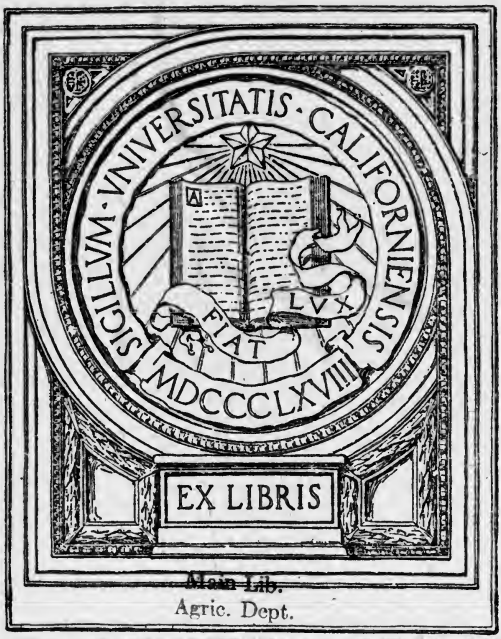

Issued December 21, 1908.

United States Department of Agriculture,

BUREAU OF CHEMISTRY—Circular No. 42.

H. W. WILEY, Chief of Bureau.

GENERAL RESULTS OF THE INVESTIGATIONS SHOWING THE EFFECT OF FORMALDEHYDE UPON DIGESTION AND HEALTH.[a]

INTRODUCTION.

Formaldehyde is one of those preservatives the use of which in foods has been almost universally condemned by experts, physicians, and the general public. Nevertheless, as formaldehyde has heretofore been used to quite an extent in certain foods, especially dairy products, and is still advertised under its own and other names for use in such products to a limited extent, it seemed wise to include this substance in the plan of investigation.

Formaldehyde is derived from the first member of the alcohol group, namely, methyl or wood alcohol. Each of the alcohols has an aldehyde corresponding thereto, as, for instance, formaldehyde from methyl alcohol, acetaldehyde derived from ethyl alcohol, which is the ordinary alcohol of commerce, and so on with the other alcohols. It has been very generally believed that the toxicity of alcohols, and they are more or less toxic, was greater as the series ascended—that is, if methyl or ethyl alcohol is considered as the basis of comparison the toxicity of the higher alcohols (such as butyl, propyl, and amyl) is greater than that of methyl or ethyl alcohol. Following this plan of classification, the toxicity of methyl alcohol

[a] By reason of the restrictions placed by law upon the printing and distribution of bulletins exceeding 100 pages, it is not possible to supply the demand for Bulletin 84, Influence of Food Preservatives and Artificial Colors on Digestion and Health, from the regular edition. In order to give as wide a circulation as possible to the results of the experimental work, it has been deemed advisable, in the case of Part V, on Formaldehyde, as in the case of Part I, on Boric Acid and Borates; Part II, on Salicylic Acid and Salicylates; Part III, on Sulphurous Acid and Sulphites; and Part IV, on Benzoic Acid and Benzoates (Circulars 15, 31, 37, and 39), to publish the results in the form of a circular for general distribution.

61958—Cir. 42—08

should be less than that of ethyl alcohol. There is a lack of exact experimentation on this point, but the evidence which has lately been secured leads to the conclusion that some modification of this common belief is necessary. The degree of toxicity of methyl and ethyl alcohol in small amounts is largely in favor of the methyl alcohol, while if relatively larger quantities are employed the methyl alcohol is far more toxic than the ethyl alcohol, and, as a corollary from this, formaldehyde under the same conditions should be more toxic than acetaldehyde. Attention should also be called to the fact that formaldehyde represents the simplest form of aldehyde known—that is, its chemical constitution shows that it is made up of carbon and water. By multiplying the simple molecule, for instance, by six the ordinary formula for a sugar is obtained. In other words, if a chemist could start with six molecules of formaldehyde and put them together in a strictly natural way, he would produce sugar, which is a highly nutritious food in respect of its power to furnish heat, energy, and fatty tissue.

