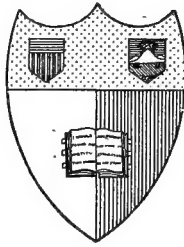


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**THE CONDENSED MILK
AND
MILK POWDER INDUSTRIES**

BY

F. W. BAUMGARTNER

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THE CONDENSED MILK AND MILK POWDER INDUSTRIES.*

1. *Origin and Expansion of the Industries.*

The manufacture of condensed milks and milk powders is a decidedly modern development. These products were unknown seventy years ago, and it is only during the last twenty or thirty years that they have become staple articles of food, familiar to nearly every household in civilized countries. Both industries have to-day reached large proportions and are still expanding rapidly in important dairy districts, especially in Canada and the United States. In many sections they are on the way to replace the manufacture of cheese and butter to a large extent. Out of small beginnings have grown powerful national and international companies, now commanding hundreds of millions of capital, operating large numbers of factories and maintaining trade relations all over the world.

Practices and methods of turning fresh milk or its main food components into more concentrated, durable and transportable forms are almost as old as the practice of keeping domesticated animals, and the use of their milk as human food itself. Cheese, butter, milk-sugar, fermented milks such as kumis, yoghurt, kephir, etc., were known in many varieties to

*The present article makes no pretension to exhaustive treatment. It is merely an outline and review of the main features of these industries, particularly in regard to their recent development, their increasing relative importance in the dairy industry and food production, and their probable future outlook. It is based on the writer's own former experience in condensed milk manufacture, as well as on his general knowledge and study of dairy conditions both in Europe and in America. Some of the statements and data are taken from O. F. Hunziker: *Condensed Milk and Milk Powders*, LaGrange, Illinois (1918), and William A. Stocking: *Manual of Milk Products*, New York: Macmillan Co. Official reports and statistics of Canada and the United States and current articles have been consulted as far as available and used as far as space permitted.

The writer wishes to express his thanks to Dr. J. K. Doherty, Canadian Commissioner at Ottawa for the International Institute of Agriculture, for the loans of reports, and for the very generous help rendered by tracing references to these industries in agricultural and dairy periodicals and governmental and institutional reports, as well as to other informants who have kindly responded to his inquiries.

civilized or pastoral peoples of all ages. References to butter and cheese are found in the Old Testament.† It is said of Arabs and Tartars that they dried camel's and mare's milk by pouring it on a flat stone exposed to the sun's rays, and that thus concentrated they used it as a staple food on their desert wanderings and expeditions. But the successful attempt to concentrate the whole of the milk solids into durable and marketable products as we know them in our present day condensed milks and milk powders, is only of recent date in the dairy industry. The great difficulty to overcome was the concentration of the solids, i.e., the valuable food elements in the milk, without changing them chemically and physically, and to preserve them in such a state that they can be used in the same way and for the same purposes as fresh milk, or, with the addition of water, be brought back to the state in which they are contained in fresh milk. Anyone familiar with the chemical, physical and physiological properties of milk and especially with the delicacy and changeability of protein substances contained in it will realize the difficulty. Something more will have to be said about this a little later.

Although Switzerland has become the classic country for the manufacture of condensed milk, the first successful experiments were made in America.‡ The claim to be the father of the modern condensed milk business must be accorded to the American, Gail Borden.* He was awarded patents on his process in 1856 by the United States and by England. The claim of the patent was for "concentrated sweet milk" . . . "the same having no sugar or other matter mixed with it." But it was soon found that sugar must be added to make a product of undoubted keeping qualities, and as early as 1856 sweet-

†Book of Genesis, XVIII, 8: "And he took butter and milk and the calf he had dressed and set it before them."

Book of Job, X, 10: "Hast thou not poured me out like milk and curdled me like cheese?" (Cited by O. F. Hunziker.)

‡The recognition of the necessity of evaporating the milk under vacuum and the first experiments are credited to a Professor Horsford. His assistant, Dalton, founded a factory in 1851, which, however, was not successful.

*He applied for a patent in 1853. In his application he does not claim his invention to be "concentrating milk in a vacuum pan for such a purpose," but says "my object being to exclude the air from the beginning of the process to the end, to prevent incipient decomposition."

ened condensed milk was manufactured and sold under the famous Eagle Brand at Gail Borden's first factory at Wolcottville, Connecticut.† The details of the process have since been improved and modified, and the products perfected. The descendant of Gail Borden's venture is the present Borden's Milk Company, to-day one of the largest industrial concerns in the United States and Canada.‡

David Page, the general agent of Gail Borden, visited his brother, Charles A. Page, then United States consul at Zürich, Switzerland, in the early sixties. Recognizing that Switzerland, on account of its climate, its aromatic pastures and the large milk production, offered natural advantages for the manufacture of condensed milk, he organized a company with 150,000 francs capital, chiefly from Swiss and English sources, in 1861, and erected a factory at Cham on the Lake of Zug. The first factory was a simple rough board shack of American pioneer style. It had a precarious existence for the first few years. But when once a market was established, the Anglo-Swiss Condensed Milk Company prospered rapidly. New factories were established in different parts of the country during the seventies, eighties and nineties. New companies were founded, many of which failed or were in time absorbed by the few large surviving concerns. From the beginning almost the entire output of the Swiss factories had to be exported, as there was practically no home market. Until very recently little condensed milk was consumed in Switzerland. Thus of necessity the market had to be sought in the wide world. For this reason as well as because of the quality of the products, Swiss condensed milk acquired a leading position in the world markets, which were chiefly England, British colonies in Asia and Africa, and tropical countries generally. The chief competitor of the Anglo-Swiss Company in the European field

†O. F. Hunziker.

‡In 1919 the company operated thirty-one complete condensaries, eleven feeders, eleven tin can manufacturing shops, two confectionery plants, two malted milk plants, and two dry milk plants. In addition to these its subsidiary, the Bordens Farm Products Company, Inc., is supplying large proportions of the fresh milk consumption in New York city, Chicago and Montreal, and in this connection is operating eight certified milk farms, 156 country bottling plants, and receiving stations, 70 city pasteurizing plants and distributing branches. (The Bordens Company First Annual Report for the year 1919).

was Henri Nestlé of Vevey (on the Lake of Geneva) whose condensed milk, milk powder, infant food and milk chocolates have become known all over the world. In 1904 the two concerns amalgamated and form now the Nestlé and Anglo-Swiss Condensed Milk Company. The combined company then represented a capital of about 40 million francs with the shares standing at 300. In 1906 the company operated seven large factories in Switzerland, four in England, two in Bavaria, one in Austria, three in Norway and two in Spain. New factories have since been added to the list.

The only other condensed milk company of comparative prominence operating now in Switzerland is the Bernese Alpine Milk Company, which maintains three or four plants in Switzerland and Bavaria. Besides these there have been established a number of milk powder plants, some in connection with the rapid development of the Swiss milk chocolate industry and some, more recently, by independent firms for the general market. The Anglo-Swiss Company also invaded the United States in the eighties, and competed for a number of years with the Borden Company for the dominance in the field, until it sold out to the latter its entire American interests in 1902. Since the beginning of the war it has apparently again crossed the Atlantic under the name of Nestlé's Food Company, which latter is now operating a number of factories in the United States and Canada.

