.

Example — In the milk under examination the lactometer floated at 100. The temperature was 69° Fahr. Then applying the rule $69 - 60 = 9$, the difference in temperature, $9 \div 3 = 3$. Now as the temperature was greater than 60° we add 3 to the degree at which the lactometer floated. Then $100 + 3 = 103$, or at 60° Fahr. the lactometer would have floated at 103.

Again — Lactometer floated in a sample of milk at 95. The temperature was 45°. Then applying the rule as before, $60 - 45 = 15$, the difference in temperature, $15 \div 3 = 5$. Then, as the temperature was less than 60° Fahr., we subtract the 5 from 95 and we have 90, or 90 is the point where the lactometer would have floated at 60° Fahr.

As has been before stated, the lactometer is merely a hydrometer indicating specific gravity between 1.000 and 1.0348 with this exception: on a hydrometer the space on the stem between a specific gravity of 1.000 and 1.0348 is quite small, while on the lactometer it is often six times as large. This is seen by reference to the diagrams given below, fig. 8. It, therefore, is a much more delicate instrument than the ordinary hydrometer.

The following table, prepared by Waller, may be used to determine the specific gravity of any degree on the lactometer.

Value of Lactometer Degrees in Specific Gravity.

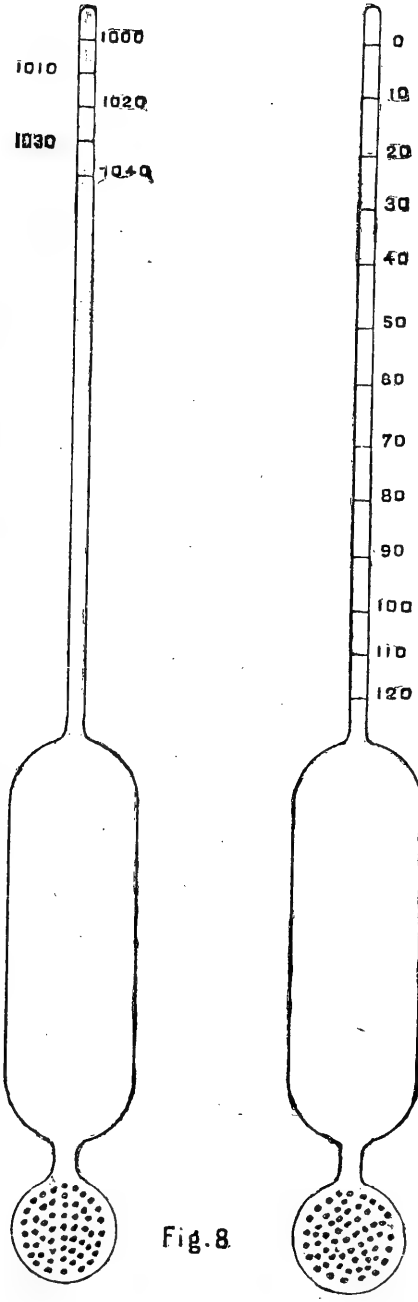


Fig. 8

Lactometer.	Gravity.
0	1.00000
1	1.00029
2	1.00058
3	1.00087
4	1.00116
5	1.00145
6	1.00174
7	1.00203
8	1.00232
9	1.00261
10	1.00290
11	1.00319
12	1 00348
13	1.00377
14	1.00406
15	1.00435
16	1.00464
17	1.00493
18	1.00522
19	1.00551
20	1.00580
21	1.00609
22	1.00638
23	1.00667
24	1.00696
25	1.00725
26	1.00754
27	1.00783
28	1.00812
29	1.00841
30	1.00870
31	1.00899
32	1.00928
33	1.00957
34	1.00986
35	1.01015
36	1.01044
37	1.01073
38	1.01102
39	1.01131
40	1.01160
41	1.01189
42	1.01218
43	1.01247
44	1.01276
45	1.01305
46	1.01334

47	1.01363	84	1.02436
48	1.01392	85	1.02465
49	1.01421	86	1.02494
50	1.01450	87	1.02523
51	1.01479	88	1.02552
52	1.01508	89	1.02581
53	1.01537	90	1.02619
54	1.01566	91	1.02630
55	1.01595	92	1.02668
56	1.01624	93	1.02697
57	1.01653	94	1.02726
58	1.01682	95	1.02755
59	1.01711	96	1.02784
60	1.01740	97	1.02813
61	1.01769	98	1.02842
62	1.01798	99	1.02871
63	1.01827	100	1.02900
64	1.01856	101	1.02929
65	1.01885	102	1.02958
66	1.01914	103	1.02987
67	1.01943	104	1.03016
68	1.01972	105	1.03045
69	1.02001	106	1.03074
70	1.02030	107	1.03103
71	1.02059	108	1.03132
72	1.02088	109	1.03161
73	1.02117	110	1.03190
74	1.02146	111	1.03219
75	1.02175	112	1.03248
76	1.02204	113	1.03277
77	1.02233	114	1.03306
78	1.02262	115	1.03335
79	1.02291	116	1.03364
80	1.02320	117	1.03393
81	1.02349	118	1.03422
82	1.02378	119	1.03451
83	1.02407	120	1.03480

A modification of the lactometer by combining with it a thermometer has been used. But Mr. W. G. Spence, one of the experts of this Commission, devised a more durable one, the whole instrument being made stronger.

This style of lactometer, called a Lacto-thermometer, is shown in the diagram below, fig. 9, and is more convenient than the ordinary lactometer. Its 100 mark indicates a specific gravity of 1.029.

THE HALLYMETER.

Reichelt (Bayr. Kunst. Gewerbe bl., 1859, p. 602) employs Fuchs' Hallymeter, fig. 10, arranged for four determinations, to ascer-

tain the quantity of water in the milk. The hallymeter consists of a glass tube closed at one end. In the middle this tube is suddenly narrowed so that it consists of an upper enlarged portion and a lower narrowed portion. The lower portion is intended as a receptacle for salt, and is so graduated that the weight of the finely pulverized salt it contains can readily be read off. A weighed quantity of milk is then added to a known quantity of salt, repeatedly shaken at a temperature of 32°–36° C. The milk and salt are then poured into the hallymeter. An excess of salt having been used, the quantity which remains undissolved can be read off, and thus the quantity dissolved is determined. It being known that 100 pints of water will dissolve 36 pints of common fine salt, the percentage of water in the milk is calculated.

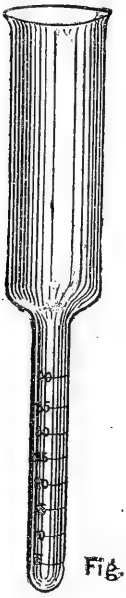


Fig. 10.

Zenneck's Hydrolactometer consists of two graduated bottles, and a funnel fitted with a filter paper. A definite quantity of milk is put into the first bottle, coagulated while warm with a little hydrochloric acid and filtered into the second bottle. It being known how much serum should be contained in the quantity of milk taken, it is an easy matter to determine whether the sample has been adulterated by the addition of water.

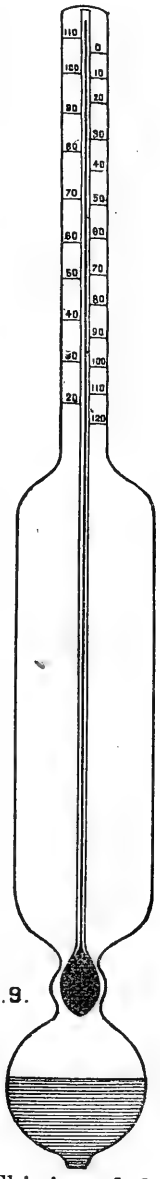


Fig. 9.

3. The Determination of Total Solids.

Brunner (Mitthl. der Naturf. Gesells, in Bern, 1857, No. 401, p. 129) suggests that a weighed quantity of milk be put into a tube filled with pumice and evaporated in a current of dry air over a water bath. He thus obtains the quantity of total solids from which the fat may be extracted by means of ether.

F. Schulze recommends for the determination of total solids to take 0.4 to 0.5 grams milk weighed in a platinum dish. The dish with the milk is moved back and forth over an open flame until the water has been driven off and the residue colored yellow. This is cooled and weighed.

E. Monier estimates casein and albumen in milk by titrating with a standardized solution of permanganate of potash. If casein

is to be determined separately, a second quantity of milk is coagulated at 40° C with acetic acid, and the albumen is determined in the filtrate, and deducted from the sum previously found. (Comp. rend., 1858, XLVI, p. 236.)

DETERMINATION OF MILK SUGAR.

The determination of milk sugar by optical methods. The principle of these methods consists in obtaining the clear serum which shall contain the sugar of a weighed quantity of milk. The sugar is then determined in an aliquot part of the serum, and from this, the quantity present in the original milk.

Various kinds of apparatus are in use; the polariscope of Biot or of Soleil, Dubosque-Soleil, Soleil-Ventzke, and the polaristrobometer of Wilde.

If a sugar solution be placed in the tube between the two prisms, it deviates the plane of the polarized ray of light, and by measuring the extent of this deviation the amount of sugar in the solution can be calculated, taking 59.3° as the specific rotation of milk sugar.

The determination of milk sugar by titration with Fehling's solution. The clear serum containing all the milk sugar is obtained by boiling, coagulating with acetic acid and filtering. This is then added from a burette to a known quantity of boiling Fehling's solution, until the cupric oxide of the latter has been reduced to cuprous oxide. From the quantity of serum required to effect this reduction, the percentage of milk sugar in the original milk is estimated. The copper reducing power of milk sugar is 70.5, that of dextrose being 100; hence the results obtained as dextrose must be multiplied by $\frac{100}{70.5}$ to be converted into per cent of milk sugar.

Von Baumhauer has constructed an apparatus to determine the percentage of total solids, fat and milk sugar, in twenty or more samples at once. An experienced chemist can use it successfully. The following is a description of his apparatus and his method:

A filter paper 10–12 c. m. in diameter is fitted into a ring of earthenware R, and filled with sand, filter paper and sand having been thoroughly cleansed with hydro-chloric acid and dried; 10 c. c. of milk are then added and weighed by placing the filter on a small light beaker, the bottom of which has been cut off as shown in the diagram.

When the desirable number of such filters has been prepared and the milk added, they are hung on a copper perforated plate.

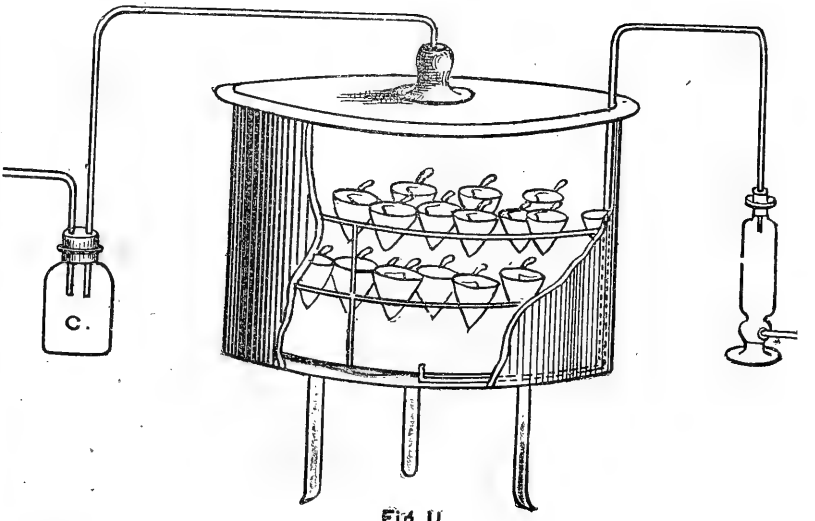


Fig. 11.

Figure 11 represents two copper plates so arranged and placed in a paraffine bath. This bath is supplied with a tight-fitting lid, through which a tube passes to the bottle C, in which the water condenses and is collected, while the tube is attached to a powerful aspirator. Another tube passes between the walls of the bath through the paraffine, and opens into the bath below; at the close of the operation the other end of this tube is connected with an apparatus containing sulphuric acid and calcium chloride to dry the air entering the bath.

The filters being placed in the bath and the thermometer inserted, the temperature is raised to 60–70° C, and kept there as long as any water is condensed in the bottle C. Then dry air is drawn through the bath, the temperature raised to 105 C, and maintained at that point for four to five hours. The filters are then cooled and weighed. The loss in weight represents the amount of water contained in the milk. To determine the fat, the filters are placed in a funnel, as shown in Fig. 12, the stem of which has a rubber joint, so that it

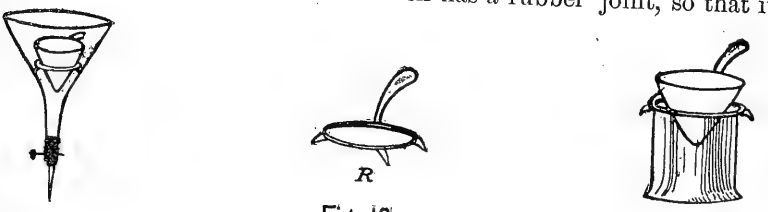


Fig. 12.

can be closed or opened by means of a pinch cock. Ether is poured upon the sand and is allowed to soak into it. It is then allowed to run into a weighed flask. This is repeated twice, and the funnel is returned to the bath to be thoroughly dried. The loss in weight of

the filter, or the increase in weight of the flask, after the ether has been expelled, represents the amount of fat extracted. The filter is then washed with hot water, which dissolves out the milk sugar, and which can be determined in the solution by means of Fehling's re-agent.

Soxhlet's extraction apparatus for determining the amount of milk fat. This process is based on the fact that if a measured quantity of milk made slightly alkaline by caustic potash be shaken up with ether the ether extracts the milk fat, and on standing collects in a clear layer. The small, quite constant proportion of ether remains in solution in the milk, and without affecting the result.

The amount of fat dissolved in the ether may be determined by the specific gravity of the ether.

The higher the specific gravity the greater the proportion of milk fat.

The details of Soxhlet's method can be found in the Zeitschr. der Landro. Ver., Bayern, 1880.

Blyth recommends the following method, which he says is sufficiently accurate for all technical purposes. He shakes up the milk, made very alkaline by soda, in a graduated tube. He then takes an aliquot part of the ether, evaporates to dryness and thus estimates:

J. West Knight's extractor, Fig. 13, consists of an ordinary flask A, connected by means of a cork with the tube of an upright condenser. B is a percolator made by cutting off the bottom of a convenient sized test tube, and blowing a hole in the side 15 m. m. from the top, and is attached to the condenser tube inside the flask. The bottom of the percolator is tied over with a piece of fine cambric. The substance from which the fat is to be extracted is put in and covered with a piece of filter paper and lastly with a perforated metal disc about 2 m. m. thick. Ether is then put into the flask and boiled, its vapor escapes by the aperture b of the condenser tube, and after condensation it falls into the percolator b, percolates through the substance back into the flask to be again evaporated. The process is thus a continuous one. The fat remains in the flask and can be weighed after expelling the ether.