Physiological botanists suppose that formaldehyde is the first product of chemical synthesis, tending to build up the cellulose or woody tissue of plants, and forming by condensation the starch and sugar which the plant contains. Its biological activity is supposed by some physiologists to extend even further, so as to be a very important aid in the building up of nitrogenous tissues. In this connection it must be remembered that formaldehyde not only possesses to a marked degree the property of combining with itself to form new bodies, but, as has already been suggested, it unites in a very intimate manner with the proteids. Therefore, when added to milk, which contains a very large proportion of nitrogenous materials, formaldehyde may enter into a chemical combination with these substances. To determine whether any difference would be observed in the activity of the preservative under these conditions, the formaldehyde was administered immediately after it was mixed with milk and also after allowing it to stand for forty-eight hours in contact with the milk. This length of time gave ample opportunity for the completion of any chemical reactions which the formaldehyde might undergo in connection with the protein substances.

Another point which was carefully considered was that presumably, in the case of formaldehyde, we are dealing with a substance universally considered to be of a poisonous character, and for this reason much more care was necessarily exercised in regulating the quantity administered in order that no sudden or unexpected toxic effects might be produced.

Another fact worthy of consideration is that inasmuch as milk is the most prone of all ordinary foods to deterioration and requires the most careful treatment the temptation to use such an efficient preservative as formaldehyde is proportionately greater, especially during the summer months. The arguments which have been advanced in favor of other preservatives in small quantities should theoretically carry more weight in the case of milk than of other common foods, and if these arguments are valid in any case they would be especially so when applied to dairy products. It is generally admitted that there is no known preservative so effective, so readily employed, and in some respects so likely to escape detection as minute quantities of formaldehyde, and therefore all the conditions which relate to its use deserve the greater care and consideration. It should not be forgotten, however, that a supposititious commercial necessity can not be cited as an excuse for the addition to foods of substances which are injurious.

In this connection it seems not out of place to call attention to the fact that apart from the injurious effects of formaldehyde itself its use as a preservative would be especially inadvisable in milk or cream, because its addition in dilute solution prevents the growth of acid-forming bacteria, but has no effect in retarding the action of many harmful organisms; in other words, the milk is prevented from becoming sour, and thus indicating its age, and the danger signal is thus removed while the other organisms which are capable of producing disease continue to multiply in the milk with practically the same degree of rapidity as if the formaldehyde were not present.

Attention is again called to the proper and legitimate signification of the term "injurious to health," when used in this connection. This phrase does not signify that a food which has an injurious substance added to it must in every instance produce notably injurious effects upon the consumer immediately. The question can only be logically and fairly studied by considering the continued or cumulative effects, nor are these necessarily of such a character as to result in objective symptoms. Insidious effects which are produced on the cells of the organs or on their histological structure are no less important; in fact, they are more important. These are the injuries which at first escape detection and may go to irremediable lengths before any outward symptoms of their existence are manifested.

All of these points have been kept in view in the consideration of this question, but none of them has had any influence on the observation and recording of the data. As in all other cases, this part of the work has been conducted absolutely without reference to any preconceived theory. The sole endeavor has been to control the quan-

tity and quality of the food, the nutritive value of the ration, and the course of life of the subject, and to record the effect observed on the health and the metabolic processes in general. This work has been distributed among a large number of observers, each having control of a particular part of the investigation and working independently. In this case, as in all of the others, it was not until the figures were collated, tabulated, and studied that the tendencies induced by the preservative were known, and not until then could any attempt be made to determine the general effects or to draw conclusions from the data.

While it is not to be expected that the mass of compiled figures presented are absolutely free from error, the general effects which were produced are unmistakable, and it is believed the conclusions drawn therefrom are deduced on sound principles of reasoning and are based on reliable data, the marked uniformity of the analytical results and the absence of contradiction in the individual data being especially marked in this experiment.

ORGANIZATION AND CONTROL OF THE EXPERIMENT.