Up until the eighties sugared condensed milk was the only kind known in the market. The business entered on a new phase with the invention of methods of making unsweetened milk and rendering it durable by a process of sterilization after its being sealed in air-tight cans. The claim to the invention of what is now known as "evaporated milk" is accorded to a native of Switzerland, Mr. John B. Meyenberg. While an operator at the Anglo-Swiss Company's factory at Cham, he experimented on the evaporation and sterilization of milk during the years 1880 to 1883. He emigrated to the United States, and was granted patents on his process and apparatus in 1884 and 1887. At Highland, Ill., the centre of a large Swiss population, the Helvetia Milk Condensing Company was organized in 1885, for the manufacture of evaporated milk. It took several years, however, before the difficulties of the process were sufficiently mastered to put the busi-

ness on a secure basis. Mr. Meyenberg became engaged in the promotion of other companies in the middle west and on the Pacific coast.* At the present day the output of unsugared evaporated milk in America by far exceeds that of sugared condensed milk.

Simultaneously with the experiments in concentrating and preserving milk in a semi-fluid state, there were carried on experiments to reduce the milk solids wholly into a dry state. Milk powders have been made with more or less success and on a small scale, ever since the middle of the last century. But it is only within the last twenty years that processes have been sufficiently perfected to assure the success of the business on a large scale. Excellent products are made to-day. A large number of factories have been erected in nearly all dairy countries during recent years and the production of milk powder bids fair to become an important factor in the dairy industry of the future.

In Europe, Switzerland is still the leading condensed milk manufacturing and exporting country. Previous to the war the yearly export ranged from 300,000 to 400,000 quintals, representing a value of from 30 to 40 million francs. The export increased during the first years of the war (461,383 quintals in 1916), but fell off to less than half the usual figures during the last years on account of various conditions caused by the war, e.g., reduced milk production on account of lack of concentrated feeds, increase of home consumption in fresh milk and all kinds of milk products, increase of grain raising at the expense of dairying, prohibition of feeding grain to cattle, etc. During the last year the situation has been aggravated by a very serious epidemic of foot and mouth disease which has already reduced the number of milk cattle very considerably, and even more the amount of milk produced. With the return of normal conditions the output and export will no doubt again reach their normal figures. But a considerable further expansion is not expected for various reasons. The companies are international, and tend to put up their factories as near to the markets as dairy and other conditions permit. Moreover, the old established Swiss cheese industry

*One of these started with one plant in 1899, and is now operating twenty large plants, in the Pacific States, in the Middle West, and in Canada.

still holds the field as the most important dairy branch. The cheese export before the war represented a value of from 50 to 60 million francs annually; in addition it enjoys a large home consumption. With the steady increase of the urban population a larger proportion of the total milk production (now over 50%) is absorbed by the fresh milk consumption.

In other countries of Europe the condensed milk business was slower to develop to any prominence. Holland and Denmark are distinctively dairy countries, but peculiar conditions prevented the newcomer from taking a solid hold. Dutch dairying was developed largely in the making of butter and of the Edam and Gouda cheese, which enjoyed a long established reputation. There are, however, now a number of factories, some of which, in connection with large central creameries and butter plants, have been making chiefly condensed skim-milk. This was either sold in bulk or put up in individual "penny tins," which among laborers in England have been familiar for some years. New York market reports also show that after 1913 (when the United States removed the former duty of 2 cents per pound or \$1.00 per case), an increasing amount of condensed milk was imported from Holland. The conditions in Denmark are rather unique. The dairy industry there has developed, and is based on an intensive tripartite combination of "butter, hams and eggs." The prosperity of agriculture as a whole with its advanced co-operative organization being nicely balanced on this interdependence of buttermaking, hog and poultry-raising, the condensing or milk powder industries would introduce a disturbing element of far-reaching consequences. Norway has had a few factories for some years and Sweden, which has lately come into the field, would seem to have favorable conditions for a considerable expansion of the milk condensing and drying industries. Germany, Austria, France and Italy have each a few condensed milk or milk powder plants, and may increase the number when once normal conditions return, especially as the products have become more familiar to the consumers during and since the war. In certain parts of Russia the industry has made a start. A recent notice in the press, containing a list of machinery and implements required from America by the Ukrainian co-operative societies, mentioned among others "milk condensing machinery." There are factories in England

and Ireland, their products, of course, being used chiefly in the home market. In Japan, a newcomer in the dairy line, the condensing industry has reached proportions considerable enough to cover its home demand and to export some surplus to China and the South Sea Islands. The Japanese production for the year 1919 is estimated at 1,200,000 cases, representing a value of \$2,991,000. New Zealand has had up to the present three large milk powder factories, which exported 325 tons of dried milk in 1914-15, and almost ten times that amount, 3,225 tons, in 1918-19. Several new factories are said to be under construction at present. There is one large condensed milk factory, which had an output of 6,205,400 pounds in 1918.*

In South America several condensed milk factories have recently been established. They are mostly located in Argentina, in the vicinity of Buenos Aires. One factory exists in Chile and one or more in Southern Brazil (probably some also in Uruguay).*

In the United States it was the civil war which first demonstrated the value of condensed milk. Armies and navies have always been among the principal consumers of condensed milk and recently milk powders. The European war accounts for the almost spectacular boom of the business in the United States and Canada since 1914. But even before that it was conspicuously on the increase. Though the export trade was not considerable, these countries were almost from the beginning favored by a good home market, which has grown phenomenally during the last twenty-five years. There have always existed extensive mining and lumbering districts, some projected far into otherwise unsettled territories, in the mountains of the West and in far north Alaska and Yukon, out of reach of fresh milk. To them condensed milk has become as necessary as fresh milk to the ordinary community. The growth of some of the large cities far outran the development of dairying in the surrounding farming districts; the supply of fresh milk became inadequate and resort had to be made to condensed milk. Pioneer farmers in many of the grain-growing districts were not only unable to supply the nearest towns and cities with fresh milk, but had to make use of the "canned

*N. Y. Prod. Review, Dec., 1919.

*Information by the Bureau of the Pan-American Union, Washington, D.C.

cow" themselves for the first years. Even the climate of America favors a large use of milk in concentrated and preserved forms. During the hot, sultry summer weather fresh milk easily sours; a regular and good daily service is not always available. During the cold winter the milk production is very greatly reduced and shortages have been suffered frequently in many large centres. Condensed milk and milk powders can easily equalize these variations. A supply may be kept on hand by the housewife without danger of surpluses spoiling and she is relieved of many troubles with the milkman, who may be late when cream or milk is wanted for breakfast, or may serve her partly water. In addition, the general household customs and ways of living in America, such as the habit of marketing and buying all food in prepared packages, the large use of preserved and canned goods, the extensive summer picnicking and camping, and other features, all favor the use of condensed milk and milk powders. The United States and particularly Canada are not cheese eating countries. In many European countries cheese is a staple food, not as here a little occasional dessert addition. The consumption there of these is somewhat bound up with the use of light wines and beer and other long established culinary habits. The tremendous increase in the ice cream and candy consumption in America is also creating an ever growing market for condensed milks in bulk and for milk powder. The following figures, supplied by the United States Bureau of Animal Industry and the Bureau of Markets, show the annual production of condensed milk powders for individuals years since 1880 and indicate the growth of the industries in the United States.