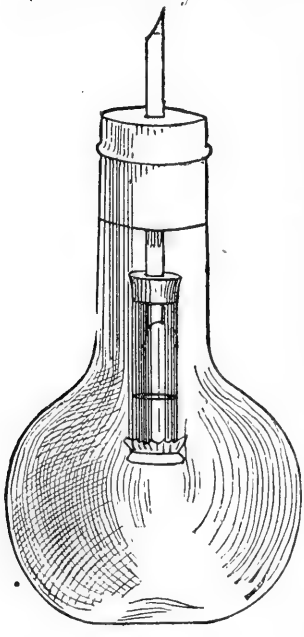


Fig. 13.

Michaelson determines the water by weighing out 5 grms. in a platinum dish, adding 30 grms. of pearl sand and evaporating it, with occasional stirring, over a brine bath. The last traces of moisture are driven off in an air bath. The loss in weight represents water, the residue the total solid.

The sand is then transferred to a glass tube b, Fig. 14, closed below by means of a plug of cotton. The dish is wiped out with cotton soaked with ether and laid on top of the sand. The tube is then corked and the neck of the retort inserted. The retort is filled half with ether, set in warm water, and the ether, distilling over, percolates through the sand partly as vapor, partly liquid, and dissolves out the fat, which solution collects in the flask below. The ethereal solution is then put into the retort, the ether distilled off and is again caught in the flask. This is repeated as long as the ether dissolves any fat out of the sand. The fat is then transferred from the retort into a weighed beaker, the ether expelled, the fat dried in an air bath and weighed.

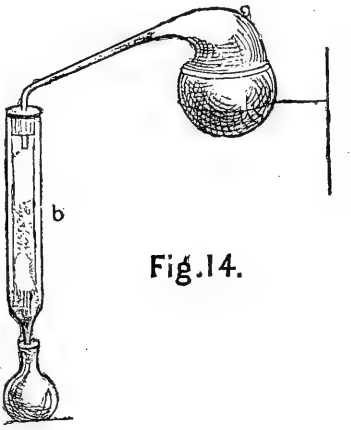


Fig. 14.

All of the best methods and instruments employed in testing milk have been given, and the question now arises, which one placed in unscientific hands will give the most reliable results. The dairyman who desires to increase his trade, to improve it and to conduct it on rational principles must study the quality of milk produced by his cows. He must, therefore, have means of ascertaining without a knowledge of chemical analysis whether the milk of each separate cow is watery or whether it contains a large amount of solids, and whether it will yield him a large or small amount of cream. He is, therefore, more particularly interested in the relative quality of the milk produced by his cows than in a knowledge of the chemical composition of each sample. These requirements can easily be fulfilled, and though the means are far from being perfect, still they are, in their present condition, capable of rendering excellent services.

For ordinary testing on the farm the following method may be recommended:

First use the lactometer in the manner previously stated, and in using the cream gauge, either fill it with milk warm from the cow and place it into water at a temperature of 40° Fahr., or in testing cold milk, fill the cream gauge half with water at a temperature of 80° Fahr., then fill with milk to the zero mark, and place in water at a temperature of 40° Fahr. All the cream will usually rise in three-quarters of an hour. In the latter case the amount of cream indicated must be multiplied by two. Or a drop or two of caustic potash can be added to the milk which is heated to a temperature of 80° Fahr. poured into the cream gauge, which is then placed into water at a temperature of 40° Fahr. Cream usually rises in this case in about three-quarters of an hour.

The amount of cream may also be obtained by the apparatus shown in the following diagram. Fig. 15. This consists merely of a wheel about two feet in diameter, connected with a smaller one two inches in diameter. These two wheels are fastened to the frame as shown in the diagram; from the lower part of the small wheel, four or more hooks project. From these hooks are suspended little sheaths of metal in which the cream gauges are placed. Around this small wheel or hub is placed a stout iron band of such a diameter as to allow the iron sheaths containing the gauges to revolve horizontally without touching it. This is merely to prevent accidents in case the hoops should break. A little water is placed into each of the sheaths and the cream gauges filled with milk are set into them. The water acts as a cushion and prevents breaking of the gauges. The sheaths are now hung on the hooks and the large wheel is rapidly turned. This causes the sheaths containing the gauges to revolve with great rapidity in the position indicated by the dotted lines on the diagram. They are kept revolving for about ten minutes, when the machine is allowed to come to rest of its own accord. The sheaths gradually assume their original upright position. The cream gauges are then taken out, and the amount of cream is read off.

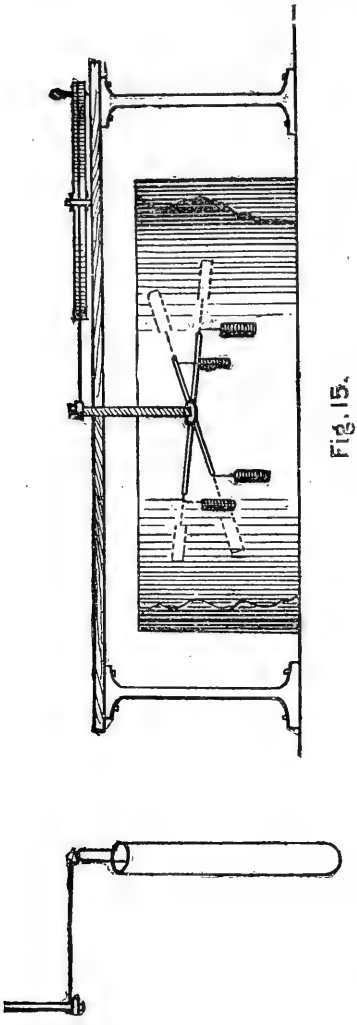


Fig. 15.

METHODS OF ANALYSIS.

The use of sand, finely powdered marble, plaster of Paris, etc., seems to be characteristic of the methods employed by European analysts. This is done to hasten the evaporation of the water and to facilitate the extraction of the fat by means of ether. For the latter purpose, an extraction apparatus of one form or another is employed. Soxhlet's extraction apparatus and some of its numerous modifications are very popular.

Twenty grms. of milk are weighed out in a platinum dish, eight grms. pulverized marble added, and set on a water bath and evaporated to dryness. Thus the larger part of the water is driven off at a temperature below that at which the albumen will coagulate. In order to prevent the milk adhering to the sides of the dish, a small

glass rod is used to remove it as it gathers there. As the mass becomes pasty, it must be continually stirred with the rod until perfectly dry, and all the lumps are reduced to fine powder. The dish is then placed in an air bath for a short time to drive off the last traces of moisture. It is then cooled and weighed. The loss represents the amount of water.

The powder is now transferred to a glass tube about 80 c. m. long, and 1.5 c. m. in width, drawn out to a point below and plugged with a little cotton. Fig. 16. Ether is poured into the tube, which is then capped with a glass vessel as shown in the diagram at b. To the lower end a flask is attached, which serves to catch the ether as it runs through the tube. The upper vessel b is then filled two-thirds with ether, corked, and the apparatus put in a warm place. In the cork d an opening is made, through which air and vapor of ether can escape. When all the ether has run through, the vessel is refilled one-fourth with ether, and this is repeated four times, or until the ether, which runs through, leaves no residue on evaporation. The flask containing the fat in solution is now detached, the ether distilled off and the flask placed in an air bath to remove the last traces of water and ether. The fat remaining is then cooled in a dessicator and weighed.

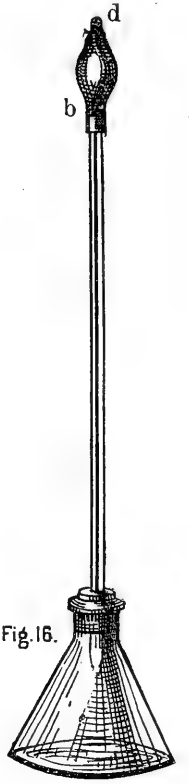


Fig. 16.

Casein is determined in 25 grms. of milk, diluted to eleven times its volume, and coagulated with acetic acid. The coagulum is transferred to a weighed filter, washed twice with water, and then with ether. In this manner the coagulum is made more firm, and can easily be transferred to a flask to be treated with ether until all the fat has been extracted. The casein free from fat, is now returned to the weighed filter, dried, placed between two watch glasses held together with a stout clamp and weighed.

Albumen — The filtrate from the 25 grms. of coagulated milk is heated to boiling, the albumen separates out and is brought on a filter of known weight. It is then dried, cooled and weighed.

Milk Sugar — This is determined in the filtrate from the albumen obtained in the previous operation. This is diluted to 500 c. c. Ten c. c. of Fehling's solution are mixed with 40 c. c. of water in a porcelain dish, boiled, and the solution of milk sugar added from a burette until all the copper has been reduced. This determination should be made in duplicate. The quantity of solution required to effect this reduction is noted, and from it the amount of sugar can be calculated.

Total Solids are determined by means of a Liebig's drying tube. Fig. 17. This tube is half filled with clean dry sand and weighed, 5 grms. of milk are then added, and the tube placed in a distilled water bath as shown in the diagram. The narrow tube A is connected by means of a piece of rubber tubing with an apparatus for generating hydrogen. After two hours, when most of the water of the milk will be evaporated, the larger end B is connected with a safety tube to prevent any steam, coming from the bath, from condensing in the drying apparatus. This is continued for two hours longer, when the drying tube is detached and weighed. It is then replaced in the bath for another hour, when it is again weighed. When the decrease in weight does not exceed one m. g. the operation is considered complete.

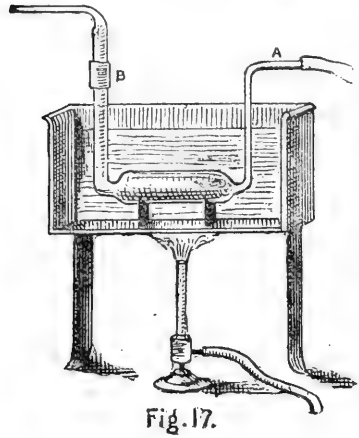


Fig. 17.

Ash, 25 grms., with the addition of a few drops of acetic acid, are evaporated to dryness in a platinum dish over a water bath. A flame is then put under the dish, the contents thoroughly charred and then repeatedly boiled with water, which is decanted and saved. The residue is then burned white. The water solution is now gradually added little by little and evaporated. The final total residue is then gently heated to redness, cooled and weighed.

Nitrogen determination — This determination is only made to check against the casein and albumen determinations. For this purpose 25 grms. of milk and a little oxalic acid are put into an evaporating thin glass dish and evaporated to dryness on a water bath. When dry, the dish with its contents are put into a mortar and thoroughly ground. The powder is then thoroughly mixed with soda lime and transferred to a combustion tube. The tube is then placed into a combustion furnace and connected with a bulbed tube containing hydrochloric acid. The tube is heated until no more bubbles enter the bulbs. The end of the tube is then broken off and air is drawn through to gain the last traces of ammonia. The bulbed tube is then disconnected and the ammonium chloride which it now contains determined by means of platinic chloride.

RITTHAUSEN'S METHOD.

Weigh out 10 or 20 c. c. of milk, dilute to twenty times its original volume, and add to it 4.5 or 9 c. c. of acetate or of sulphate of copper.

The acetate should contain 50 grms. of the salt per pound, the sulphate 63.5 grms. per pound. Immediately after the addition of copper just enough caustic alkali is added to decompose the copper

salt, but must not be added in excess, for this would dissolve the precipitated casein-copper. The clear fluid is now decanted, the precipitate of copper, protein substances and fat thoroughly washed with water and brought upon a filter. The filtrate and washings contain all the milk sugar, which may be determined with Fehling's solution.

The precipitate is broken up with a platinum spatula and washed with absolute alcohol and then with ether, until all the fat has been removed. The last traces of ether are then removed with alcohol and the residue dried over sulphuric acid. The ethereal solution is distilled, the fat residue dried and weighed.

The copper, etc., residue is weighed, heated to 125° for one to two hours and then to redness, whereby the albumen is burned off and the amount determined on weighing the residue.

Water and total solids are determined in the usual manner with sand.

Waller's Method.

Of all the methods of analysis, I have found the following, recommended by Dr. Waller, to be the most rapid and practical. Weigh out about five grams of milk in a platinum dish, evaporate to dryness on the water bath, dry to constant weight in the air bath, which should never be allowed to attain a higher temperature than 105 degrees C., or lower than 100 degrees C.; cool and weigh. Loss equals amount of water. Extract the fat with ether, dry to constant weight, cool and weigh. Loss equals amount of fat. The ether extract containing the fat is evaporated in a tarred beaker until all ether is driven off, dried and weighed; increase in weight equals the amount of fat. The residue in the dish are the solids not fat; place the dish over a Bunsen burner and heat at a red heat until the ash is white, cool and weigh the ash. The solids, not fat, consisting of sugar, casein and salts or ash, may be separated as follows: Place the dish containing the solids, not fat, on the water bath; fill the dish with a mixture of equal parts of alcohol and water and evaporate to dryness. This will generally make the albumen and casein perfectly insoluble. Water containing ten per cent of alcohol is now added, and after heating on the water bath, for about fifteen minutes, the water now holding the sugar and soluble salts in solution is to be decanted into a tarred platinum dish; repeat this three or four times, evaporate both to dryness, carefully observe if any albumen has run over with the sugar. If so, this must be filtered out and added to the casein. If none has come over, dry both residues to constant weight, cool and weigh; now burn off the carbon at a low red heat, until the remaining ash is white, cool and weigh. Subtract the ash from the sugar, and the ash from the casein, and we have the amounts of the sugar and casein. Add the weight of the insoluble ash and soluble ash together and we have the amounts of ash contained.

ANALYSIS OF CONDENSED MILK.

Weigh the dish, then add about ten grams of sand, thoroughly purified; heat to redness, cool and weigh. Next weigh a small glass rod, place the dish containing the sand on the balance and weigh out from one to two grams of the milk; place on water bath and after the milk becomes liquid carefully mix it with the sand; stir with the rod from time to time, so that the milk will not adhere to the dish; dry to constant weight; loss = water; transfer the sand to a tarred funnel, in the neck of which, a plug of cotton, previously washed with ether, has been placed. Weigh the funnel and sand and note the loss of sand; the loss must be taken into consideration when calculating the final results. Now pour boiling ether through the funnel into a tarred beaker, drive off the ether and weigh the beaker and fat; gain in weight equals the amount of fat. Slightly moisten the contents of the funnel with alcohol and water, and dry in air-bath at 105 degrees C. Now pour boiling water through contents of funnel into a tarred platinum dish, evaporate to dryness and weigh. Weight — sugar and soluble ash; incinerate and weigh. Weight equals soluble ash, which must then be subtracted from the sugar. The total ash can be determined by incinerating about one gram of the milk. The casein is to be determined by difference or by determining the amount of nitrogen, as recommended by Wanklyn, and from that calculating the amount of casein.