The twelve men who became members of the table for testing the effects of formaldehyde on health and digestion were carefully examined before the beginning of the experiment, as in previous cases. The medical history of each man was ascertained, no one being admitted who was not free from organic disease or who had suffered from serious illness of any kind within a year or two, who was predisposed to any hereditary malady, or who exhibited any feebleness of constitution which would make him an easy victim to disease. The usual daily examinations were made of each man, the temperature, pulse, and body weight being recorded. When any variation from the normal was noticed, the observation was checked by an attendant, who was always present and supervised the securing of the data for the clinical and medical history; and any symptoms reported were carefully considered, to determine how far such disorders might be attributed to the use of the preservative.

ADMINISTRATION OF THE PRESERVATIVE.

SCHEDULE OF ADMINISTRATION.

This series of investigations was begun on the 12th of November, 1904, and concluded on the 17th of December, 1904. The fore period covers ten days of observation, the preservative period fifteen days, and the after period ten days. The dates of the several subperiods are given in Table I.

TABLE I.—*Dates of periods and subperiods, Series IX.*

Period and subperiod.	Date of beginning.	Date of ending.
	1904.	1904.
Fore period	Nov. 12	Nov. 21
First subperiod	...do...	Nov. 16
Second subperiod	Nov. 17	Nov. 21
Preservative period	Nov. 22	Dec. 6
First subperiod	...do...	Nov. 26
Second subperiod	Nov. 27	Dec. 1
Third subperiod	Dec. 2	Dec. 6
After period	[a]Dec. 8	Dec. 17
First subperiod	Dec. 8	Dec. 12
Second subperiod	Dec. 13	Dec. 17

[a] In tabulating the results the data for December 7 are omitted owing to the fact that the preservative was administered only on the morning of that day, and it was then deemed advisable, on account of the condition of the subjects, to begin the after period.

Table II shows the administration of the formaldehyde during the preservative period. The quantity given daily during the first preservative subperiod is 100 milligrams, during the second preservative subperiod 200 milligrams, and during the third preservative subperiod 200 milligrams, making a total of 2.5 grams administered during the entire preservative period.

TABLE II.—*Schedule of administration of preservative, Series IX.*

Period and date (1904).	Formaldehyde added to milk immediately before taking.						Formaldehyde added to milk two days before taking.[a]				
	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 10	No. 11	No. 12
First subperiod:	*Gms.*	*Gms.*	*Gms.*	*Gms.*	*Gms.*	*Gms.*	*Gms.*	*Gms.*	*Gms.*	*Gms.*	*Gms.*
Nov. 22	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
23	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
24	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
25	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
26	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
Total	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5	.5
Second subperiod:											
Nov. 27	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
28	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
29	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
30	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Dec. 1	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2	.2
Total	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Third subperiod:											
Dec. 2	.2	.2	.2	.2	.2	.2	.2	.1	.2	.2	.2
3	.2	.2	.2	.2	.2	.2	.2	.0	.2	.2	.2
4	.2	.2	.2	.2	.2	.2	.2	.0	.2	.2	.2
5	.2	.2	.2	.2	.2	.1	.2	.0	.1	.2	.2
6	.2	.2	.2	.2	.2	.0	.2	.0	.0	.2	.2
Total[b]	1.0	1.0	1.0	1.0	1.0	.7	1.0	.1	.7	1.0	1.0

[a] No. 9 left the city before the entire observation was completed and therefore his data are omitted.
[b] On Dec. 7 those subjects who were still receiving the preservative were given 0.1 gram, but it was deemed inadvisable to continue the preservative period for another five days, and the after period was accordingly begun on Dec. 8, the data for Dec. 7 being disregarded in the tabulations.

It will be noted that only Nos. 6, 8, and 10 failed to take the scheduled amount of preservative. No. 8 received the smallest amount, taking only 0.1 gram on the first day of the last subperiod and none thereafter, while Nos. 6 and 10 took only 0.1 gram on the next to the last day of the preservative period and none on the last day, making a total for the subperiod of 0.7 gram.

METHOD OF ADMINISTRATION.