	<i>Condensed Milk</i> <i>Pounds</i>	<i>Milk Powders</i> <i>Pounds</i>
1880.....	13,033,267	.....
1890.....	37,926,821	.....
1900.....	186,921,787	.....
1904.....	308,485,182	.....
1909.....	495,197,844	.....
1914.....	875,507,438	20,987,911
1916.....	997,835,115	18,586,613
1917.....	1,353,005,594	25,763,166
1918.....	1,729,378,527	30,828,955
1919†.....	2,095,952,869	44,594,842

†Subject to final revision.

The output of condensed milk in 1919 may be valued at about \$250,000,000 and that of milk powders at about \$15,000,000. In the United States there were in 1914, 240 condensed milk factories. Exact later figures are not at hand, but more likely than not, they have nearly doubled since. In the State of Wisconsin the number rose from 26 in 1914 to 52 in 1918; two concerns that operated 11 factories a few years ago have now 55 factories under one management.* The total production of 1919 was about 240 per cent. that of 1914. The chief condensed milk producing states are New York, Illinois, Wisconsin, New Jersey, Pennsylvania, Indiana, Michigan, Ohio, Washington and Oregon. The tremendous boom in the condensed milk business during the last few years is, of course, largely the result of the stimulus given it by market conditions due to the war. The New York Produce Review on January 30, 1918, writes: "There appears to be no end to the demand for condensed milk. We are informed that all manufacturers of reliable condensed milk machinery have orders for equipment booked far ahead and that every week sees preparations made for new condensing plants. Many new companies have entered the milk condensing business, and numbers of manufacturers of other dairy products who have command of a regular supply of whole milk, are installing the necessary equipment to switch to condensed milk manufacture . . . , and not only have the number of plants largely increased, but many of the old plants have greatly increased their output." Of the total milk production in the United States about half is consumed in the fresh state. In the year 1919 there were used for the manufacture of various dairy products 45,439 million pounds. Of these there went into condensed milk 4,813 million pounds or 10.6%, i.e. about $5\frac{1}{3}\%$ of the whole milk production. For the production of whole milk and cream powders there were used 84 millions and for malted milk 40 millions. As the larger part of milk powders is made from skim-milk, i.e., from milk which in these figures is included in that used for butter production, the relative importance of the dried milk industry cannot be estimated. The excess of exports of condensed milk from the United States over imports before the war was comparatively slight, and the balance dropped to almost zero for the years 1914 and 1915

*O. F. Hunziker.

on account of the removal of the import duty of 2 cents per pound to \$1.00 per case, which opened the market for European products. The war orders of the U. S. Government and the allied nations, however, turned the disastrous slump into a great boom and the exports rose to tremendous proportions. Exports from and imports into the United States of condensed milk were as follows for individual years:

	<i>Exports</i> <i>Pounds</i>	<i>Imports</i> <i>Pounds</i>
1912.....	20,642,738	698,176
1914.....	16,209,082	14,599,339
1916.....	159,577,620	18,174,505
1917.....	259,102,213	18,375,698
1918.....	529,750,032	.....
1919.....	728,740,509	.....

These figures may suffice to show the tremendous expansion of the condensed milk and milk powder industries in the United States.

The United States can also boast of a condensed goats' milk factory located at King City, California, evaporating and sterilizing the milk from a herd of over 3000 goats. It is probably the only factory of its kind in the world. The product is sold in drug stores.

In Canada the condensed milk industry dates from 1883, when the first factory was established at Truro, N.S., by the Reindeer Condensed Milk Company. During the eighties and nineties several new plants were erected by this and by the St. Charles Company, chiefly locating in the best dairy districts of southwestern Ontario. Most of these were later absorbed by the Borden's Milk Company. A number of new plants have been added, during the past twenty years, and especially since the beginning of the war. To-day there are some twenty factories in Canada. This includes some plants which merely concentrate milk or skim-milk in bulk to be used in the ice cream, confectionery and chocolate business. The important plants putting out canned milks are those operated by the Borden Company (Ingersoll, Norwich and Tillsonburg, Ont.; Huntingdon, Que.; Truro, N.S., and Sardis, B.C.), the Carnation Milk Company (Aylmer and Springfield, Ont., formerly Dominion Cannery), and the Nestle's Food Company (Chesterville, Ont.) Plants of individual companies, some of

which are connected with ice cream and confectionery establishments, are located at St. George, Brockville, Beachville, Woodstock, Picton and Sydenham, Ont.; Courtenay and Lerner, B.C., and Charlottetown, P.E.I. Within the last ten years five modern milk powder plants have been erected and are operated by the Canadian Milk Products Company, at Brownsville, Belmont, Burford, Glanworth and Hickson, Ont.

The following comparative statistics may show the relative importance of the condensed and powdered milk manufacture in the Canadian dairy industry in 1917:*

	<i>Establish- ments</i>	<i>Capital Invested</i>	<i>Paid to Patrons</i>	<i>Value of Products</i>
	No.	\$	\$	\$
Creameries	949	8,166,248	27,509,755	36,582,296
Cheese Factories	1900	4,176,916	30,426,721	33,917,724
Combined Butter and Cheese Factories	549	3,884,494	11,932,154	15,282,089
Condensaries	20	3,400,343	4,004,215	8,097,217

The Canadian production of condensed and evaporated milk for 1919 is estimated, according to the U.S. Market Reporter, at 110,000,000 pounds, valued at approximately \$20,000,000. The quantity of milk powder produced during the year amounts to 5,323,537 pounds, valued at \$1,662,352.

The table below shows the Canadian exports of milk and cream condensed, canned or preserved, to principal countries for the years 1912-14-16-18, in pounds:

	1912	1914	1916	1918
United Kingdom	155,088	.....	4,909,495	8,082,149
British South Africa .. .	619,980	.....	268,840	504,000
British West Indies ...	33,518	6,120	278,174	545,763
Hong Kong	77,200	105,350	34,118	122,550
Newfoundland	206,768	210,700	228,301	652,242
China . . . . .	.....	434,800	33,536	2,400
Cuba	3,317,500	1,063,400	9,595	666,974
Japan	960	1,878,750	.....	5,066
United States	34,168	5,573,737	7,256,991	24,191,048
Other Countries	14,168	66,525	228,784	8,884,526
Total	4,389,350	9,339,382	13,247,834	43,656,718
Value in \$	305,678	666,941	770,566	4,955,048

The figures show a considerable fluctuation from year to year

*Report on Dairy Products of the Census of Industry, 1917.

and to the different countries, due to unsettled world market conditions.

2. *Technical Features.*

Space does not permit us to go into any details of the processes of manufacture and equipment. Nor is it within our purpose to deal fully with this phase of the subject. But the outlines have to be noted in order to permit a general view into the industrial and economic features of these industries as well as to give a general idea of the nature of the products.