It has been found in practice, that the use of sand, plaster of Paris, pulverized glass or some substance of this character is necessary in making an analysis of condensed or preserved milk in order that all of the fat may be extracted. I have found by experiment that condensed or preserved milk, to which the water taken from it was returned and then evaporated to dryness according to the method recommended by Waller, will not part with more than two-thirds of its fat when the extraction with ether is attempted in the usual way. The following method occurred to me. Weigh out about one gram of the condensed or preserved milk in platinum dish which should be two inches across at bottom and capable of holding about 25 c. c. Weigh also a small glass rod; add to the milk in the dish 8 c. c. of absolute alcohol and stir with the weighed rod until the coagulum formed by the addition of the alcohol is finely divided. Place the dish (the rod being left in it) upon a water-bath, and drive off the alcohol and water, stirring the contents of the dish from time to time with the rod. When apparently dry, place it in the air-bath at 105 degrees F. for about twenty minutes, which is usually long enough. The loss equals the water. The dish of course must be weighed until it ceases to lose weight.

Fat, casein, sugar and salts are then determined in the usual manner.

I have compared the sand method and this method, and find the latter fully as accurate as the former.

The advantages which can be claimed are, that it takes less time and there is no transferring of sand from one vessel to another, during which operation some sand is sure to be lost.

It seems well to state here that, of the methods of analysis, the most accurate will be that which involves the smallest amount of manipulation.

Dr. Newton says, that "if we are to judge the standard or to compare samples of milk with it, a method of analysis equal to, and not more rigorous than that by which it was adopted, should be employed. To use a process that will destroy some one of the ingredients, or that will falsify the results, would be unjust. What is required of the method is, that when a sample is submitted to two or more chemists for analysis, the results obtained by each shall be accurate and concordant. If this result can be obtained by each chemist, working by a different method, the problem is easy of solution; but if it is necessary that all shall use the same process, it seems to me very important that some one method should be fixed upon and used to the exclusion of all others."

Without going into detail I will state that I am fully persuaded that Wanklyn's method of milk analysis is all that can be desired. It is accurate, and two or more analysts working at the same specimen can arrive at concordant results. Any method that requires prolonged evaporation or drying is very apt to get false figures, for the reason that such processes destroy or dehydrate the milk sugar, and thus make the total solids appear lower than they really are. The use of sand or any substance added to increase the bulk of the milk has been abandoned by nearly all chemists for the reason that not only is it impossible to get concordant results, but, as sand is a hydroscopic substance, accurate weighing is impossible or difficult.

As to the fat extraction it may be said that where an extraction apparatus is used, such as Liebig's, Soxhlet's or Gerber's, higher fat determinations result than by Wanklyn's or Waller's method, for if the ether be not dry, or if the solids contain much moisture, there is a source of error in the possibility of extracting some of the milk sugar, which result will cause the fat to appear greater than it really is.

Detection of the Adulterants.

By the adulteration of milk is meant the addition of water or other substances, or the removal of cream.

Many substances have been used to adulterate milk, and almost all text-books give a long list, copied and recopied, including calf's brains, rape-seed and other substances, the use of which are extremely problematical.

Whatever may have been used, we find at the present day that the addition of water and the removal of cream, or both, constitute ninety-nine per cent of the fraud. Carbonate and bicarbonate of soda, borax, and nitrate of soda are sometimes used as preservatives;

annatto, butter color and burnt sugar, to color the milk, and salt and sugar to impart a taste, and to increase the specific gravity are probably the only adulterants used at present. Salacylic acid or the salacylates are said to be used.

A compound known as rex magnus, and consisting of salt, carbonate of soda and borax, was at one time sold to some extent, for the purpose of preserving the milk, but the health authorities in Brooklyn discovered and stopped its use.

But as has been before stated, water is the principal adulterant, and should this be sewage water or even slightly contaminated, the most fatal results may ensue.

In determining the adulteration it must be remembered that an article used as an adulterant must of a necessity be cheap and easily obtained.

1st. Addition of water.

This may be detected by means of the lactometer in the manner described.

Also by analysis, provided we have some definite standard for milk in regard to the amount of its constituents.

It has been conclusively shown that average healthy, normal milk, will never have more than 87.5 per cent of water or less than 12.5 per cent of total solids, and of these total solids, 3.2 per cent should be fat and 9.3 solids not fat, and not less than 0.65 per cent of salts.

Now, if we have a sample of milk which contains less than 12.5 per cent of total solids, we may estimate the amount of added water by the following proportion.

Let us suppose, for example, that the sample in question had 10 per cent of total solids; then we can make the proportion,

$$12.5 : 100 : : 10 : X$$

in which 12.5 = per cent of solids in pure milk; 100 = 100 parts of pure milk; 10 = the amount of total solids found; and X the parts of pure milk in the mixture reduced by the addition of water so as to reduce the total solids to 10 per cent.

Solving we have X=80.

That is, in the mixture of milk and water, eighty per cent was pure milk, and twenty per cent was water.

In a similar way any of the constituents might be taken to determine this fact.

But it has been found that the solids not fat, are the least variable of all of the constituents, so that these are usually taken to calculate the amount of added water. Of course the addition of water reduces the per cent of salts found, and these latter thus become a check or guide upon the final results.

The detection of the addition of impure water is undoubtedly a very important point, and fortunately for the consumer this kind of water can be detected.

I say fortunately for the consumer, for water contaminated with sewage, if used to adulterate milk, may spread diseases, like typhoid fever, etc., with fatal results.

In speaking of potable waters, Waller says, that the presence of nitrites usually indicates contamination with sewage, and further that such water should be considered as unfit for human consumption, and dangerous.

In order to detect impure water in milk, we can apply a modification of the ordinary sanitary analysis of water, as follows:

300 c. c. of the milk are to be coagulated with acetic acid and filtered; to 100 c. c. of this filtrate are added abont 10 c. c. of a mixture of a solution of equal parts of sulphanilic acid and sulphate of napthylamine; the solution of sulphanilic acid must be freshly prepared each time; now should the milk contain nitrites, or in other words water contaminated with sewage, a rose red color will commence to form, deepening in intensity on standing, and the deeper the color, the more nitrites present, and this is an undoubted indication that impure water was used to adulterate the milk.

I have tried this test on milk which I knew to be pure, with negative results, and have detected the presence of nitrites in milk to which one part in a million of nitrites had been added. This test is said to detect one part of nitrites in forty million parts of water.

A portion of the filtered serum may also be tested for the nitrogen in nitrates by the well-known copper zinc couple method of Gladstone and Tribe, care being taken to test for nitrites by the method given before nesslerizing, in order to be sure that all of the nitrogen has been converted into ammonia.

The removal of the cream may be detected by the methods of analysis given, Waller's being preferable. I do not recommend the cream gauge, because all of the cream will not rise as the per cent of cream indicated depending upon the temperature, age of the milk, etc. Still, by using half water and half milk as before recommended, or by heating the milk to 80° Fahr., and adding five drops of a saturated solution of caustic, soda or potash, to every 100 c. c. of the milk used, and then placing in a cream gauge in a cold place, more constant results may be obtained.

Any non-volatile substance, as soda, borax, etc., except nitrates of the alkalies, added to milk will increase the weight of the ash or salts, unless the adulterator has added sufficient water to reduce them to their normal amount.

Of course in this case we would have a normal ash, while the other indications would point toward the addition of water, and in such cases the ash should be tested for adulterants.

Soda or carbonates of the alkalies may be detected in the ash, if the solids are decarbonized at a very low red heat. Effervescence ensues on the addition of an acid, and the ash is strongly alkaline, or evaporate 100 c. c. of the milk; in a capacious platinum dish carbonize and boil this carbonaceous residue with water.

Evaporate this to small bulk and titrate with $\frac{N}{10}$ sulphuric acid solution, using cochineal as an indicator.

Salt may be detected by a similar treatment, using $\frac{N}{10}$ solution of nitrate of silver and neutral chromate of potash as an indicator, and subtracting the amount of salt, naturally in the milk, about 5.7 per cent of the ash from the result.

For borax, the milk should be treated in a similar way, except using 200 to 500 c. c. The solution, resulting from boiling the carbonaceous residue with water, is to be made alkaline with caustic soda. Evaporated to dryness and examined with the spectroscope, when the characteristic bands shown on plate 5, figure 3, will be seen. A quantitative analysis for borax may be made as follows:

To the solution, evaporated to about 100 c. c., 5 c. c. of chloride of ammonia are added and 10 c. c. of a saturated solution of chloride of calcium. Evaporate to dryness, transfer to a small platinum crucible and fuse at the lowest possible heat with an excess of a mixture of equal parts of chloride of soda and chloride of potash. Keeping the bottom of the crucible red hot and the sides only moderately hot.

As the fusion continues, borate of calcium separates out, and after cooling, the fused chlorides may be washed away and the calcic borate, thus separated, dried and weighed. and from this the amount of borax calculated.

Addition of Sugar.

This may be detected by the increased amount of sugar in the milk. Normal milk containing about $4\frac{1}{2}$ per cent of sugar.

Cane sugar would probably be the one added.

STARCH.

This is not probably longer used as an adulterant, but may be detected by putting the milk in a long glass and examining the sediment with iodine, which produces the characteristic blue color, or by means of the microscope when the starch granules are easily recognized.

CHALK.

As in starch, examine the sediment for carbonate of lime by any of the ordinary tests, such as effervescence with acid, etc.

GLYCERINE.

This may be looked for, more particularly in cream, as it is often added in the form of a boroglyceride to preserve it in warm weather.

500 c. c. of the milk or cream are diluted to four times its bulk with water and acidified with acetic acid, until the casein coagulates in floculent masses. Now pass through it a current of carbon dioxide, and the precipitate is allowed to settle out.

FIG. 1. HEALTHY WOMAN'S MILK. X 420.

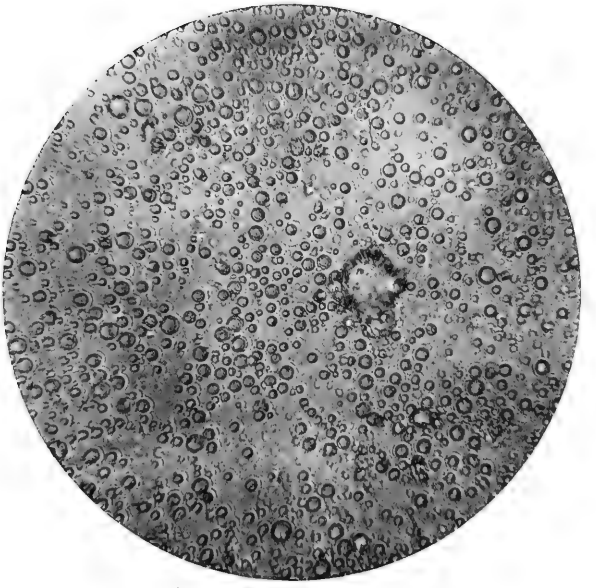


FIG. 2. UNHEALTHY WOMAN'S MILK. X 420.

Syphon off the clear serum; neutralize and evaporate to dryness; extract the fat with pure ether; dissolve out the glycerine with a mixture of alcohol and ether.

Evaporate off the ether and alcohol, and test for glycerine.

1st. By the acrolein fumes when heated with sulphuric acid.

2d. By adding a little borax, and observing if the flame produced on heating and igniting is colored green.

Annatto or Butter Color.

Evaporate 200 to 500 c. c. of the milk nearly to dryness and extract the residue with alcohol. This alcoholic solution evaporated to a small bulk turns brown with acids and yellow with alkalies, or concentrated sulphuric acid may be added drop by drop, when, if annatto be present, a blue color is formed, deepening into dark-brownish purple on standing.

Salicylic Acid or Salicylates.

Shake up the serum acidified with hydrochloric acid with ether.

Evaporate the ether and add a small quantity of neutral ferric chloride, when, if salicylic acid be present, a violet color is formed.

Nitrates.

Carbonization of the residue is, in this case, neither safe nor satisfactory. The best method is to acidify 200 grams of the milk, previously warmed to 80° Fahr., with acetic acid, allow to stand and cool, filter, and then proceed as in the determination of the "nitrogen in nitrates," taking 1 c. c. or more of the solution, acted on by the zinc copper couple according to the amount of nitrates present, dilute this to 50 c. c., and nesslerize in the usual way, calculating the ammonia found to nitrate of soda or potash.

Example.

Two hundred grams of the milk were acidified, filtered, and the filtrate acted on by the zinc copper couple; 1 c. c. of the filtrate was diluted to 50. Upon nesslerizing this, it was found to be equal to 0.04 m. grams of $N H_3$; then 200 c. c. would contain 200 times that amount, or $0.4 \times 200 = 8$ m. grams of $N H_3 = 6.59$ m. grams of $N = 29.65$ m. grams of nitric acid $= 40$ m. grams of nitrate of soda, or 0.02 per cent of nitrate of soda.

Microscopical Examination.

The examination of milk by the microscope is of great importance to detect blood, pus, colostrum cells, etc., and should never be omitted. Pure, healthy cow's milk when examined under the microscope has the appearance shown in the photomicrograph (plate 1, fig. 2). The fat globules are in constant motion, and, as will be seen, vary in size, and this according to the kind of food. It having

been found that normal food produces milk in which the globules are more uniform in size.

Cream has the appearance shown in the photomicrograph (fig. 1, plate 2), and consists, as will be seen, of an infinite number of fat globules massed together.

The average size of the fat globules is about 1-5000 of an inch in diameter; they vary, however, from 1-1500 to 1-12000 of an inch.

Skimmed milk (fig. 1, plate 2) shows that the cream has been removed by the smaller number of fat globules present.

Fig. 2, plate 2, shows the colostrum cells in milk. They are the large, round bodies, and some contain cells within, having a yellow color.

These are always present in milk when the calf is born, and continue to be secreted by the cow in diminishing quantities for about two weeks. The colostrum cells shown were taken from the milk of a cow about one week after calving. Such milk should be, of course, and is, prohibited by law. A microscopic form sometimes seen in milk, taken from cows suffering with foot and mouth disease, and called after their discoverer "Blyth's bodies," may be detected with the microscope. They consist of elongated, flattened, highly refractive bodies, ranging in length from 1-800 to 1-1000 of an inch. In some there are divisions at intervals which appear to be rather the contractions of a sarcode substance than an indication of a cell. (Blyth.)