An aqueous solution of formaldehyde was administered in milk. The strength of a stock solution was determined from time to time and the proper volume to secure the amount required by the schedule was added to the milk taken by the subjects. On account of the liquid nature of this substance it was not possible to administer it in any better way. The quantity added in the first subperiod was not sufficient to impart any taste to the milk, but in the larger quantities a slightly disagreeable taste was noticeable. In the case of half of the men (Nos. 1 to 6) the preservative was added to the milk immediately before it was drunk; and in order that ample time might be given for any chemical union which might take place between the formaldehyde and the protein constituents of the milk, that administered to Nos. 7 to 12 was added to the milk two days before consumption.

SUMMARY OF RESULTS.

MEDICAL AND CLINICAL DATA.

The formaldehyde in the quantities administered did not produce any marked symptoms until the third preservative subperiod, a lapse of ten days; then headache and pain in the stomach and intestines became general, in many cases producing cramps, and in a few cases attended by nausea and vomiting. Only two exceptions are noted. A burning sensation in the throat was reported in the majority of cases. In four cases out of eleven a well marked itching rash appeared on the chest and thighs, causing great discomfort, slight symptoms of this nature being reported in a fifth case. The general symptoms, therefore, are headache and abdominal pains, while a slight tendency to lower the temperature may be noted as a minor symptom, and the development of the rash, though marked, occurs in only about half of the cases.

It is important to observe that in the case of healthy young men it requires some time for this drug to produce an effect noticeable in a symptomatic way, as above described. That no effect is produced,

however, until after ten days would not be a logical conclusion. It is evident that the system is able for some time to control the development of conditions which later become pronounced, but that no ill effects are produced prior to that time is not probable. After ten days, however, ten cases out of twelve develop marked symptoms of malaise, intestinal trouble, and distress, and in many cases positive symptoms of a local character, such as the rash which has been mentioned. The apparent tendency to lower the temperature is mentioned as one of the symptoms, but inasmuch as no special investigation was made in this respect it is advisable that further studies be prosecuted before positive statements are made, yet it is not without signification that this unexpected condition of affairs was noticed, and also that there was a tendency to its continuation in some instances into the after period. (See figs. 1 and 2.)

BODY WEIGHT.

There is a slight tendency shown in the case of those subjects receiving the formaldehyde directly in milk to a loss of body weight under the administration of the preservative amounting to 0.2 kilogram per day for each man, while in the case of the subjects receiving milk preserved for forty-eight hours there does not appear to be any noteworthy decrease in the body weight until the after period, when an average loss of 0.5 kilogram is recorded. (See figs. 3 and 4.)

The ratio of food weight to the body weight is practically constant throughout the experiment. These changes in weight are of interest as correlated with the corresponding increase in volume of the urine and in the moisture in the feces, and as contrasted with the tendency to decrease the excretion of the principal food elements studied.

WEIGHT AND WATER CONTENT OF THE FECES.

These data show, in the case of the subjects receiving formaldehyde directly, an increase in moisture amounting to 2 per cent and a slight decrease (1 gram per day) in the amount of dry feces excreted. In the case of the subjects receiving the preservative forty-eight hours after it had been added to the milk there is a decrease both in the moisture content and in the weight of dry matter excreted, amounting to 1.6 per cent and 3 grams daily, respectively, this decrease being further augmented in the after period. There is thus shown a slight derangement of the normal processes, which is unfavorable and probably has some bearing on the loss of body weight.

URINE.

VOLUME, SPECIFIC GRAVITY, AND TOTAL SOLIDS.

The data in the case of the direct administration of the preservative (Nos. 1 to 6) show an increase in the volume of the urine excreted, accompanied by a slight decrease in its specific gravity and practically no change in the amount of solids excreted. The same condition prevails in the case of the indirect administration, though it is less marked during the preservative period and more so in the after period.

There is in general, therefore, a tendency to slight diuresis and a decrease in specific gravity under the administration of the preservative, while practically no effect is produced on the excretion of total solids. It is interesting to note the connection between these increases in volume of urine excreted and the losses in body weights. The increase in volume for Nos. 1 to 6 and the decrease in weight occur during the preservative period, while for Nos. 7, 10, 11, and 12 these conditions are both more marked in the after period.

ALBUMIN AND REACTION.