Milk is a very complicated substance. It is not a mere mixture or solution in water of the various constituents making up the solids shown by the chemical analysis. The many attempts to make milk artificially have all failed. One of the simplest of its constituents, the milk fat, is itself a combination of many fats and ethers. Still more complicated are the protein substances, so much so that no chemical formula can be given them, and it is still a matter of dispute among chemists whether there are one or two or twenty distinct protein bodies in the milk. Milk is in a sense a living substance, with chemical and physical as well as physiological properties in itself and as a food. The following table gives the average composition of normal cow's milk and the margin of variations in its principal constituents:†

	Average % (U.S. Dep. of Agric.)	Variations (Koenig)
Water	87.27	80.32—90.32
Fat	3.68	1.67— 6.47
Casein	2.88	1.79— 4.23
Albumen	0.51	0.25— 1.44
Sugar (Laktase)	4.94	2.11— 6.03
Ash	0.72	0.35— 1.21
	12.73 } Tot. Solids	

Fresh milk has very poor keeping qualities. It contains all the elements necessary for organic growth in such proportion and in such condition as to make it not only the most perfect human food, but also a most favorable substratum for bacterial growth. If not checked by cooling, and pasteurization or sterilization, fermentations quickly set in. The most important of these is that caused by lactic acid bacteria, which makes milk sour. Under the influence of the lactic acid, as also under the influence of rennet, an enzyme extracted from

†William A. Stocking: *Manual of Milk Products.*

calves' stomachs, the casein, which in fresh milk is contained in what is termed colloidal condition, changes its nature. It coagulates, 'thickens or curdles, as every housewife knows. This takes place sooner when milk is heated. These are points of extreme importance in the making of condensed and especially evaporated milk and also milk powder, all of which processes attempt to change the milk solids as little as possible. In proportion to the concentration of milk, naturally the acid content is increased, and the curdling occurs so much sooner.

But there are great differences even in fresh milk as drawn from the udder, not only as to the proportional variations of its constituents (as shown in the above figures) but also as to its behaviour in regard to coagulation. The careful cheesemaker knows that there are differences as to the kind of cows, the season of the year, the weather, the locality, the feed and general care of milk herds, etc. He adjusts his methods accordingly, in the amount of rennet used and temperatures applied for "setting" his milk and treating the curd. At closer inspection we find that there are considerable variations in the coagulability of milk between individual cows, in the same stable and fed on the same feed. Many of the factors are uncontrollable, and are not yet fully explained by science.*

These preliminary remarks have been made to indicate that the first technical essential in the manufacture of all these products is a first-class milk from healthy, well-tended and well-fed cows, and that the milk must enter into the process in

*The writer may suggest from experience a simple and practical test which might prove useful to stable inspectors especially in evaporated milk districts to detect cows that secrete milk of abnormal coagulation: Adjust a rennet solution to such a strength that a teaspoonful will coagulate a water glass about $\frac{1}{2}$ full of milk just as drawn from the udder in about 30 seconds. After about another 30 seconds the coagulum should be firm and smooth. If the content of the glass is turned over on the palm of the hand it should stand like a nice jelly pudding. If broken with the finger a clear greenish whey should run off from it. Abnormal milk will be readily detected by the time it requires for thickening, by a less firm, flaky or stringy coagulum or a whitish troubled whey. It may be remarked that differences are frequently found between the milk of individual teats of the same cow. Any kind of affection, even the slightest inflammation, careless milking, etc., will affect the milk in this respect. After udder diseases are apparently healed it may still take months before a normal milk is secreted again.

the best possible condition. Clean milking, prompt cooling, clean containers, regular delivery during early morning hours, cannot well be dispensed with. In cheese and butter making a second-grade product can be made of less carefully produced milk. In the condensed milk business the product is either good or not marketable at all. Faulty condensed milk has to be disposed of for a mere pittance.† Most condensaries carry on stringent inspection among their patrons, and they have by this means and through their educational campaigns, and by supplying cooling devices, sanitary milking vessels, transport cans, etc., as well as by introducing first class milk stock (usually selling them to farmers on terms in exchange for milk), considerably raised the standard of dairying in many districts. At the factory each individual can of milk received is carefully inspected by an expert as to cleanness, coolness, taste and smell. Any irregular odour or too advanced souring is detected and the can in question rejected.

So much for the preparation of the milk. To describe the further process we must distinguish between the products.

1. *Condensed Milks.*

There are two main kinds of condensed milks in sealed cans on the market to-day.

(a) *The sweetened or sugared condensed milk.* This is cow's milk condensed at the ratio of about $2\frac{1}{2}$ to 3 parts of fresh milk into one part of condensed milk. To it about 12 to 18%, figured on the fresh milk, of sucrose (cane or beet sugar) is added. The product is a thick semifluid substance containing 30 to 45 per cent. of sucrose besides the milk solids. It is preserved by this high content of sugar, and will keep for many months.

(b) *The unsweetened condensed milk commonly known as evaporated milk.* This is pure milk condensed to about half its original volume on the average (the ratio has to be varied slightly), and subjected to a sterilizing process after it is sealed in cans. The product has a consistency of average

†There are times when something like an epidemic occurs in the condensed milks. This may be due in sweetened milk to a poor quality of sugar. I am informed that at the present time many condensaries are troubled with bitter milk, caused by a very resistant kind of bacteria which lodge in certain factories.

cream and a yellow or slightly brownish colour. Being sterile it will keep indefinitely, but unless it is of the best quality separations will in time take place in the cans.*

The main outlines of the processes are as follows:

The fresh milk is first heated in open wells, called fore-warmers, to a temperature ranging from 180°F. to boiling point. The heat is either applied by injecting steam directly into the milk or through a steam jacket around the kettle. From there it is drawn into the air-tight vacuum pan where the condensation takes place. These pans are of huge size in larger factories, so that up to 25,000 pounds or even more of fresh milk can be drawn into one batch. The top or dome of the pan extends into a condenser consisting of a cylindrical chamber usually placed vertically, into which a stream of cold water is injected in a spray during operation. The condenser is connected by a large pipe with a powerful vacuum pump on the floor below which draws off the water together with the condensed vapors from the milk. The vacuum in the pan is kept at about 100 to 180 mm. Hg, corresponding with a boiling temperature of from 125 to 150 degrees F. The pan has a jacketed bottom and usually two spiral copper coils in its lower part through which steam circulates to impart the necessary heat. It is fitted with steam gauges, thermometer, a vacuum gauge, a sampling tube, one or two sight glasses, a vent-hole or "blow down" valve and a manhole with air-tight cover, and an intake pipe for the fresh milk as well as a pipe at the bottom to draw off the condensed milk. All steam, milk and water pipes are, of course, fitted out with the necessary regulating valves so that the whole becomes a rather complicated apparatus requiring considerable skill for its operation, especially for finishing up a batch exactly at the desired concentration. In the case of sweetened milk the necessary amount of sugar is added during the process of condensation

*Considerable quantities of condensed milk and skim-milk are also sold in bulk. They are designed for more or less immediate use in the ice cream, bakery and confectionery business. Sweetened condensed bulk milk is usually packed in barrels and will keep according to the degree of sugar added. Unsweetened or plain condensed milk is shipped daily to the place of consumption in ordinary cream or milk cans. Its keeping quality is that of pasteurized milk. It is condensed chiefly to reduce bulk and freight of whole milk, and the degree of concentration can be adjusted to the convenience of the consumer and the purpose of its use.

either by dissolving it in the hot milk in the forewarmers, or in a portion of it in a special sugar well, or in distilled hot water and drawn into the pan in the form of a sirup. The sugar must be thoroughly dissolved and must be of the best quality, as any impurities would impart themselves to the product. Formerly cane sugar alone was used, but in Europe where cane sugar is not so easily available the best refined beet sugar is also used.