They are not altered by acetic acid or iodine — not stained by magenta. They appear on the third day of this disease. By the fourth day they are fewer in number and larger. In the later stages they are absent.

In plate 3, fig. 2, is shown the appearance of milk taken from an unhealthy woman.

The small number and size of the fat globules can readily be seen, as well as the pus, which was found in considerable amount, also particles of epithelium.

The following history of the case has been kindly furnished me by Dr. White, from whom I obtained the specimen:

M— H—, thirty-nine years old, eighth child; always nurses children, was nursing when milk was taken.

One year before this, had enlargement of the heart, and periodic attacks of vapid heart action and dyspnæa with cough, and expectoration of mucus and blood; much anxiety manifested as to confinement, labor natural and short, lasting only four hours, convalescence rapid upon ninth day.

Temperament lymphatic, not cheerful; but good natured; short and stout; pale complexion; appetite at time milk was taken good.

Not much milk, yet thought sufficient to nurse child; infant pale, feeble and not well nourished; age at time of taking milk, one month.

Fat globules scanty and small, and particles of epithelium present

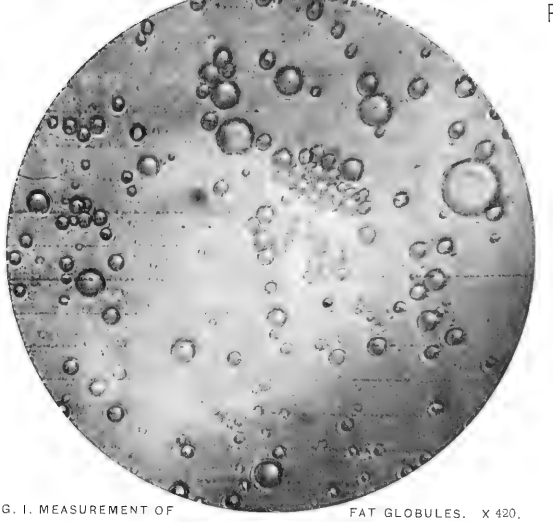


FIG. 1. MEASUREMENT OF FAT GLOBULES. X 420.

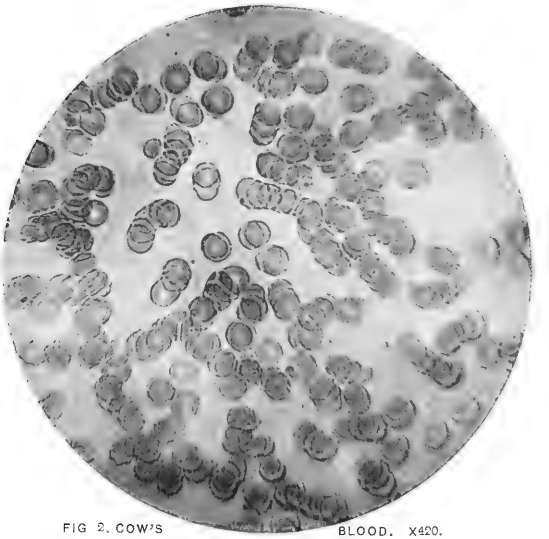


FIG 2. COW'S BLOOD. X420.

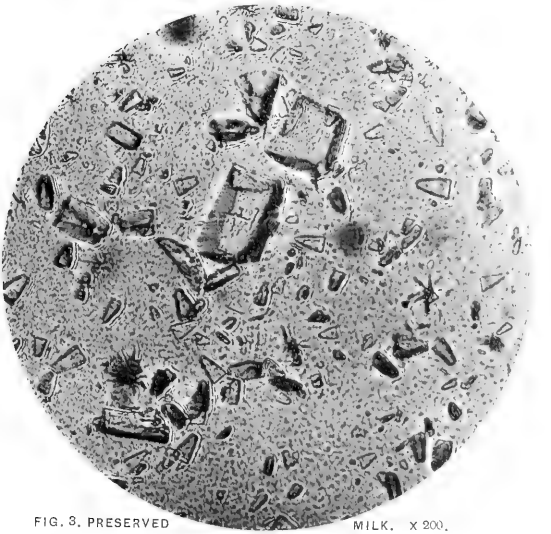


FIG. 3. PRESERVED MILK. X 200.

ARTOTYPE. E. BIERSTADT, N. Y.

Analysis.

Water	88.72
Fat	1.45
Sugar	7.21
Casein	1.85
Salts	0.72

Blood.

Blood gives a pinkish tinge to the milk, if present in small quantities. If a large amount is present, it sinks to the bottom in flocculent masses.

When present in small quantities, its appearance under the microscope must be relied on. The blood corpuscles of the cow are like those of the human being, except the average diameter of the cow's is about 1-5000 of an inch, while in the human being, the average diameter is about 1-7000 of an inch.

The appearance of blood is shown in fig. 3, plate 3.

When present in larger quantities, blood may be detected by means of the microspectroscope, when the absorption bands of haemoglobin can be seen.

Oxidized blood showing the two bands between D and E, fig. 1, plate 5.

While deoxidized blood shows only one band and that very faintly, fig. 2, plate 5.

The size of the fat globules can readily be seen by reference to fig. 1, plate 3.

The spaces between the lines were originally, 1-2500 of an inch apart.

In examining milk with the microscope, it is better to have as thin a layer as possible. To do this, the surfaces of the cover and slide must be perfectly flat. After mounting the specimen to be examined, press gently on the cover glass, and by means of blotting paper, soak out all the milk possible and examine at once.

Condensed and Preserved Milk.

The art of economizing the two most important constituents of milk, butter fat and casein, has been practiced for ages, but it is only recently that the problem of condensing milk has been solved in a satisfactory manner.

In the beginning of this century, a Frenchman, named Appert, conceived the idea of subjecting cow's milk to a certain treatment by which its natural properties could be preserved for a long time, and which would render the milk capable of being transported over long distances. Numerous attempts were then made by all nations to carry out this idea. The principles of the process employed to-day, viz.: The evaporation of the milk at a temperature below 100° C; the evaporation in a vacuum, and the addition of 30 to 40 per cent of cane sugar to the milk to be condensed, were applied separately

and collectively, until finally an American succeeded in making his experiments of practical value, and condensed milk was soon placed upon the market.

In the middle of this century, E. N. Horsford made numerous experiments showing that milk could be successfully condensed by evaporating it at a low temperature with the addition of cane sugar. He did not employ a vacuum pan, but nevertheless he pointed out the means by which his assistant Dalson, together with Blatchford and Harris, suceeeded in placing the first condensed milk upon the market.

This milk contained a little bicarbonate of soda and was sold in cakes packed in tinfoil. As such it formed part of the store of provisions which Dr. Kane took with him on his Polar expedition.

In 1856, Blatchford improved the process by introducing the vacuum-pan. In the same year, Gail Borden obtained a patent for applying the vacuum-pan in a particular way to the preparation of condensed milk without the addition of sugar or other foreign materials. This milk, however, would not keep any length of time. Borden then added sugar, and his preserved milk appeared on the market in tin boxes, hermetically sealed.

Horsford and Borden share the honor of having invented condensed milk. The first variety, which appeared in the form of cakes, was prepared by Horsford's directions. Gail Borden, however, is the founder of the manufacture of condensed milk on a large scale, by the process employed to-day.

Condensed milk is prepared by evaporating ordinary milk at a temperature below 100° C.

Preserved milk is condensed milk to which sugar has been added during the process of evaporation.

Condensed and preserved milk, if prepared from partly skimmed milk at a high temperature, has a yellow color and great viscosity and the fraud is hard to detect. The following analyses show the poorest and richest samples, which I have examined, of condensed milk.

	No. 1.	No. 2.
Water	59.07	51.43
Fat	5.04	15.37
Solids not fat	35.89	33.20

No. 1 was a thick yellow milk of great apparent richness and was made from skimmed milk.

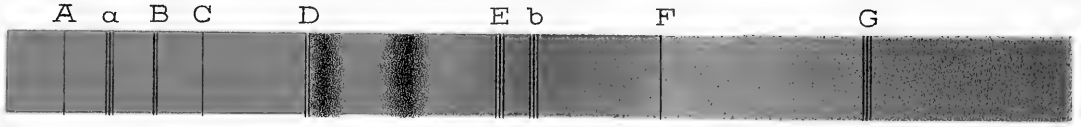
No. 2 was a thin white milk, and was made from whole milk. It appears then that the yellow, thick condensed milk is generally of the poorest quality.

The appearance of preserved milk, preserved with cane sugar, is shown on plate 4, fig. 1. The fat globules have been destroyed by heating and only the crystals of cane sugar can be seen.

PLATE V.

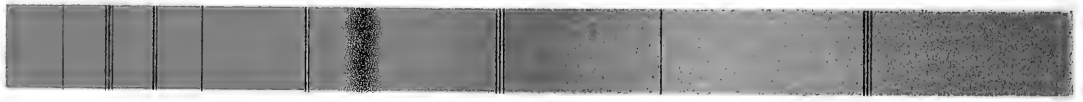
Absorption bands of Haemoglobin.
Oxidized Blood.

Fig. 1



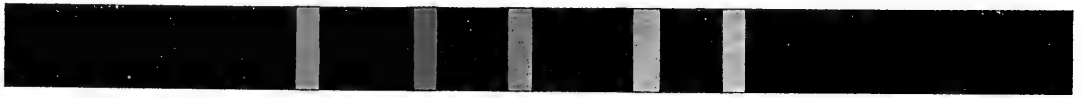
Absorption band of Haemoglobin.
Deoxidized Blood.

Fig. 2



Spectrum of Borax.

Fig. 3



The following will serve as a description of the method of condensing milk and the apparatus employed. See fig. 18.

The milk is received in the tank A and is drawn from it into cylindrical tin vessels about two feet in depth. These vessels, when filled, are placed in the water-bath B, and the milk is warmed to about 90° C. The bath is heated with steam, introduced through the pipe F, which is connected with a coil placed in the bottom of the bath. The tank H is employed in scouring the tin vessels with steam. As soon as the milk has become warm, it is transferred to the tubs C and D both of which have false bottoms. To keep the milk warm, steam is kept passing through the space between the true and the false bottom. The tub E contains the necessary amount of cane sugar. The milk having dissolved the sugar is ready for evaporation. It is then slowly siphoned over into the vacuum-pan through the pipe G, which terminates in a sieve near the bottom of the tub.

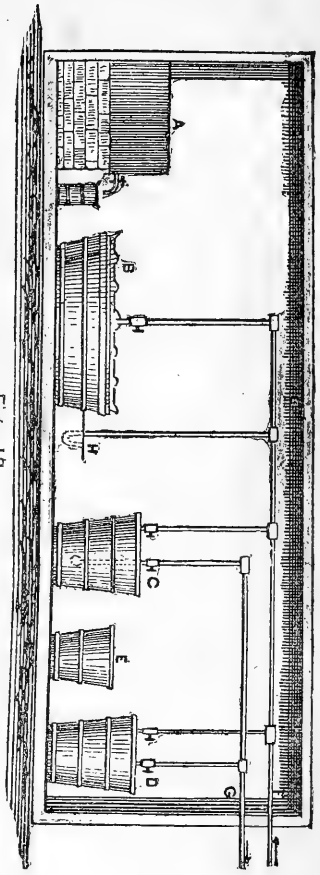


Fig. 18.

The vacuum-pan, fig. 19, is made of iron and contains a false bottom. Into the space beeween the false and the true bottom, and also through the coil placed in the lower part of the vacuum-pan, cold water or steam can be introduced. The milk enters through the pipe A. B is an opening, closed air-tight by means of a plate of glass; E is the condenser which is supplied with cold water from the pipe F and the condensed water passes

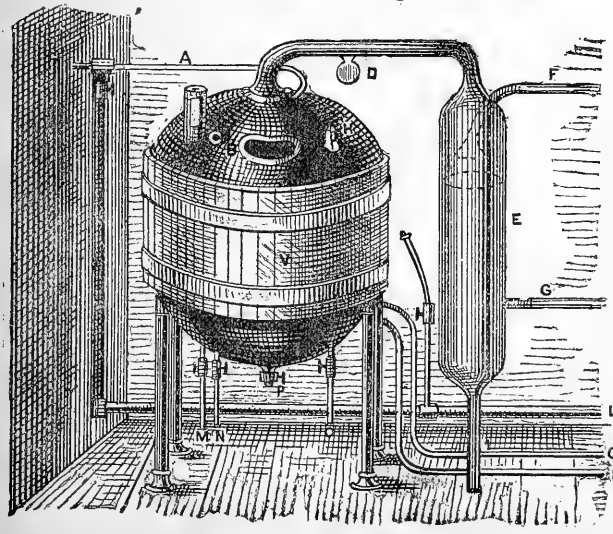


Fig. 19.

from the condenser through the pipe I; K is a pipe to which a hose can be attached, when the pan is to be cleaned with cold water introduced through the opening B; cold water can also be introduced through the pipe I; it carries off the water which condenses between the two bottoms, while N is connected with the coil. While the evaporation is in progress, samples can be drawn from the pipe O, while P is the regular outlet for the condensed milk. Steam is conveyed to the space between the two bottoms by the pipe Q; R conveys the steam to the coil. Directly opposite the opening B, a similar opening is made, behind which a flame is placed, so that a man, who must carefully watch the entire operation, can see what is going on inside the pan. It requires much experience to conduct this operation properly. Steam must not be introduced into the coil until the milk is boiling violently, otherwise the milk adheres to the warm surfaces and a crust is formed which absorbs the heat and must, therefore, be removed. If the operation is carried on too long, the quality of the product will be seriously injured. The operation being completed, cold water is passed through the coil and through the space between the two bottoms. The milk is then drawn off and cooled in the water bath to 15° C. The milk remaining in the pan is washed out with water and generally fed to the pigs.

MILK IN THE ARTS AND MANUFACTURES.

Casein possesses certain well-known properties which might render it very useful in the arts. Its solutions, when evaporated, have a residue which is hard and hornlike, but still elastic and almost insoluble in water. Furthermore casein unites with the oxides and the salts of the alkali earth metals, calcium, magnesium, etc., forming an adhesive mass, insoluble in water. It is well known that if a solution of casein, such as full milk, skimmed milk, or butter-milk, be added to milk of lime, a white-wash of excellent quality will be produced. Also that if the same solutions be used as substitutes for water in the preparation of cements, the quality of the latter for certain purposes is greatly improved.

It has been recommended to mix cement with milk until a thick pasty mass is formed and to employ this in painting wood-work which is exposed to all kinds of weather. The wood must have a rough surface and two or three coats must be applied. Wood, which has been thus prepared, will withstand the destructive influence of weather for an indefinite period of time.