When the desired density is reached, the process is stopped and the milk drawn off, and cooled promptly. In the case of sugared condensed milk the cooling must be done gradually in order to prevent the crystallization of the sugar. This is done by drawing off the milk into large cylindrical cans which are set in a water tank with a system of cog wheels on its bottom into which the cans fit. The wheels are set in motion so that the cans slowly revolve in the water. Above them is placed a frame with paddles for each can which, while the cans are revolving, keep up a slow and even stirring movement of the milk. The water, at first warm, is gradually changed by the cold inflow until it is cold, and the cans are kept in motion till the milk is cooled to the temperature of the water. The condensed milk then either goes immediately to the filling and sealing room, or is stored in tanks in the refrigerating room until used up. With the filling in cans and sealing the condensed milk is finished and may be labelled and shipped out. It is usually kept a certain time in a heated store room in order to detect faulty cans or any faults of the product that might develop, before it is let out on the market.

In the case of evaporated, i.e. unsugared milk, the cooling can be done rapidly, without injury by running the milk over a pipe cooler with cold water or cold brine circulating in the pipes. From the cooler it runs directly into the storage tanks in the refrigerating room and is ready for the filling and sealing process. The sealed milk is then immediately subjected to a sterilizing process. This is done in cylindrical retorts into which hot steam is conducted. Inside the shell of the sterilizer, there is a frame work into which the milk is packed. The sterilizers are of various makes and sizes. Some are fitted with an end door through which the milk-holding frame may be put in and taken out on a rail arrangement permitting loading and unloading outside; others are fitted by side doors


and the framework is stationary. In any case it must be so arranged that the milk slowly revolves during the process, which is necessary to insure even heating and to prevent the formation of a scum on top of the milk in the cans. The sterilizing has proved the most delicate part of the whole process of making evaporated milk. On it many new untried ventures broke down and it is the cause of occasional losses in all factories. This heating process has really two purposes. In the first place its object is to sterilize the milk, i.e., to kill all living organisms, the vegetative bacterial cells as well as the very resistant spores. To assure this the milk must be subjected to a temperature of at least 220°F. for about 30 to 40 minutes. But a second object of the heating process is the following. Evaporated milk is not condensed to so high a degree as the sugared milk and its viscosity is not enhanced by the addition of sugar. When it enters the cans it is still a white and comparatively thin liquid. We have noted before that heat precipitates or coagulates the casein in milk. In sterilizing, the evaporated milk must be heated to such a degree that this thickening just begins. This is necessary not only to give the product a nice creamy appearance, but to give it a "good body." Otherwise the butter fat will rise to the top in the cans in the warehouse or on the shelves of the stores, or it may even be churned into lumps during transit. Such milk, though sound, is unmarketable as it cannot be used for the ordinary purposes it is intended for, e.g., in coffee, tea or on fruit. But the heating must not go beyond that point or else the coagulation will reach such a degree that the milk becomes grainy or lumpy, so that the precipitated protein will not dissolve any more. Such a milk is equally unmarketable. A slight graininess may be shaken out and for that purpose all factories are fitted with special shaking apparatus, and some even put all evaporated milk through this shaking process. No amount of shaking, however, will make a smooth soluble milk again if it has been precipitated in large or hard grains or lumps. The important point, therefore, is to determine just what the milk "will stand," e.g., to adjust time, mode of applying the heat and temperatures in such a way that the milk is thoroughly sterilized and that it arrives just at the proper stage of thickening. Now the fact is that no definite point can be fixed for that. As indicated at the beginning of

this chapter, milk is very variable as to its coagulability. It depends largely on the acidity of the milk which in turn depends largely on the good care of the fresh milk, on the thorough cleanliness of all apparatus, pipes, etc. But, as pointed out, it depends also on many other factors less known and less controllable. The higher the condensation the less heat also will be required to thicken the milk. Generally speaking, the milk is heated to about 220 to 240 degrees F. for from 20 to 40 min. The exact mode of application differs considerably for different firms, and is usually kept strictly secret. Constant experimenting, close watching and sampling ahead is indispensable. According to season the ratio of condensation has also to be varied to make the milk sterilizable* When in the sterilizing process the desired heat and time is reached, the milk is immediately cooled by shutting off the steam and running cold water into the sterilizer while framework is still in revolution. The process has been made somewhat more secure since the introduction of the homogenizing machine. This is a device to break up the fat globules in the milk into smaller particles so that on account of the higher surface tension they remain suspended, i.e., the fat does not rise to the top. The milk is run through the homogenizer directly as it comes from the condensing pan.

After sterilization the milk is placed in a heated store-room for about a month and during that time turned over in the trays several times. Milk in cans that are not absolutely air-tight, on account of faulty soldering, will decompose mostly under gas production so that they show up as "bloats" or "swell heads." Other faulty milk is easily detected by an experienced tester by the sound in shaking the cans. In every batch a few samples are taken also from the good cans before they go to the storeroom and before they are shipped out, in order to inspect the milk for its general condition as to butter fat separation, grainyness, colour, etc. Exact records are kept

*From this it also follows that hard and fast rules in regard to standards cannot always be followed. The manufacturer is bound by exigencies of the process to a large extent. The relation of fat and other solids in milk varies with the seasons, and with other factors, as does also the behaviour as to coagulation. Manufacturers have been put to considerable inconveniences by the prescribing of government standards without expert knowledge, and with which it was at times impossible to comply. This condition has been more or less remedied of late.

in the process of every batch and the cans marked with date and number of batch, just as they come out of the sterilizer, so that later, if any fault comes to light, the causes may be traced back. The keeping and testing in a heated room is particularly important for all kinds of condensed milk, for goods destined to go to warm climates or that have to cross the equator on transit.

The above are only the main features of the processes. In detail they are naturally very much varied. Superheating by blowing steam into the milk directly after condensation is practiced by some manufacturers and for special purposes, especially in the case of bulk milks. Machinery, pumps, scales, pipes, refrigerating and cooling devices and testing apparatus as well as the general arrangement of factories vary much, and undergo constant improvement, especially from the points of view of sanitation and saving labor. The filling of the cans is done by machinery. The capping and sealing of the cans was formerly all done by hand soldering by girls, but is now mostly done by soldering machines, especially since the introduction of vent-hole filling devices. 

Large concerns usually manufacture their own cans either in a tinshop connected with each plant or in a central factory from which they are distributed to the individual plants.

A new device of recent date which will probably modify the process somewhat is the *continuous concentrator*. This is a machine by which milk can be concentrated in a continuous stream and the ratio of concentration regulated by regulating the inflow of milk. It is not certain yet to what extent this machine is destined to replace the vacuum pan. The concentrator may find application where plain unsweetened condensed milk or skim-milk is made as a side line in large creameries, concentrating plants for confectioners, etc. But large concerns are likely to continue with the vacuum condensation, which cannot well be displaced, especially for sweetened condensed milk, on account of the addition of sugar.

Condensed and evaporated milks are packed and marketed in cans of various sizes: 1 gallon, 20, 16, 15, 14, 12, 10 and 8 ounce cans. These are packed in cases holding from six to ninety-six cans.

2. *Powdered or desiccated milks.*

The object of reducing the solids of milk to a state of complete dryness is, of course, the same as that of the manufacture of condensed milk, i.e., reducing the bulky milk into a concentrated food product and thus reducing the cost of transportation to about one-eighth, and preserving the solids in a convenient and durable form. The first object is achieved in milk powders to a much higher degree and the second has in recent times been also realized in a remarkable measure.

A great number of various patents have been registered in America and in European countries for the manufacture of milk powders. The first commercially known milk powder was that patented by Grimwade in England in 1855. All present methods are more or less variations and combinations of two main principles.

One is that of applying milk, either fresh or partly condensed, in a thin film or in a spray, to heated surfaces, usually steam-heated rollers. Perhaps the best known system based on this principle is that of Just-Hatmaker, in which the milk is sieved on two large horizontal, steam-heated, smooth-surfaced revolving rollers. The heat of the rollers evaporates the water of the milk-drops almost immediately upon their striking the surface. The solids drop off or are scraped off by knives in the form of fine scales or chips which are gathered below, and after being put through a grinding process the product is finished. Working more or less on this principle combined with vacuum chambers are the Eckenberg, the Buřlovak, the Campbell and other processes.

The second principle known as the "spray process" has been introduced by the Merrell-Soule Company of Syracuse. A current of hot air is produced by conducting pure filtered air through a system of steam-heated pipes. This hot air is circulated through open chambers by strong fans. Into this hot current the milk, which has been pasteurized and usually partly condensed, is injected by force pumps in the form of a fine spray, producing a fog similar to that of spraying devices used for imparting fungicides or insecticides finely to the leaves of plants. The milk thus "atomised" is dried while in the air, and precipitates in the chamber in the form of a fine flour. No grinding is necessary, and the product may immediately be packed in tins. According to Stocking (Manual of

Milk Products), the inventor of the process of desiccation by spraying into a current of hot air was Robert Stauf, a German, who patented it in 1901. The patent was bought by the Merrell-Soule Company in 1905, and applied to milk. On this principle the Merrell-Gere process patented in 1907 is based. The process is no doubt a great improvement over former methods. By this almost instantaneous evaporation of the water while in the air and without the subjection of the milk to high temperatures, the precipitating solid constituents are left in their natural state. They readily dissolve again in water, and the qualities of fresh milk are practically unimpaired.

Whole milk, cream, skim-milk, buttermilk and whey can be and are thus desiccated to powder. At present it is chiefly powdered skim-milk which gets into the open market. Powdered whole milk and cream, though perfectly sound in a fresh state, lack in keeping quality on account of the butter fat they contain, which is subject to becoming rancid, a decomposition in which butyric acid is formed, giving rise to the familiar odour and taste of rancid butter. Powdered skim-milk is of much superior keeping qualities. For the industry as a whole this is hardly a serious disadvantage. Fresh cream and butter are always in demand. The combination of the cream and butter business with the manufacture of skim-milk and buttermilk powders offers the way to an almost ideal conservation of all food value in the milk. Popular prejudice against skim-milk and the ignorance which rates the food value or "richness" of milk solely by the content of butter fat or "cream" is the only obstacle to a wide extension of this industry.

As to these milk products in general (condensed, evaporated or dried milk), it may be said that they can be classed among the purest food products on the market. Good milk is used to start with, and it is immediately worked up. It is pasteurized, and in the case of evaporated milk sterilized. No foreign matter is added, except pure sugar in the case of condensed milk and some milk powders. As a rule no preservatives, flavoring or coloring matters are added. The addition of small quantities of bicarbonate of soda or lime, cream of tartar, or similar basic substances has occasionally been tried, in order to neutralize excessive acidity of milk. But it has been found out that it is much better to use only the best qual-

ity of milk, especially for canned goods, and to add nothing whatever. In the manufacture of milk powders carbonate of soda or potash was formerly added to the milk to render the casein more soluble. But with the perfected processes this has mostly been abandoned as unnecessary.

In the following table there is set forth the average composition of the more important of these milk products, as given by O. F. Hunziker:

	<i>Condensed Milk</i> (sugared)	<i>Evaporated</i> <i>Milk</i> (unsugared)	<i>Whole Milk</i> <i>Powder*</i>	<i>Skim Milk</i> <i>Powder*</i>
Water	26.5	73.	1.40	7.00
Milk fat	9.0	8.3	29.20	1.00
Proteids	8.5	7.5	26.92	37.00
Milk Sugar (lactose).	13.3	9.7	36.48	47.00
Ash	1.8	1.5	6.00	8.00
Cane sugar (sucrose)	40.9	..	...	...
	100.00	100.00	100.00	100.00

Various other preparations in which milk in concentrated form is used are known on the market, such as "Humanized milk," "Malted milk," "Infant foods," "Condensed coffee and cocoa," and others, as also milk chocolates and candies. The U.S. Federal Food standards give the following definition of malted milk. "Malted milk is the product made by combining whole milk with the liquid separated from a mash of ground barley, malt, and wheat flour, with or without the addition of sodium chloride, sodium bicarbonate and potassium bicarbonate in such manner as to secure the full enzymatic action of the malt extract and by removing water. The resulting product contains not less than seven and one-half per cent. (7.50%) of butter fat and not more than three and one-half per cent. (3.50%) of moisture."

"Hebe" milk is a condensed milk made out of skim-milk, to which vegetable fats have been added (as substitute for the milk fat) and finely imparted by homogenizing the mixture.

3. *Industrial and Commercial Features.*

The condensed milk and milk powder industries have developed entirely on private initiative. While cheese and but-

*Merrell-Gere process.

ter making have long been the subjects of special solicitation and promotion by public departments, while their processes have long been the subject of investigation and instruction at agricultural and special dairy colleges, in public laboratories and experiment stations in all countries, and while a great wealth of literature exists on all phases of these branches of the dairy industry, the condensed milk and milk powder manufacture has been left singularly untouched. Indeed until very recently it has hardly been considered a branch of the dairy industry at all.† On the other hand condensed milk manufacturers were themselves loath to be interfered with. The processes were and are still carried on under special patents and most of the apparatus is also patented. The firms acquired these patents at considerable cost and in most cases had to pay heavy tolls in the form of losses, until the necessary experience was gained. Once on a footing of permanent technical success high profits were assured, and the firms naturally were anxious to guard their secrets strictly. Outside of the few bonded operators none of the factory laborers were allowed to know anything of the details of the process. Access to certain parts of the apparatus was prohibited to all but the operators and ciphers were used on gauges and thermometers.

This veil of secrecy and mystery over the new business was intensified by another factor. The condensed milk industry from the beginning took on the character of "big business," of large scale manufacturing. The companies were financial undertakings with head offices in the large commercial and financial centres. What could they have in common with the thousands of small cheese and butter makers! But more recently there is noted a tendency to get in closer touch with other branches of dairying. The recognition that they have, after all, much in common gains way. Common interests in bargaining for the fresh milk supplies, in dairy education, in dairy stock-breeding, and so forth, are being recog-

†The excellent treatise by O. F. Hunziker, formerly professor of dairy husbandry at the Indiana Agricultural College, Lafayette, Ind., is practically the first book treating these industries in all their phases and giving a full account of their technical features. The investigations carried on at the Lafayette Experiment Station under Professors Hunziker and Spitzer, also did much to popularize knowledge in regard to these milk products and to dispel many misconceptions that existed not only in the public mind but on the part of government departments.

nized. Most condensed milk firms formerly were averse to having separators in their factories and to putting out anything but condensed milks. Of late, however, there is a tendency to combine the business to a greater or less extent with the fresh milk and cream supply of cities, or to instal butter plants in connection with their factories. In this way milk not qualified for condensing but yet perfectly good for butter-making can be used up and losses prevented, and the large fluctuations in the condensed milk market offset to a great extent.

The nature of the development and of the technical characteristics of the processes condition other general features of these industries which must here be noted.

1. Condensed milk and milk powder factories should be established only in districts where dairying has already reached a high degree of development. Only the best produced and cared for milk will assure success.