In 1848, Pattison patented a process for manufacturing a substance which he called "lactarin," and which he prepared as a substitute for albumen in animalizing cotton. Lactarin is prepared from casein which has been precipitated with an acid, thoroughly freed from fat, dried and ground to a powder. For use it is dissolved in ammonia, using 50 pints of the solvent to 100 pints of the powder.

Glue and cements are also very useful preparations.

The casein must be prepared from skimmed milk containing as little fat as possible, thoroughly dried and ground to a powder.

This is then mixed with 20 per cent of quick lime and 1 per cent of camphor (the latter acting as a preservative) and the mixture kept away from contact with the atmosphere. For use, this material is mixed with a larger or smaller amount of water according as glue or cement is to be made. When applied, the pieces of wood must be held firmly together for at least twenty-four hours, when the glue will be thoroughly dry, very hard and insoluble in water. The cement also possesses excellent binding qualities and can be applied with equal success to wood as well as to stone.

Casein is also employed in the preparation of plastic materials such as pipes, cigar-holders, jewelry, etc., and is also employed in the manufacture of emery wheels. It is claimed that emery wheels prepared with casein will saw through a plate of iron an inch thick at the rate of an inch a minute.

Milk sugar is another important constituent of milk. Whole milk contains on an average about 4½ per cent of sugar, and in the manufacture of cheese about 85 per cent of this passes into the whey. This whey is either given to the pigs or is entirely wasted. In certain localities in Switzerland, where fuel is very cheap, attempts are made to economize this valuable ingredient. Large quantities of whey are evaporated to a syrupy state, when it is suddenly cooled, upon which the lactose crystallizes out in large quantities. The crude sugar is washed with cold water and purified with animal charcoal.

Milk sugar is extensively employed in medicine and commands a price of twenty cents per pound.

REPORT ON COW'S MILK IN REFERENCE TO ITS MEDICAL BEARINGS.

By R. D. CLARK, M. D.

To the Hon. J. K. Brown, *State Dairy Commissioner:*

Sir — In response to your request to make a report on cow's milk, in reference to its medical bearings, I have the honor to submit the following:

The most important consideration of milk, in a medical point of view, is as a food for infants. It constitutes their entire nutriment during a period of the most rapid development.

It is a lamentable fact that modern civilization or refinement, together with poverty, and other causes, are constantly increasing the proportion of mothers who are unable or unwilling to nurse their offspring; and the difficulty of obtaining good wet-nurses, coupled with the fear of their contaminating the child and the pecuniary inability of the poor to employ them, render it necessary to provide a substitute for human milk. Now it is conceded, by nearly all medical men, that cow's milk is the best substitute.

It is stated in the "Third Annual Report" of the New York State Board of Health, that "it is believed two-thirds of all the infants and children in the State depend upon milk as it is daily purchased at the door or in the market places." In the "Fourth Annual Report" Edward W. Martin and Charles E. Munsell, State Inspectors of Milk, say that "three-quarters of our infant population in cities are brought up on cow's milk."

Milk is the perfect type of natural food. It contains all of the three classes of alimentary principles which are essential to maintain the living animal organism. These are —

First. The hydro-carbon, or heat-producing principles, which supply the process of respiration and the formation of heat and fat in the body; these, in milk, are the butter and sugar.

Second. The nitrogenous or albumenoid principles, which go to supply the fleshy portions of the body, and are found in milk in the form of casein, albumen and, according to Blyth, nuclein.

Third. The saline, which "supply the bones and hold in chemical union, combination and action, the solids and liquids of the body;" which in milk are represented by the phosphates, chlorides of lime, soda, potash, etc.

The purity of milk is affected in various ways, viz., by adulteration, by the sanitary conditions, feed of the cow, etc., etc.

In reference to adulteration, many foreign substances have been added to milk, but by far the most common forms of adulteration are the taking off of fat and the addition of water. The taking off of fat from milk that is to be given to an infant as its only supply of nutriment is of greater moment than is generally known.

The total amount of fat in a healthy adult human body is, according to Witthous, "from 2.5 to 5 per cent of the body weight." It is still greater in infants. And milk (nature's food) furnishes an indication of the amount of fat required by the human being in the large proportion of butter-fat to its other solid ingredients, it being from 25 to 35 per cent of them.

It is fat that fills up the vacant places, and gives rotundity to the body. It aids in resisting and distributing external pressure. It facilitates the movements of the parts and renders the tissues flexible, and by its accumulation in a thick layer underneath the skin, materially aids in retaining the bodily heat.

Besides performing these purely mechanical offices, fat is essentially concerned in all the chemical and most vital processes of the body. It is believed to render important, if not necessary assistance, to the digestive fluids in the digestion of the other principles. It is known that no animal cell or fibre is formed without the presence of fat; and Lehmann declares that "no animal cell or fibre can be formed without it; and that it is the active agent in exciting the changes that take place in the nitrogenous principles." It forms the nucleus of all cellular growth. It is indispensable, if not the most important agent, in the formation of blood; and Letheby says "there is good reason for believing that it is largely concerned in the formation of bile, and that the biliary acids, the essential ingredients of bile, are fatty compounds. Fatty matter forms a great part of the brain, spinal cord, sympathetic nervous system and cerebro-spinal nerves. As a heat producer, fat stands pre-eminent among the alimentary principles, having been found by actual experiment to possess two and one-half times the heat-producing power of sugar and starch.

Its intimate association, in such large quantities, with the nervous tissues throughout the body has long caused the suspicion that it had some important connection with the generation of nervous action, and recent experiments have demonstrated that it is the chief source of muscular force, and probably of nerve force.

It is mainly from the fat stored up in our bodies that we derive our sustenance when the supply of food is temporarily cut off by sickness, etc., and though some fat is produced in the body, it is done with a great loss of material and the expenditure of considerable labor, the great bulk is taken in as fat.

Furthermore, it is believed that nature has especially adapted butter-fat to the digestion of the infant; for fats are mostly digested by the fluid secreted by the pancreas, an organ supposed to be poorly developed in the infant, but owing to a large amount of free fatty acids in butter fat it can be assimilated without this fluid.* Thus we

* Rauth on Infant Feeding (3d ed.), p. 131.

see that milk fat is one of the most, if not the most, important ingredient of an infant's food; indeed it is essential, in large quantities, to its proper nourishment, and consequently a deficiency of it cannot but produce serious effects. We have all noticed the sleek plumpness of a healthy child, and also beheld the dingy leanness of an unhealthy one.

How many of the latter are due to the rapacity of the "milkman," may be inferred from the following few facts: In the "Second Annual Report" of the State Board of Health, 1881 and 1882, it is stated: (The facts were taken from the report of C. F. Chandler, Ph. D., and C. E. Munsell, Ph. B., to whom it was given to investigate the adulteration of milk.) That "while a large proportion of milk sold has been but moderately watered and skimmed, and is still above the standard of the poorest milk (for which they allowed only 2.5 per cent of fat), much of the milk has been *extended* and skimmed far below this standard. So openly are these frauds practiced that "creameries" have been established in many localities, the names and locations of seventy-three such establishments being known to the writers, of which sixty-three are known to send skimmed milk to New York city, all of which is sold as whole (pure) milk on its arrival." And later reports by C. E. Munsell, Ph. B., have shown from analyses that this skimming amounted to from about 29 to 78 per cent of the fat.

The writer has analyzed milk sold in this city and found that over 50 per cent of the fat had been taken off, and has strong reasons for believing that over 90 per cent of the milk sold in Albany, before the dairy department was created, was skimmed and watered.

The addition of water to milk also has an important bearing upon this aspect of the subject. As the solid constituents of cow's milk, except sugar, are in greater proportion to the water than in human milk, it is found necessary to dilute it more or less with water for young infants.

The amount of dilution required is determined by actual experience with each individual case; and, generally, there is a strength found on which that particular infant will thrive, and when deviated from, trouble will soon arise.

Now, when water is added in unknown and fluctuating quantities it is impossible for lay people to find or keep that strength.

The greatest danger, however, from the adulteration of milk with water lies in its capability of carrying the germs of disease into the system, and this has an especial importance in the case of children, as they are peculiarly susceptible to such poisons owing to their weak digestive powers.

The latter fact has received special importance during the present epidemic of cholera in the east, in the fact that Dr. Koch, of Berlin, found that those possessing weak digestive powers were the surest to be attacked by this dread disease

The frequency of the development of miliary consumption in the bowels of children has long been noticed by the profession.

That milk does sometimes carry disease germs into the human system is beyond question. The events told by Routh, in his work entitled "On Infant Feeding," are alone sufficient to demonstrate this sad truth. The following is an abstract of them:

* * * "The danger of admixture of water to milk has been lately sadly displayed, and fully justifies the most severe measures of repression which any government could well enact. It is in the wholesale poisoning of infants through milk diseased with typhoid poison."

"In 1870, Dr. Ballard, while officer of health for Islington, was able to show that an outbreak of enteric (typhoid) fever, which had attacked in ten weeks seventy-six families and one hundred and seventy-five persons in part of his district, coincided with the use of milk from a particular dairy, where shortly before there had been cases of enteric (typhoid) fever, and where apparently the infected house drainage must have had easy access to an underground water-tank in the premises." The same physician, in 1872, found that out of sixty-eight houses invaded by the same disease, fifty-one, including that of the milk seller himself, were supplied by the same dairyman.

He found in another instance, where fifty families were invaded, forty-seven obtained their milk supply from two milk sellers whose dairies were situated close together, and water from the same well was used by them.

In an epidemic of typhoid fever which broke out in Marylebone, in the summer of 1873, out of 244 cases investigated, 218 were in households which consumed milk from a particular dairy, and it was clearly shown that the water used for the dairy purposes contained the excrementitial matters from a person suffering from typhoid fever immediately before and at the time of the outbreak.

Another still more striking case occurred in 1875 at Crossbells, where the water used in milk was contaminated with excreta from typhoid fever patients, and of forty-two families using this milk, eighteen cases occurred; whereas in forty families in the same neighborhood, which used condensed milk, or none at all, not a single case of fever occurred.

As conclusive evidence is found nearer home, in the report of Dr. F. C. Curtis, of Albany, on his investigation of an epidemic of typhoid fever in Port Jervis, this State, where he traced directly 126 out of 148 cases (which last number constituted the epidemic) to the milk supplied by one "milkman," who obtained it from a farm house wherein had occurred three cases of the fever just previous to and at the time of the outbreak. The milk was probably infected through the water and cloths used to wash out the cans.

The London *Lancet*, of April 29, 1876, says in regard to this matter: "Public attention has again been directed to the danger of the system of milk supply still current in large towns. Milk brought from the country in cans by the night trains is carried by the retailers to their own premises, where it often remains for five or six hours. These premises are often little dirty shops or

kitchens, close to the rooms in which the families live. There is no security whatever that epidemic disease may not be raging in the place, that vessels contaminated in the worst possible way may not be used to contain the milk, or, except in places where the adulteration act is rigidly enforced, that the milk may not be adulterated with foul water. * * * *

"But the last few years have brought a flood of new light to bear on the peculiarities of milk. We now know, at the cost of many serious epidemics, how peculiarly sensitive to noxious influences is the fluid which forms so important a part of the national food supply. If clothing will spread the infection of fever, so, when once infected, will milk, and that in a far more insidious and extensive manner, for with milk it is impossible to say how widely or how far the disease may be carried.

"If water will carry the germs of cholera and enteric (typhoid) fever, so will milk, and with milk there is an added danger, not indeed demonstrated, but suspected by many, that the highly complex organic constituents, so closely analogous to those of the body, which are present in it, may serve as a pabulum for the development and indefinite multiplication of disease germs. Recent experience seems to show that milk-spread epidemics are particularly virulent, and the observation tallies, though, of course, it cannot be said to establish the last-named theory."

The spread of other zymotic diseases, as scarlet fever, diphtheria, etc., have been traced to foul water in milk.

That the *food* given to milch cows may be such as to modify their milk deleteriously seems to be irrefutable. That it may be made to increase or diminish the quantity secreted is well known to all dairymen, and has been demonstrated by experiments many times; and, also, the different ingredients of milk have been made to change their proportionate relations by food, rich or poor, in the principles producing such ingredients. But the modifications by food which render milk injurious to the consumer have not been so obviously proven. The writer is unable to find much standard literature upon this point.

But the following known facts are convincing: The natural food of a cow is grass, either green or dried, and when she is fed exclusively upon it, her fresh milk is generally alkaline in reaction; and, on the contrary, the milk of cows fed either wholly or in great part upon food other than the natural is almost invariably acid.

The latter point is made manifest by the experiments of Dr. Mayer of Berlin, quoted by Routh:

"(*a.*) Of cows fed with brewer's lees, red potatoes, rye bran, and wild hay, in five instances the milk was slightly sour, in one very much so.

"(*b.*) Of forty cows fed with potato mash, barley husk, and clover and barley straw, in ten examined the milk was sour, in three very sour.

"(*c.*) From among fifty cows, fed on potato husks, barley husks, and wild hay, five were examined, and in all the fresh milk was sour.

"(*d.*) From fifty-two cows fed on potato mash, husks, wild hay, and rye straw, out of twelve selected for examination, the fresh milk of all was sour.

"(*e.*) From six cows, fed by a chief gardener on coarse beet-root, red potato, bran mash, and hay, the fresh milk was slightly sour.

"(*f.*) From five cows, fed by a cow-feeder on lukewarm bran mash and hay, in four the fresh milk was quite neutral, in one it was decidedly alkaline. * * * *

"Dr. Mayer does not believe that this acidity is due to want of exercise so much as to the unscientific manner in which the cows are fed. * * * *

"He considers the potato mash the cause of the acidity. The milk of the cows of gardeners and cow feeders is usually praised by the Berlin women as being particularly good. But Dr. Mayer has observed that it often gives rise to diarrhœa and cutaneous (skin) eruptions in children; which, he supposes, is due to the cows being fed with the cabbage, turnip and potato refuse. The very worst milk is that supplied by cows fed on potato refuse from brandy distillers; the best among the stall-fed being that obtained from the cows of cow fatteners, which feed on hay and grass in stalls. By substituting the milk of the latter for the former, he was often enabled to arrest at once the intestinal derangements previously referred to."

All physicians know how intolerant infants are of acid milk, and nursing mothers generally have a strong prejudice against eating acid food.

Dr. Lewis Smith, of New York, in his work on the "Diseases of Infancy and Childhood," says: "Milk used for infants should always be alkaline. If it is acid, as shown by the proper test, it should be rejected."