2. Sufficient quantities of milk should be produced within a comparatively small circuit so as to assure daily delivery during the morning hours. The shorter the distances the milk has to travel, the better. About two thousand cows within a radius of five or at most ten miles from the factory should be the minimum for a condensary supply. Where gathering stations with good cooling facilities are established and where the milk can be transported by motor trucks on good roads, by boats or railway, the circuit can be extended to twenty or thirty miles, but in any case the milk of an evening's and a morning's milking should reach the factory before the next noon, within the same day. The daily supply should be 50,000 pounds or more, and should never drop below 20,000 pounds.

3. Factories must not be started on too small a scale. The apparatus and equipment are of a highly specialized and expensive nature. Factory buildings must be substantial. In them and their surroundings cleanliness, sanitation and thorough drainage must be maintained, and full consideration should be given this when choosing a location. Every plant must have access to one or more railway lines. A plentiful supply of good cold water is important. In a condensing plant it takes at least three gallons of water to condense one pound of fresh milk. In addition water must be present ad libitum in all parts of the factory for cooling purposes, and for wash-

ing and flushing of all machinery pipes and floors. A comparatively large boiler plant is necessary, not only for generating the motive power required for the operation of machinery but because much steam is required for condensing and heating, for sterilizing the products (in the case of evaporated milk plants) and for cleaning and sterilizing all machinery and pipes. Hunziker estimates a boiler capacity of 400 H.P. necessary for a condensary of 50,000 pounds of milk daily capacity. Artificial refrigerating plants and electric lighting are also essential. Stocking says that "reliable authorities have conservatively estimated that adequate buildings and equipment for a minimum production on a commercial scale would cost in the neighborhood of \$25,000 exclusive working capital." A reliable informant, plants inspector for a large concern, writes that with the present cost of material and labor it will take from \$100,000 to \$150,000 to put up a plant of substantial and permanent construction to handle from 50,000 to 100,000 pounds daily. In addition to this, running expenses are also high. The farmers are generally paid monthly. But the products must be stored a certain time in any case, and on account of wide fluctuation of the market large stocks must at times be kept on hand for several months.

It is apparent then that initial investment, overhead and running expenses are high, and that a factory can be operated the more economically per unit of product the larger the fresh milk supply, provided that this can be gathered in sufficient proximity so as not to endanger its quality. There are thus lower and upper limits set to the size of factories by a number of conditions to be considered.

4. It is on the commercial side that the industries differ most from other branches of the dairy business. The products are not standardized in the market as are cheese and butter or fresh milk. Condensed milks and milk powders are marketed under certain brands and labels. To introduce and keep them on the market expensive advertising must be carried on. Large concerns have usually their standard brands but often also some minor ones in order to dodge competitors. The milk may be of the same quality but sold at different scales of prices. Companies must be able not only to keep large stocks on hand at times, but also to distribute the products in a wide market in order to equalize as much as possible local fluctua-

tions. This necessitates the establishment of advertising and commercial agencies in widely separated centres. For the same reason large concerns tend to distribute their plants over different sections of a country, of a continent or even of the world. Hardly any other industry shows this characteristic to such a degree.

Two consequences plainly follow from these considerations. In the first place large concerns with many factories and with adequate capital at their disposal have an overwhelming advantage over small individual ventures. In the second place all these conditions favor a certain tendency towards combination. As indicated above, in reference to individual factories or concentration in localities, the large scale production has its limits in technical exigencies, especially as regards the fresh milk supply. But on the marketing side, if many factories can be brought under one general management, there is hardly any limit. The larger portion of the condensed milk business of all countries is in the hands of a comparatively very small number of firms. Their products enjoy on the market a monopoly position sometimes out of proportion to the quality of the goods compared with those of minor establishments. When once the nature of the products is more generally understood by the public this feature will no doubt be lessened to some extent.

It may be well to summarize here the main causes of the failures of new concerns, particularly in Canada and the United States.

1. Not sufficient attention paid to the necessity of first class fresh milk.
2. Lack of capital to establish a market for new brands of goods.
3. Inadequate knowledge of the essentials and details of the processes.
4. Promoting schemes. Small companies were promoted among inexperienced farmers or local business people by some firms that sold condensing apparatus or that pretended to specialize in setting up condensing plants. These promoters would set up a building of very inadequate construction and arrangement and install the apparatus in it, at a total cost of only a portion of the money subscribed in shares. The promoters would promise to teach the people the process and

would perhaps keep a more or less experienced operator in the factory for a while. The products perhaps looked quite well at first, and only after some had been stored a while was it found that they "were going wrong." At the same time something was learned about the difficulty of introducing the goods on the market. In the meantime the promoters had disposed of their shares, had been paid for their plant and machinery and had left the local company in the lurch. Some of them, if they were in otherwise favorable locations, were absorbed by the established larger firms, others, after an unsuccessful struggle, were abandoned altogether. The dairying in not a few local districts has thus been subjected to more or less serious temporary setbacks.

The mode of paying for the fresh milk in condensed milk factories is usually by weight, the price being set per 100 pounds. Most factories, however, take daily samples and tests of every patron's milk and in order to make due allowance for the quality of the milk as indicated by its content of butter fat, a standard price is set for 4 or 3.50 per cent. milk and additions or deductions are made from this in proportion as the test goes above or below. According to Hunziker the prices paid patrons at condensaries in the United States average in most cases from twenty to fifty cents higher per hundred pounds of milk than those paid by creameries and cheese factories. It must be considered, however, that during the expansion condensaries were trying to secure patrons and also that no by-products (whey or skim-milk) are returned to or remain on the farm. While ten years ago milk could be got for 90c. to \$1.25 per 100 lbs., just before the war the prices ranged between \$1.25 to \$2.00. During and since the war prices as high as \$3.50 to \$4.00 have been paid. The Dominion Bureau of Statistics gives the averages for prices paid in 1918 and 1919 in Canada as follows:

	<i>Ontario</i>		<i>British Columbia</i>	
	1918	1919	1918	1919
Creameries	2.85	....	3.703	3.46
Cheese Factories	1.83	....	2.54	2.49
Condensaries	2.21	....	2.44	3.17

The cost of production has naturally greatly increased during recent years with the increase in the price of fresh milk and other supplies and equipment, as well as wages.