A striking illustration of the evil effects of the milk of slop-fed cows on children was afforded Dr. C. S. Merrill, of this city, in the case of his own two-year old child. The facts are briefly these: While traveling in Germany with his family in the summer of 1884, they stopped at a hotel in Neuhausen. The day after their arrival at this hotel, his child, who was previously well, was taken with a diarrhœa. The doctor, after having been assured by the landlord that the milk supply was from his own cows, kept at grass upon the premises, restricted the child's diet to milk alone; but finding him growing rapidly worse made a private investigation of the source of the milk supply, and found the cattle confined in a barn; and learned from the cow-feeder that they got nothing save the refuse matter from the table of the hotel — mostly stale fruit. He immediately left that hotel and his child speedily recovered, notwithstanding he continued with a milk diet. That the sickness was due to the milk of these slop-fed cows there can be but little doubt, as the other sanitary conditions were good. The hotel stood on high ground, and some distance from any other building.

Dr. Hassall, in his work on "Food, Its Adulterations," etc., says: "As is well known, a very considerable number of the cows which

supply London with milk are kept in various confined and unhealthy places in the metropolis; such cows are seldom turned out to grass; the system of feeding adopted being altogether artificial and unnatural, brewer's grains and distiller's wash forming much of their food; these stimulate the animals unnaturally, and under the stimulus large quantities of milk of inferior quality are secreted, the cow quickly becoming worn out and diseased in consequence."

He also quotes Mr. Harley as saying: "Brewer's and distiller's grains and distiller's wash make the cattle grain-sick, as it is termed, and prove injurious to the stomach of the animal. It has been ascertained that if cows are fed upon these grains, etc., their constitutions become quickly destroyed."

Another danger which may occur from feeding brewer's grains is seen in the following circumstances: A few years ago in "The Brown Institution," England, it was found by experiment that brewer's grains afforded a most favorable soil for the development of the *anthrax* germ (*Bacillus Anthracis*). The disease (*Anthrax*) was produced in cattle by feeding them the grains in which the germs had been cultivated. Also an epidemic of this disease broke out in about 1879, in a district in England, which had been previously free from it, and it was found upon investigation that all of the cattle infected had been fed upon grains from one particular brewery. It does not appear how the grains became infected.

The well-known effect of drugs given to the mother, upon the child; the peculiar odor of milk from cows fed upon turnips, cabbage, onions, etc.; the change of taste of the milk by feeding the cow wormwood, decayed leaves and other bitter substances; the change of color produced by feeding saffron, rhubarb, madder, etc.; the poisoning produced by milk from cows having eaten poisonous plants, though harmless to themselves, all go to show that the milk of a cow is quickly influenced by what she eats, and that it is deleteriously affected (as a food for infants at least) when the natural food is wholly or in great part substituted by artificial, especially if the "artificial" be in an advanced state of fermentation or putrefaction. But how much artificial, in a good healthy condition, may be given with the natural is a question yet to be ascertained by experiment.

The effects of the sanitary condition of the cow upon her milk, and the probability of milk being the agent in transmitting disease from the cow to the human being have received special attention from scientists of late, and they have shown that this branch of the subject overtops them all.

If unnatural food will impart pernicious properties to milk, it would seem that unnatural surroundings would produce still more injurious effects. And observation strongly supports this supposition. It is frequently seen that the milk of mothers suffering from emotional disturbances, as hysteria, anger, fright, etc., will produce convulsions and other violent symptoms in the child. It is also known that fatigue of the mother has vitiated her milk. Though a cow greatly differs, mentally, from a human being, no one who has

ever seen her appearance and actions when her calf has been ruthlessly taken from her will doubt that she is susceptible of deep emotion. Cases are on record showing that the milk of cows driven too great a distance has produced severe sickness in children.

In the light of analogy we see that cows are affected pretty much the same way by the same influences as mankind, and with this view their treatment is an important factor. Depression of spirits in man is known to be a fruitful source of indigestion, and one of the marked phenomena of digestive derangement is a change in the character of the secretions (or excretions). Many cow owners are aware of this fact and treat their cattle with great kindness, some as a matter of conscience and others as a matter of economy.

The shameful and repulsive manner in which cows have been kept and doubtless are still so kept in many localities is related by Routh: "I have, in the course of a large dispensary practice, visited some of the wretched inhabitants living either in the immediate neighborhood or over these sheds (cow-sheds). On one occasion I remember having to cross through the shed to get to the small upper room above it, where lay a child infected with fever. The puddles of liquid and fœcal matters through which I was forced to pass, and the abominable odor pervading the apartment, I have not forgotten; and yet from this cow-shed a large proportion of the neighborhood was supplied. The character of disease which attacks the wretched inmates of the small, close cottages just around it is always low, if not typhoid."

He also quotes from the *Lancet* of 1855, volume 2, page 551, the experience of Dr. Normandy: "Dr. Normandy states he was lately in the neighborhood of Clerkinwell, for the purpose of examining a well in that locality, when he met with a sight which prevented him from tasting milk for six months afterward. He there saw from thirty to forty cows in a most disgusting condition, full of ulcers, their teats diseased, and their legs full of tumors and abscesses; in fact quite horrible to look at; and a fellow was milking them despite of all these abominations. This was by no means an exceptional case, a great many dairies being in the same condition. The milk in consequence provided was really diseased milk. This state of the poor animals must have been produced by the manner in which they were kept."

To show that these conditions are not all confined to the lower class, we quote from the same author: "The filthy state in which some cow-houses were found in 1857 by Dr. Lankester in the aristocratic district of St. James is also evidence of a most disgraceful state of things, formerly very generally prevalent."

Dr. Hassell, in his work on "Food; Its Adulteration, etc.," cites instances of the same shocking conditions in which cattle are kept.

A similar state of things was found in New York and Brooklyn in 1859. A report on the investigation was made by S. R. Percy, M. D., and published in the "transactions" of the "New York Academy of Medicine," Vol. II, part 4.

The writer well remembers when a boy in the country, of seeing herds of cows huddled together in a small yard with nothing to sleep upon but their own excrement, and also seeing their udders so befouled as to make the not too fastidious owner partially cleanse them before milking, and a perceptible taste of fæces has been imparted to milk in this way.

The effect of these conditions upon the cow herself is shown by the great mortality of cows so kept. Routh says in reference to this: "One cow-keeper, out of a large number, lost one year 90; another, who keeps a good stock, lost 300 in six years; another with from 400 to 500 cows, considered it not bad luck to lose two cows weekly from disease. Insurance prices tell a tale. * * * They consider the risk on town cows three times as great as on country cows."

Besides the direct effects of these filthy conditions their indirect effects may be productive of still greater evils in fostering the germs of disease.

The accumulative evidence is constantly strengthening the "germ theory" of disease, which is, briefly, that the morbific material is a living germ. It is known that filth favors the development of germs. In this way the filth may serve to propagate infection among cattle.

The danger attending the use of milk from diseased cows will be seen from the following demonstrated facts: Apthous fever, or foot and mouth disease, is a highly infectious febrile disease of cattle characterized by a vesicular eruption upon the feet, mouth and udder, and their milk has been shown by experiment to convey the disease to man.

Dr. Billings, in his book entitled "Relation of Animal Diseases to the Public Health," says upon this subject: "Dr. Hertwig (of the Veterinary Institute, Berlin, Prussia) first proved the same by direct experiment. He drank daily, for four consecutive days, a quart of milk taken from cows having the disease. On the second day he observed a mild fever, pains in the limbs, headache, a dry and hot throat, and a peculiar sensation in the hands and fingers. These mild phenomena continued about five days; then the lining of the mouth became swollen, especially the covering of the tongue. In a short time small vesicles began to develop. At the same time that these symptoms appeared in the mouth and on the lips, there appeared an eruption of similar character upon the hands and fingers. Two medical practitioners also subjected themselves to the same experiment, and at the same time similar results followed." * * *

"The danger from the consumption of the milk of cows afflicted with this eruption is most emphatically demonstrated by the fact that young animals fed upon the same frequently perish in consequence of gastritis, *i. e.*, inflammation of the stomach and bowels. For man, milk from such cows, to which 90 per cent normal milk has been added, is still dangerous when consumed."

He also cites many cases showing how readily this disease is communicated from the cow to man.

Inflammatory diseases of the udder, even in a mild form, produce perceptible changes in the milk; one of which is a condition resembling the milk shortly after calving, known as colostrum or "beastings," and which acts as a laxative, when taken in small quantities, upon children; and doubtless when taken in large quantities or continued small quantities would produce severe intestinal irritation.

Blyth says of milk taken from a heifer suffering from inflammation of a portion of her udder, "The milk was pink in color, and contained about a twentieth of its bulk in blood; it was perfectly fresh when examined, but rapidly putrefied."

The same author also says of a sample of milk drawn from an udder diseased with consumption (after giving its chemical analysis) "the whole quantity of the fluid did not exceed 70 c. c. (about two and one-fourth fluid ounces). It was of dirty amber color, with the casein partially separating.

"A microscopical examination showed very few fat globules, and the following abnormal elements:

"1. Clusters of oval or round granular cells, for the most part .0005 inch in diameter, with a well-marked oval nucleus.

"2. Granular masses, irregular in shape, varying in size from about 0.0006 inch to ten or twelve times that size.

"3. Granular rounded bodies, stained brilliantly by magenta or carmine.

"This, then, is phthisical (consumptive) milk in its most intense form, and one never likely to be found in commerce, but admixture of such a fluid with genuine milk is possible." * * *

The milk of a cow suffering from typhus also shows marked changes; a deficiency of all the solid ingredients, except the salts, an increase of the watery element and salts, and sometimes the presence of blood and matter.

We had an occasion within a few weeks of observing the appearances of milk from a woman suffering from a mammary abscess. The gross appearances were marked. The milk was thick and viscid, of a bluish yellow color, very much resembling the pus from the abscess, though the microscope did not reveal any pus corpuscles or other abnormal elements.

Dr. Percy, of New York, gave some drawings (in the "Report of the New York State Medical Society," for 1860) showing the microscopical appearances of a sample of milk taken from a cow in a state of high fever from inflammation of the bowels. It contained broken-down fat globules and a low form of vegetable growth called conferva. It also contained blood corpuscles and was scanty and blue.

The recent experiments upon milk in regard to its being the medium through which disease is communicated from animals to mankind have shown some startling results. They have conclusively shown that the milk of a cow affected with apthous fever (foot and mouth disease) will, when taken, produce a similar disease in the human being. Enough of the experiments to demonstrate this were given above.

They have shown that it is more than probable that the disease, "anthrax," may be so transmitted. This is a highly infectious febrile disease, which is very fatal to cattle, as well as to some other domestic animals. It is known to be due to a vegetable parasite, one of the specific forms of bacteria. The blood of the animal affected is known to contain the specific germ of the disease and has produced the disease in other animals when inoculated with it. The milk of sheep affected with anthrax is known to have produced it in other animals.

This disease in man is known as malignant pustule, and has in many instances proven fatal. Men have taken it when inoculated with the products of the cow and from handling such diseased cattle, and from the consumption of the meat.

George Fleming, F. R. G. S., etc., in his "Manual of Veterinary Sanitary Science and Police," says, in reference to the milk of cattle affected with anthrax, "The examples of its pernicious effects are not numerous. Gohier mentions that he has known a case in which a man was attacked with severe diarrhœa, from consuming the milk of a cow affected with anthrax. He has also witnessed the same occurrence in a family of five persons. Morris reports a similar occurrence. Chisholm gives the case of a girl, three years old, who presented all the symptoms of anthrax from drinking the milk of a diseased cow. Desplas has given some instances, noted during an epizoöty of anthrax at Quercy, in which the malady was transmitted to other creatures by the milk."

Blyth (Ed. 1882) relates the following: "*A new form of febrile disease associated with milk*—The milk from a dairy near Aberdeen appears to have been the propagating agent of a peculiar and entirely new malady. This remarkable outbreak has been investigated and described with great ability by Dr. Ewart. Twenty persons were attacked, and there were three deaths. The symptoms consisted essentially of fever, with one or more relapses, and swelling of the cervical glands, frequently ending in suppuration. The connection of the epidemic with the milk supply was established by the fact of the illness being confined to those who drank the milk, as well as by the microscopical appearance of the milk, and some well-devised experiments on animals."

"The microscopic appearances of the milk showed:"

"1. Numerous micrococci (bacteria), some free, others in groups or chains."

"2. Numerous spores and cells of the yeast plant."

"3. Spores similar to bacteria anthracis."

"Some pus from the neck of one of the patients was found to contain bacilli and spores (germs) apparently identical with those found in the milk, and such pus caused fatal illness when injected into small animals subcutaneously (under the skin). These elements were submitted to cultivation, and a variety of experiments on rats were instituted with the suspected milk, side by side with control experiments with healthy milk, the main result being to prove satisfactorily a direct connection between the bacilli and the disease."

"The evidence pointed to a contamination of the water supplying the dairy, and the author concludes that the organism producing this new fever was morphologically not unlike the anthrax organism in its mode of development and life history; and, further, that it was introduced into the milk after it had left the udder."

If Blyth's opinion is correct as to the source of the contamination being the water, though he does not state the evidence that led him to this conclusion, then this would bear more strongly upon the danger of adulterating milk with water.

The experiments relating to milk as a conveyor of tuberculosis (consumption) from the cow to the human being have shown facts of the deepest importance to all.

It has long been suspected that consumption was infectious, and the possibility of the patient transmitting the disease to others through his breath and expectorations has been guarded against by the physician, but experimental knowledge of this subject is one of the striking evolutions of modern scientific advancement.

Most of the leading pathologists of Europe, and many of other parts of the world, have demonstrated experimentally the infectiousness of tuberculosis (consumption).

In Europe, Villemin, Chauveau, Klebs, Gerlach, Virchow, Harms and Gunther, Böllinger and many others, but those of a few of them will answer our purpose.

Villemin, who was one of the first to experiment in this direction, inoculated rabbits, sheep, dogs and cats with matter taken from the tuberculous tissues of the human being, and in many instances succeeded in producing the disease in them. He also produced the disease in some of these animals by feeding them the diseased parts.

The following is an abstract of cases cited by Fleming: Chauveau, of the Lyons Veterinary School, has fed cats and young cattle on tubercular matter, and produced tuberculosis in them after a certain period. Harms and Gunther, of the Hanover Veterinary School, have induced the disease in rabbits by feeding them with the flesh and lungs of a tuberculous pig and phthisical (consumptive) cow.

Liesering, of the Dresden Veterinary School, fed a sheep for three days on the tuberculous lymphatic glands of a cow. After the fifteenth day the thermometer indicated an increase of the temperature of 1° to 1.5°. On the sixth week there were cough and emaciation; and toward the tenth week the breathing was hurried; and a physical examination showed that the right lung was diseased. The sheep was killed on the eighty-fifth day, and an examination of its body showed that the various internal organs were tuberculous. He got the same results from sheep and rabbits fed upon a very small amount of tubercular matter. He also says that successful inoculations have been made with tubercular matter from a patient who had been dead for thirty-six hours; and with sputa (expectorations) which had been in a dried condition for twenty days. Also the disease has

often been produced by experimenters through inoculation with the sputa (expectorations) from tuberculous subjects.

Flemming relates an instance where a Grecian physician of Syra, by the name of Zallouis, inoculated a man who was suffering from gangrene of the foot, with the expectorated matter of a person affected with consumption, and in three months the inoculated man died with unequivocal signs of consumption, which a *post-mortem* examination verified.

The following, from Billings, will show the influence of the breath of a tuberculous subject in communicating the disease: "Too many sad cases of death from tubercular consumption have been unquestionably traced to the influence of expired air from persons having the disease, upon nurses and others around them, even in cases where any inherited disposition to the disease could be excluded beyond all question." "Most strikingly, yes, shockingly, illustrating this point, viz., *the infectiousness of the breath of persons affected with tuberculosis*, are the cases given by Dr. Reich in the "Berliner Klinische Wochenschrift," No. 37, 1878. * * * * * * In these cases the disease was transmitted to *ten* children by a nurse who had the habit of sucking at and blowing into the mouths of such little ones as were born asphyctic (asphyxiated)."

"Dr. Reich sums up his observations as follows:

"1. In the time which elapsed from the summer of 1875 to the fall of 1876 (July 11 to September 29), there died at Neuenburg, of meningitis tuberculosa, ten children that were born between April 4, 1875, and May 10, 1876.

"2. There was no ascertainable disposition to tuberculosis in any of the ten children.

"3. All these ten children were brought into the world by the nurse Sanger.

"4. In the practice of the nurse Regisser (in the same town) not one single child died or sickened of tubercular meningitis during the same time.

"5. The nurse Sanger suffered from tubercular consumption at the time. In July, 1875, an examination of her lungs revealed cavities in the same, and she raised purulent ichorous sputa. She died from the disease July 23, 1876.

"6. Nurse Sanger had the habit of removing the mucous from the babies' mouths by means of suction with her own; and of blowing her own breath into the mouths of asphyctic children; and, in general, treated children in a manner which rendered it possible for the expired air from her lungs to get into theirs, kissing them much, etc.

"7. In three of the cases of tubercular meningitis which came to my personal observation, the sickness began with bronchitis.

"8. Meningitis tuberculosa is not an endemic disease among children at Neuenburg."

"In the nine years, from 1866–74, only two deaths are reported from this disease among children under one year old. Of twelve

children, under one year old, that died in 1877, only one died from this disease; the parents of this child were both subjects of tubercular consumption."

The production of tuberculosis with milk by inoculation and ingestion, it is asserted, was first accomplished by Gerlach of Berlin. He asserts that the infectious properties of this fluid can be no longer denied. (The details of his experiments may be found in the "London Veterinary Journal," Vols. 8, 9 and 10.) We will give a few quoted by Billings. "Having a cow afflicted with tuberculosis that still gave milk, it was resolved to use the same to test the question '*whether the milk from such cow is capable of producing a similar disease in young animals when fed upon it.*'" "The cow was seven or eight years old, much emaciated, respiration difficult, and had a rough, weak cough; vesicular respiration perceptible over all parts of the thorax (chest), which inclose the lungs, but numerous unnatural, especially dry 'râles' were perceptible. *In no place was the percussion deadened.* No fever; appetite good; daily milk quantum 1,500 grammes (about 3 1-2 pints). After the lapse of three months the cow was killed. The emaciated condition had gradually increased; the milk-secretion likewise decreasing; in the first month the yield of milk decreased 600 grammes (about 1 1–5 pints); in the second 500 grammes, and during the last eight days the secretion ceased entirely, although the animal received all the nourishment she could consume." The result of the *post-mortem* examination shows (without giving Billings' details) that the lungs and their appendages were extensively tubercular. "With the milk from this cow were fed two calves, two pigs, one sheep and two rabbits. The first calf died from an accidentally acquired disease."

Calf No. 2.—A healthy, well-nourished calf, eight days old, was fed with milk from the above-mentioned cow, for a period extending over 1 2-3 months; at first it received 1,000 grms. (about two pints and three-tenths pints), and later 300 grms. of milk daily, an average of about 650 grms. per day; in fifty days the whole quantity of milk consumed amounted to from thirty to thirty-two kilogrammes (about from thirty-four to thirty-six quarts). Aside from this, the calf received other milk; later, diluted milk and oatmeal. Neither phenomena indicating the presence of disease, nor disturbance of the nutritive functions, were observable. The calf was killed 100 days from the time that the experimental feeding began, and fifty days after the feeding with milk from the tuberculous cow had ceased."

I give the following synopsis of the *post-mortem* examination: The lungs, their appendages, the lymph glands of the neck and abdomen, were found to contain tubercles. The microscopical examination of the tubercles gave the same characteristics as those in man. Some of the experiments with the other animals mentioned previously gave negative, while others were followed with positive results.

"These and other more recent experiments prove *that the milk from cows with tuberculosis is not only harmful, but that*

it also contains elements of a specifically dangerous character; it is capable of generating elements of a similar character; it, therefore, bears the character termed infectious."

Böllinger fed three pigs, three calves, one sheep, two dogs, two cats, eight rabbits, on the unboiled milk from a tuberculous cow; of the three pigs he produced the disease in one—failed in the other two; of the three calves he produced the disease in two; he produced the disease in the one sheep, and failed in the cases of both cats and dogs; of the eight rabbits he produced the disease in two, and failed in six. He failed to produce the disease in fourteen rabbits fed with milk boiled.

Gerlach produced the disease, by feeding the unboiled milk of a tuberculous cow, in two calves, two rabbits, two pigs and one sheep.

Klebs has produced the disease in the same way in nine guinea pigs.

Blyth states that "the accidental infection of a large St. Bernard dog, which, having come across the milk designed for one of the experiments, drank it, and became tuberculous, is perhaps more striking than a formal experiment."

M. Peuch fed two pigs and some rabbits upon the milk of a tuberculous cow, and found upon *post-mortem* examination they all had the disease.

In the *Medical Record* of October 15, 1881, we read: "Prof. Demme, physician to a children's hospital at Berne, had brought to his care an infant about six months old. The child was born of vigorous and healthy parents, and it weighed at birth 6 1-2 pounds. It had been nursed by its mother for five months, and had during that time doubled its weight, continuing healthy in every way. In the sixth month it was weaned, and received regularly, besides other food, the milk from a single cow. Very soon the infant began to sicken; the abdomen became enlarged; from time to time it had diarrhœa; an examination of the thoracic organs (lungs, etc.), revealed no signs of disease. Prof. Demme prescribed the most careful and nutritious diet, adding to the regular amount of milk, beef juice, brandy, etc. The patient continued to lose flesh, however, and died in about four months. The autopsy revealed tubercular lesions (changes in tissues from disease) in the intestines." * * * "The lungs and minings were normal. Two months later the cow from which the milk for the infant had been obtained died. On opening the body, the lesions of the pearl disease (consumption) were found to be strikingly developed. As the family of the child was perfectly healthy, including two older brothers, the case looks somewhat like one of tuberculous infection." * * *

"And this case is sufficient to be a warning to physicians that they learn something about the health of the cow when its milk alone is used by an infant patient."

In the "*British Medical Journal*," of August 26, 1882, under the heading, "the flesh of tuberculous animals," we find the following:

"The city physician of Vienna, Dr. Kammerer, has addressed a report to the magistrates of that city on the dangers which threaten the health and life of the population through animals affected with tuberculosis. The victims are insidiously struck down, says Dr. Kammerer, through two of the most important articles of daily diet, milk and meat.

"The milk of cows with tuberculosis acts as an unconscious vaccination upon adults and children who partake of it; and, in the case of the latter, the seed of tuberculosis is being imperceptibly sown amongst thousands in the great towns.

"Dr. Kammerer regards infection by this channel as being quite as fruitful a source of the disease amongst the young as hereditary, to which it is usually traced." * * *

In the *Veterinarian* (an English journal) for February, 1884, will be found the following: "We are glad to direct attention to some experiments of Dr. Ferd. May, published in the first part of the 'New Archiv für Hygiene.' Pieces of lung, infiltrated with tubercle, were finely divided and rubbed up in a mortar with milk. The milk thus prepared was injected subcutaneously (under the skin) into guinea-pigs. Tubercle in the majority of the cases followed, but there were many failures. In a second series of experiments the milk, contaminated as before, was boiled from a quarter of an hour up to three hours; but, though sixteen animals were operated upon, no effect followed. It also seems established that if the milk-producing gland is itself infiltrated with tuberculous deposit the secretion is far more dangerous than if derived from a cow much advanced in phthisis (consumption), but with the mammary gland unaffected. It would be interesting to know, from the experience of our veterinary surgeons, whether they ever met with local tubercle in the udder of milch cows, the rest of the system being, comparatively speaking, unaffected. In the light of recent research, we can but admit that such an occurrence would infect a milk supply, and produce what might be called an '*epidemic of consumption.*' If there is a difficulty in referring outbreaks of scarlatinal and enteric (typhoid) fevers to infected milk in which the period of incubation is approximately known, how much more difficult to prove the connection between milk corrupted with tubercle, and a number of cases of consumption, which, from the slow, insidious nature of the malady, would probably develop at various dates and be ascribed to various causes. We recommend medical officers of health to study closely the incidence of tuberculosis in young children, especially those brought up by hand, and repeat the advice given in a former article, namely, in the present unsatisfactory state of the milk supply, to drink no milk which has not been boiled. — *Medical Times and Gazette.*"

It seems to be pretty well established that a variety of consumption in the cow, called "perlsucht" by the Germans, is identical with a form of tuberculosis in man. The following is an abstract

of what Charles Creighton, M. D., of the University of Cambridge, says in the London *Lancet* of June 19, 1880, in reference to this: He found in the *post-mortem* examination of seven cases of death from consumption conditions identical with those of perlsucht. And in reference to the history of one of the cases, who was alleged to have had typhoid fever six months before her death, he says: "A doubt is suggested whether the disease six months before was really typhoid fever; and that doubt would extend to certain other cases, or groups of cases, supposed to be typhoid, and more particularly to the remarkable group of four cases recorded by Dr. W. H. Spencer. I do not doubt, after reading Dr. Spencer's cases, to which my attention was directed by Dr. Bradbury, that the outbreak in the Industrial school, of which they formed the fatal contingent, was not an outbreak of typhoid, but one of bovine tuberculosis."

He quotes Prof. Virchow as saying in 1877: "It has, in the first place, been determined, by the inoculation upon animals of substances from other animals that have died of perlsucht, that the disease may be communicated exactly in the same way as in the inoculation of tuberculosis. On that point, there is in Germany no longer any doubt. A further question is whether, by the partaking of substances coming from a tuberculous animal, similar, and, in fact, tuberculous diseases may be induced in man? This question divides itself into two points: In how far such an infection may arise from the partaking of flesh; in how far through milk." Dr. Creighton believes his cases were infected through the cow, and says that "the bovine disease in man shows the same features as in the cow." He also says that "it is in the juices and particles of the tainted animal that we must suppose the contagion to reside."

The British Medical Journal of December 2, 1882, in giving a review of a German work edited in Berlin, relates the following: "Prof. Johne, of Dresden, contributes the article on pearl disease and tuberculosis of cattle, which he maintains to be identical with human tuberculosis, and to be communicable by means of the milk."

Dr. Johne considers this well proved, that the milk of tuberculous cows is as capable of conveying the disease to man as it is to their own offspring (and as, presumably, that of human tuberculous mothers is to theirs), and should, therefore, not be used."

"Dr. Esser, treating of milk, is equally decided as to the communicability of tubercule by its means, as well as of foot and mouth disease. * * * Though boiling destroys the activity of the poison. In acute febrile states, the milk is altered, and Wiedman asserts that he has seen a pneumonia anatomically identical with the bovine form, produced in children by the use of milk from cows suffering therefrom."

There have been numerous failures in endeavoring to communicate this disease, by all experimenters, but they would not militate against the successes unless they were in very large proportion, as we all know that of many who are exposed to contagious and infectious diseases but comparatively few contract the disease.

Many more circumstances of the same character might be adduced in reference to the subject of tuberculosis as well as to all the subjects pertaining to the sanitary condition of the cow.

We have dwelt somewhat upon this branch of the subject, as it is comparatively new, and we deem it by far the greatest source of danger to the public, and from which they are the least protected.

Doubtless many injurious effects are imparted to milk from the careless manner in which it is often kept and handled after being taken from the cow. Fleming says, under the head of "Anomalies in coagulation," "the alterations in this group are characterized by the fact that milk, perfectly normal at the time when it is drawn, acquires abnormal qualities during the time of coagulation, which are, according to Haubner, due to the existence of special ferments, which are produced in the milk at the expense of the blood or modified mucous which may be mixed with it, or they are derived from without. These ferments are not volatile in some instances — cannot be conveyed by the air, but are frequently transmitted to healthy milk by means of the dairy pans and also during the evaporation of the milk. Damp, hot weather and an atmosphere charged with vapors, and dirty, ill-ventilated dairies are favorable to their propagation."

It is also thought by some that the so-called blue milk, that is, milk characterized by a low form of vegetable growth which has the property of imparting a blue color to the milk, is due to the want of cleanliness in the dairy. This milk has produced fatal effects in children.

There is a form of milk which is covered with yellow transparent patches, and has in it bubbles containing gas. But little butter can be made from this milk and that quickly decomposes and the milk has a bad taste. Fleming says "this alteration appears to be due to the ferment, and may be artificially excited by vegetable acids; bad dairies and uncleanliness are the favoring circumstances."

Another important consideration of cow's milk is in relation to its forming the basis of diet in the treatment of exhaustive diseases, and also as the curative agent in the treatment of many diseases.

In order to give a correct appreciation of the importance of this phase of the subject, it will be necessary to make some statements regarding the treatment of disease. Within the past half century a reversion has taken place in the method of treating disease. The present plan is based upon the principle of conservatism, that is, as well as any thing pertaining to a rational science can be formulated, there is a large class of diseases, including all of the inflammations and fevers, except the "malarial," which cannot be arrested by any known means, but which are self limited. The idea in the present plan of treatment is to "preserve the powers of life," till the disease runs its course. In view of these facts the importance of diet will be readily seen. Prof. Austin Flint of New York, the celebrated author of a work on "The Theory and Practice of Medicine," says: "It may, perhaps, safely be said that the greater success

attending the management of disease now, than heretofore, is due as much to improvements as regards diet, ventilation, etc., as to the more judicious use of remedial agencies."