Professor Hunziker, who has made detailed investigations into the cost of production, arrives at the following figures for the years 1913 and 1917, evidencing the increase due to war conditions:

	1913	1917	Increase
<i>Sweetened Condensed Milk</i>			
Cost per case of 48 cans containing 46.4 pounds of condensed milk, net.....	4.015	7.23	80%
<i>Evaporated Milk</i>			
Cost per case of 48 tall size cans containing 54 pounds of evaporated milk, net	3.080	5.73	86%

The condensed milk market has in the past been subject to very wide fluctuations. At times the milk has accumulated at the plants and at others manufacturers were not able to fill orders. As until now the consumption as well as the production have been in the state of rapid expansion, supply and demand have not yet adjusted themselves evenly. Most of the condensed milk is marketed through jobbers and brokers. If the buyers look forward to a large demand and a rise in prices, they will buy all they can possibly get hold of; if the contrary is expected they buy very short. This is, of course, the case in any kind of business; but for the reasons indicated reliable forecasts are not always easy to make in this one. A very disturbing feature was naturally introduced by the European war. With the increase of foreign importations after 1913, on account of the removal of the U.S. duty, domestic prices suffered a great slump in 1914, causing enormous losses and bankruptcy of numerous financially limited concerns. Some stores were unloaded at sacrifice prices as low as \$2.50 per case of sweetened condensed milk and \$1.90 for evaporated milk. With the coming of the war orders the situation changed and prices were boosted to a level not attained since the Civil War. The following were wholesale prices quoted in 1916 (January) and 1917 (June):

Sweetened condensed milk	\$6.50	\$8.75
Evaporated milk	3.85	5.75

Not war orders only caused the great boom, but United States and Canadian milk captured many of the markets that were formerly served almost wholly from European sources. Thus, for instance, the imports to Hong Kong from the United

States reached in 1918 a value of \$3,611,500, while those from other countries sank to \$466,106. This market was formerly supplied almost solely by Swiss condensed milk. Similarly has the situation changed in Latin American countries. Brazil and Chile alone imported each about 1200 to 1300 tons of condensed milk annually. The larger portion of this was of Swiss origin before the war. But lately the amounts of United States milk shipped to South America have greatly increased, as the following figures show:

Condensed milk shipped to South America from the United States (in pounds)

1913	1915	1917	1918
792,373	1,643,123	4,442,675	9,216,275

The great boom, however, was checked early in 1918 on account of lack of transatlantic ship room and vast stores accumulated. Orders were reduced while the output vastly increased and high prices had been contracted for fresh milk. Condensaries begun under war stimulation had neglected to provide domestic outlets. Some of these were forced through financial stringencies to sell at disastrous prices; this demoralized the market generally and caused some factories to shut down. The temporary embarrassment was relieved when better shipping facilities were re-established. The export continued large to the present time and prices kept fairly high. The stocks, however, because of the large production, were never entirely exhausted and have again been accumulating in the first months of this year. The total stocks of condensed and evaporated milk in the United States were, according to the U.S. Market Reporter, on March 1, 1919, 49,226,760 pounds, on March 1, 1920, 136,529,752 pounds, and on June 1, 1920, 212,697,402 pounds. This indicates that the situation is none too bright at present. There would no doubt be a much larger demand in Europe if conditions were more settled and the exchange rates not so prohibitive to the most needy European consumers. The following are some of the more recent prices quoted in the U.S. Market Reporter as the averages for the United States:

Prices paid by Condensaries for 3.5% Milk

1919			1920					
Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
3.32	3.45	3.51	3.59	3.48	3.17	2.82	2.77	2.80

Wholesale Prices (domestic) of Condensed and Evaporated Milk
(per case=48 14 oz. cans sweetened condensed milk and
48 16 oz. cans evaporated milk)

	1919		1920		
	Oct.	Dec.	Feb.	Apr.	May
Sweetened Condensed Milk.....	8.05	8.09	8.77	8.74	9.17
Evaporated Milk	6.23	6.32	5.64	5.14	5.50

For milk powders the following average prices are quoted by the U.S. Bureau of Animal Industry:

	Skim Milk	Whole Milk	Cream Powder
1915.....	8.4c to 9.7c	17.5c to 21.0c	30.5c to 31.8c
1916	9.5 to 11.2	20.6 to 27.2	31.1 to 37.4
1917	11.1 to 20.0	27.5 to 35.4	37.6 to 45.7
1918 .. . . .	....	32.2 to 36.9	45.1 to 47.2

Below are given the wholesale prices at which a skim milk powder made in Canada, was advertised in June, 1920:

		which makes per pound
Case of 4 dozen 8 oz. cans.....	\$12.50	52.08 cents
Case of 2 dozen 1 lb. cans.....	11.50	47.91 cents
Case of 6 ten pound cans.....	25.00	41.66 cents

In bulk skim-milk powder is sold under the name of "milk stock" at 28½ cents per pound in 50 pound tins and at 26½ cents per pound in 200 pound barrels.

Whole milk and cream powders are only made to order and are supplied directly from the factories, prepaid by parcel post, express or freight. The following prices for whole milk powder were announced by the same company on May 1, 1920:

	Corresponding Amounts of Fresh Milk
1 20 oz. tin \$ 1.00	9.4 — 10.00 pounds
1 2½ lb. tin 2.00	18.75— 20.00 "
6 2½ lb. tin 11.10	112.5 —120.0 "
1 8 lb. tin 6.00	60. — 64.0 "
6 8 lb. tin 33.00	360.0 —384.0 "

It may be remarked in conclusion that condensed milks at present prices are among the cheapest products for food value received.

4. *Conclusions and Outlook.*

The manufacture of condensed milk and milk powder has no doubt become a permanent and important factor in the

dairy industry. In many districts it has seriously eaten into the cheese and butter branches. As to the future of the industries it is difficult to make exact forecasts. It depends much upon the operation of world forces made abnormal by war influences. The following considerations may nevertheless be ventured. Some of the new won exporting fields will likely be wholly or partially maintained by the United States and Canada. The European countries will need some American milk for some years as far as they are able to buy. The depreciation of foreign exchanges and the gradual recovery of the milk production in most European countries are working against an export from America as large as it might otherwise be. The consumption in European countries will likely remain larger than it was before the war, as the products have become popularized. But production in the newer producing countries may also be increased when once the hunger crisis subsides and normal prosperity returns. The chief reliance for Canadian and United States production will always be the home market, which will no doubt continue to be large, although it may not expand as rapidly as in the past. On account of the war boom the increase in production on this side of the Atlantic has, at least temporarily, outrun the expansion of the home market. Some time will be required till readjustment may be established.

It would be well in any case in the interests of the dairy industry as a whole, not to neglect its older branches too much in favor of the new. For the present at least the market for the new products is still less stable. The loss of the by-products, whey or skim-milk, is a factor the influence of which is often underestimated by farmers. Moreover, condensaries when long established in a district are apt to acquire somewhat dictatorial powers towards the milk producers, when once creameries and cheese factories have been left to decay. Swiss dairying has had some experience in that respect. Somewhat heated struggles have been carried on at times until the farmers found it necessary to renovate their forgotten cheese factories again at considerable cost and trouble. In the meantime the farmers had also to some extent got out of the practice of hog raising, which is always a side line in cheese districts in order to utilize the whey. Thus a return to old methods after dairy habits and the farming system were

adjusted to the new ones involved more than merely a choice between hauling the milk to the cheese factory instead of to the condensary. The condensed milk companies on their part contended, and probably not always without justification, that they could get cheaper milk in other countries, and threatened to shut down Swiss factories. Of late, however, fair harmony has prevailed and the prices for the different branches, city consumption, cheese making and condensing, are fairly adjusted to each other with due allowance for the loss of by-products in the case of condensary milk.

This leads to a last consideration. The condensing and milk drying industries have made of milk a world market product. Some of the companies have located their plants in widely separated countries and can push the production wherever they get the raw product the cheapest. Both factors have the effect that milk prices of all countries will tend to come more or less to the same level. True, cheese and butter also are articles of international trade. But as regards cheese, every country produces its special kinds which often are bound to certain climatic conditions and old established methods of dairying. Butter is best fresh, and if transported far, it has to be in specially refrigerated cars or bottoms. Condensed milk and milk powder are more or less uniform in all countries; they can be transported any distance, and can be substituted for fresh milk.

F. W. BAUMGARTNER.

Queen's University,
Kingston, Canada.

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