Milk has latterly attained first place among the articles of diet for the sick. Prof. Bartholow, now of Philadelphia, the author of a standard work on "Therapeutics," says "milk is one of the most important articles of food for the sick, and enters largely into the composition of various diets." * * * * * * "Whenever fresh and pure milk can be procured, this only should be prescribed for the sick, but in large cities it is not always practicable to obtain it. Under these circumstances 'condensed milk' must be used." * * * * * "The numerous and important applications of milk diet in the treatment of certain forms of disease render it necessary to devote considerable space to the consideration of this subject. Milk is a food already prepared and, therefore, needs no intervention of unskillful cooks; it can be obtained everywhere; few patients are disinclined to take it, etc., etc."

The preference for milk is not founded wholly upon empiricism either; for scientific investigation shows that milk possesses the requisites for the nourishment of the sick, which are variety of alimentary principles, concentration and digestibility.

As to the variety of the principles we have stated, while dealing with milk as a "food for infants," that it contained all of the three classes of alimentary principles which are essential to the proper nourishment of the body, and it is important to bear in mind that it has been shown by actual experiment that we cannot be deprived of either one of these three classes, for a great length of time, without fatal results; and, furthermore, that they should be in proper proportion to each other, as an excess or deficiency of either, is injurious.

Unadulterated commercial milk probably fulfills these conditions more perfectly than any other article of food.

It would be interesting to you, no doubt, to read the experiments relating to the effects of feeding animals upon a diet including only one or two of the three classes of alimentary principles, but as the scope of this report is too limited, and as they can be obtained in all works of Physiology, I refer you to them.

Concentration within certain limits in the nourishment to be given to the sick is essential. In a state of health nature furnishes the guide as to the time for, and the amount of, food to be taken in the instinctive senses of hunger and satiety; but in diseased conditions these senses are perverted, and there is generally a repugnance to food; and, in the case of fevers, in which there is probably living germs in the blood, multiplying themselves at the expense of the nourishing elements, there is rapid destructive chemical changes going on throughout the body. The following is the graphic form in which it is put in the Encyclopedia Britannica, volume VII: "Now, fever closely resembles muscular effort in its arrest of the digestive functions, at the same moment that it makes an urgent de-

mand for nutriment, with ultra Egyptian vigor, while straw is withheld "The tale of bricks is doubled," and we know by the quantity of urea and phosphates in the urine, and by the fœcal excretion that the muscles and nerves of the bed-ridden sufferer are melting away as fast as if he were scaling the Alps with nothing to eat."

To give any thing like an accurate idea of the concentration of nourishment in milk, it would be necessary to show the comparative nutritive value of the many different articles of food, and that is attended with more difficulty than might be supposed, as it involves a thorough knowledge of the functions of the different classes of elements; and to a great extent, the process of digestion, and at the present time, this subject is undergoing great changes, and consequently there is diversity of opinion. The space and time allotted me forbids going into any such field. However, something of an estimate can be formed by comparing milk with beef. Taking the chemical analysis of each, from a table showing the nutritive values of food given in Letheby's work "On Food," we find that beef (a food very rich in nutrients) contains:

		Per cent.			Per cent.
Lean Beef without bone	Water	72	New Milk	Water	86
	Albumenoids	19.3		Albumenoids	4.1
	Starch	....		Starch	...
	Sugar	....		Sugar	5.2
	Fat	3.6		Fat	3.9
	Salts	5.1		Salts	.8
		100			100

According to the above figures lean beef contains 28 per cent of solids and milk 14; that is, one-half; so if a pint of milk weighed a pound, one quart would contain as much nutrient solids as one pound of lean beef (of course fat beef would contain a much larger proportion of solids). Another method of determining the nutritive value of foods is based upon the amount of carbon and nitrogen they contain; and comparing that with the amount of the same required to sustain the body. Dr. Edward Smith found by examining the amount of food upon which a class of factory people in Lancashire, England, were able to live during a cotton famine to contain for an average adult, per day:

Carbon (grains).	Nitrogen (grains).
4,100	190

And from a table constructed upon this basis in Letheby's book we find beef and milk contain the following comparative amounts:

	Grains, carbon.	Grains, nitrogen.
1 lb. beef.....	1,854	184
1 lb. new milk (about 1 p't)	599	44

We see by this method of comparison that a little over three pints of milk are equivalent to a pound of beef. But there

is a great disparity in the proportion of the ingredients in beef. A large excess of albumenoids, and a diminution of carbohydrates; then, there is considerable loss in cooking beef. Furthermore, beef is much more difficult of digestion than milk, and as the diet of the sick (especially in fevers) is fluid, beef enters into it only in the form of teas, soups and the so-called essences or extracts, and its value then as compared with milk may be estimated from the following facts: "Liebig's extract of meat," one of the best liquid forms of meat and which enjoyed a great reputation a few years ago as a food for the sick, and is yet used, contains, according to Letheby, only from three to four parts of the 26 to 30 per cent of solid nutrients of beef, and one-quarter of these are salts; the other three-quarters consist of unknown extractive matters, and there is no albumen or fat. Perhaps it is needless to say that milk has pretty nearly supplanted all these as the basis of food in exhaustive diseases, especially fevers.

James E. Wilson, M. D., the author of the recent work on "continued fevers," says, that "milk occupies the first place among fever foods."

The egg presents a greater concentration of nourishment than milk, and when raw is as easily digested, but few can tolerate raw eggs, besides without the shell it is deficient in the variety of principles, and, according to our experience, it is too concentrated for fever patients; and if diluted with any thing palatable besides milk it is inferior to it.

In reference to the digestibility of milk Prof. Austin Flint, Jr., of New York, in his great work on "Physiology," says: "Milk is one of the articles digested in the stomach with greatest ease. Its highly nutritive properties and the variety of principles which it contains make it extremely valuable as an article of diet, particularly when the digestive powers are impaired, and when it is important to supply the system with considerable nutriment."

The following, showing the time required by the stomach to digest different articles of food, is taken from a table in "Flint's Physiology." Enough only are taken to show a fair comparison for milk:

Articles of diet.	Mode of preparation.	Hours.	Minutes.
Milk	Boiled	2	
"	Raw	2	15
Beef, fresh, lean, rare	Roasted	3	
Beefsteak	Broiled	3	
Beef, fresh, lean, dry	Roasted	3	30
" with mustard	Boiled	3	10
" with salt only	"	3	36
"	Fried	4	
Soup, barley	Boiled	1	30
" chicken	"	3	
" mutton	"	3	30
" oyster	"	3	30

Articles of diet.	Mode of preparation.	Hours.	Minutes.
Soup, beef, vegetables and bread.	Boiled	4	
Lamb, fresh	Broiled	2	30
Mutton, fresh	"	3	
Veal, fresh	"	4	
Pork, steak	"	3	15
" fat and lean	Roasted	5	15
Turkey, wild	"	2	18
" domesticated	Boiled	2	25
" "	Roasted	2	30
Chickens, full-grown	Fricassied	2	45
Fowls, domestic	Boiled	4	
Ducks, domesticated	Roasted	4	
Oysters, fresh	Raw	2	25
"	Stewed	3	30
Eggs, fresh	Raw	2	
"	Whipped	1	30
"	Soft-boiled	3	
"	Hard-boiled	3	30
"	Fried	3	30
Custard	Baked	2	45
Codfish, cured-dry	Boiled	2	
Trout, Salmon, fresh	"	1	30
Bass, striped, fresh	Broiled	3	

It is seen by the table that milk is one of the quickest of articles to undergo stomach digestion. The addition of lime-water to milk is known to favor its digestion. Within the past three or four years a new impulse has been given to milk, and its value as a food for the sick much enhanced.

It is the casein of milk which seems to be the part most difficult to digest, and the new development is to partially digest this outside of the body by an animal ferment known as pancreatine. The milk so digested is called "peptonized." The writer has had considerable experience with this, and is convinced that milk is rendered much easier of digestion by this process.

From the little knowledge attainable it seems that milk (except the ash in adults) is as completely assimilated after digestion as meat or eggs.

It may be added in reference to the nutritive value and the digestibility of different foods, that the scientific knowledge of them is very imperfect at present, and the results only approximate. There has been but comparatively little research; and the subject is attended with much difficulty; for instance, a man is able to confine himself to one kind of food for so short a time that experiments on him cannot be continued long enough for conclusive results. And the investigation of the nutritive value of foods have been made mostly with reference to economy. But much interest has been manifested of late in regard to these matters and definite knowledge is increas-

ing, and is found to harmonize with observation which shows that milk is the most valuable single article of diet for the sick.

Milk is also found to be the best article in which to administer stimulants. By thoroughly incorporating spirituous liquors with milk, their irritating effects upon the stomach are nearly obviated, and the unpleasant taste liquors has to many is overcome; also, it enables us to administer the nourishment and stimulants together, all of which are valuable items in the treatment of certain diseases.

The date of the "milk-cure" extends away back into the childhood of medicine, and has experienced the vicissitudes attending the passage from youth to old age. We cannot go into its history and will content ourselves with stating the classes of disease to which it is applied with more or less success. Perhaps its greatest efficacy is in chronic stomach and bowel troubles; as, stomachal and intestinal dyspepsia, catarrh, neuralgia, ulcer and cancer of the stomach, chronic diarrhœa and dysentery. In these diseases it furnishes the requisite nourishment for the body at the least expenditure of labor by these organs, thereby affording them time for rest and recuperation.

It has had a high reputation as a cure for diabetes, and many cures have been reported. The various "dropsies" have been successfully treated by it. It is used in "Bright's disease" and gout with much benefit, and the hereditary tendency of the latter has been removed by its persistent use. Diseases of the heart and blood-vessels have been much improved by a milk diet. Certain forms of skin diseases have been cured by it, and we all know its value as a diet for consumptives, etc.

Finally, milk is rapidly taking the place of blood in the operation known as transfusion. This seems a natural result from the close resemblance it bears to that fluid. It has been said that "milk is blood without the coloring material." Dr. Hodder of Canada saved two out of three cases of cholera, after they had reached the stage of collapse, by transfusing milk into their blood; and cases of hemorrhage, after child-birth, have been successfully treated by this means. It is needless to state that milk must be absolutely pure for this purpose.

SUMMARY.

First. We have endeavored to show the importance of cow's milk as a food for infants, in that it is believed two-thirds of the infant population of the State, and three-fourths of the infants of cities, are wholly dependent upon it for their sustenance — and the number is constantly increasing, owing to the increase of mothers who are unable or unwilling to nurse their own offspring — and in the belief that commercial cow's milk is the only practical substitute for human milk.

Second. We have stated that milk is the perfect type of natural food, as it possesses all the three classes of alimentary principles, in proper proportions, to maintain the living animal organism.

Third. We have pointed out some of the various ways in which the purity of milk is affected, the chief of which are by adulteration,

sanitary conditions, feed of the cows, etc. We have stated that the common forms of adulteration are the taking off of fat and the addition of water. We have stated that taking off of fat was formerly carried on to a great extent, and shown its evil effects by pointing out the importance of fat in the economy. We have shown the danger of adding water by citing a few instances where epidemic disease has been propagated through milk contaminated with foul water. We have also shown that there is strong suspicion that milk affords a rich soil for rapid development of disease germs. Also, gave Blyth's account of a new form of febrile disease associated with milk, which was probably infected through water.

Fourth. In treating of the feed for cows, we have stated that she is quickly influenced by what she eats, and that certain kinds of food affect her milk deleteriously for infants, at least; citing a case in point of a child of a well-known physician of Albany, who was made sick by taking milk from slop-fed cows. Also giving the results of examination of milk from cows fed upon different kinds of food. Referred to experiments where brewer's grains have been used to cultivate certain disease germs and where the disease was produced in cattle from eating these infected grains.

Fifth. Under the head of sanitary conditions, we have shown how ill-treatment and unclean surroundings have injured the health of cows and thereby injuring their milk. Also cited appalling instances of filthy conditions in which cows were kept and disease produced thereby. We have cited experiments which prove that certain diseases are transmitted from the cow to man through her milk. We have also given the results of some of the chemical and microscopical examinations of diseased milk. We have alluded to dangers which may arise from milk which has been polluted by unclean surroundings after it came from the cow.

Sixth. We have given proof which establish the fact that there is a variety of consumption (and one speedily fatal, too) in the cow which is identical with a variety in the human being, and have given experiments which go to show that there is more than a strong probability that it is communicable through milk.

Seventh. We have endeavored to show the importance of milk in the treatment of disease by pointing out the importance given to diet in the modern practice of medicine. And, that, as it contains the variety of alimentary principles necessary to the body nourishment in a form easy of digestion, it is the most valuable single article of food for the sick.

Eighth. We have mentioned a new process for partially digesting milk outside of the body, and the curative agency of milk in some diseases, also its utility as a vehicle for administering stimulants to the sick. We have stated that milk is rapidly taking the place of blood for the purpose of "transfusion."

In conclusion we would add that much could be said upon milk in relation to its cheapness as a food in general, and to its many culinary uses; but it is to be understood that this report is not an ex-

haustive disquisition upon the subject. Our aim has been to show in a concise and suggestive manner the vitally important position this article occupies; and to point out some of the various ways in which, if left unprotected, it may become, instead of a boon, a most destructive element. While the State has intervened and removed many of these sources of evil there is much yet to be done, and nothing but constant and vigilant surveillance will keep this important article of food free from impurities.

It is desirable that a matter so important, and involving such great money interests, and in reference to which there is so much controversy and uncertainty, as the question whether brewers' grains are a healthy food for milch cows, or not, should be settled by an exhaustive and unprejudiced series of experiments.

Another matter we wish to emphasize is, the great danger to which the community is exposed in the consumption of milk from diseased cows.

There is an apparent indifference to this matter, but we have stated above sufficient tangible evidence to show that there is real danger. If Wiedman is correct in his assertion that "he has seen a pneumonia anatomically identical with the bovine form, produced in children by the use of milk from cows suffering therefrom," it is fair to infer that there is great danger from contagious pleuro-pneumonia prevalent among cattle in this country. The local authorities of Brooklyn, but a few months ago, had occasion to revoke the license of a milk-seller for selling milk from a consumptive cow or cows.

Though a cow suffering from a most fatal malady may give milk in which there cannot be found by chemical analysis or microscopic examination any deviation in quality (there is always a decrease in quantity) from the normal, it seems impossible for an observer of disease in the human being, if to judge only by analogy, to believe but that it must be injurious. In short, how an unhealthy cow can produce healthy milk is incomprehensible to the writer.

There should be means provided so that rigid inspection, by competent men, could be frequently made of the health and surroundings of all cows whose milk is to be sold for consumption.

In addition to the above, I wish to report the following work done by me:

Whole number of		samples of milk examined	76
"	"	" milk analyses	23
"	"	" prosecutions	6
"	"	convicted and fined $25 each	4
"	"	of butter analyses	16
"	"	" samples of butter procured	5

Respectfully submitted,

R. D. CLARK, M. D.

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