From the somewhat limited data at hand no definite conclusions can be drawn regarding the presence of albumin in the urine or the acidity of the urine. There is, however, in a few instances an apparent tendency to produce albumin, and in general during the administration of the formaldehyde there is a tendency to decrease the normal acidity. Considering the action of formaldehyde in general on secretions, especially the digestive secretions, this observation is in accordance with that of others who have shown that changes in the gastric juice are accompanied by corresponding changes in the acidity of the urine, an increased secretion of acid producing a decrease in the acidity of the urine. These two conditions have an important physiological bearing on the normal functions of the body, and such a derangement must be regarded as harmful or at least as leading to harmful results.

CHANGES IN THE RELATIVE EXCRETION OF SULPHUR COMPOUNDS.

In the case of the direct administration of the preservative there is a slight tendency manifested to derange the normal relations of the compounds of sulphur excreted during the preservative period. There is a decrease in the neutral sulphur amounting to a little over 1 per cent of the total sulphur eliminated and a slight increase in the

inorganic sulphates, while the ethereal sulphates remain practically the same throughout. For those subjects who received the preservative after it had stood in milk for two days there is seen an increase in the quantity of neutral sulphur excreted amounting to about 1.4 per cent, accompanied by a slight decrease in the inorganic sulphates, while again the ethereal sulphates remain constant.

These data alone show evidence of an increased sulphur metabolism in the case of Nos. 1 to 6 and a retardation in the case of Nos. 7 to 12, though the excretion of total sulphur shows practically no change.

NITROGEN METABOLISM.

A remarkably uniform tendency is manifested, in regard to the metabolism of the nitrogen of the food, to increase slightly its assimilation and to retard the breaking-down processes in the cells. The stimulating of assimilation is in accordance with the observations of numerous authors who ascribe to formaldehyde the power of exciting digestive secretions, its influence on the pancreatic and biliary secretions being very marked. On the other hand, formaldehyde has a retarding effect on the digestive enzyms, which in this case appears not to have been so marked as the stimulating effects exerted on the digestive juices themselves. The decrease in the metabolized nitrogen excreted in connection with the loss of weight contraindicates any increase in the anabolic processes. Apparently the same effect is produced by the formaldehyde on the nitrogen metabolism when it is added directly to the milk and when it has stood in contact with it for two days, though in the latter case it is somewhat more marked.

PHOSPHORIC ACID METABOLISM.

There is an unmistakable tendency shown to derange the metabolism of phosphoric acid, which again is manifested to practically the same extent under the two conditions of the experiment. There is a slightly increased absorption of the phosphorus compounds from the alimentary canal, accompanied by a marked increase in the excretion of metabolized phosphoric acid, amounting to over 4 per cent. There is only one exception to this increased excretion in the individual data, namely, No. 7, in which case an abnormal excretion of phosphoric acid was recorded in the fore period.

The balances are decreased in all cases except No. 7 — a condition which is quite abnormal in the case of phosphoric acid and can not be regarded as other than an unfavorable effect, which would ultimately produce harmful results.

SULPHUR METABOLISM.

In the sulphur metabolism the same conditions are shown to exist as were found in the case of nitrogen, namely, a tendency to increase the absorption of the sulphur constituents of the food and retard the normal katabolic activities. The decrease in nonmetabolized sulphur is a little over 1 per cent in both cases. while the decrease in metabolized sulphur excreted amounts to 4.6 per cent for Nos. 1 to 6 and 2.7 per cent for Nos. 7 to 12. There is almost as close an individual agreement shown in this case as in the previous balances, and there is no marked difference between the summaries for those taking the formaldehyde directly and those to whom it was given in milk preserved for two days.

TABLE III.—*Comparative summary of principal determinations made—Series IX.*

[Averages are per man per day.]

Data.	Formaldehyde (Nos. 1-6).			Formaldehyde (Nos. 7-12).[a]		
	Fore period.	Preservative period.	After period.	Fore period.	Preservative period.	After period.
Temperature (°F.)	98.3	98.0	98.1	98.4	98.3	98.1
Body weight (kilos)	63.50	63.27	63.27	63.01	62.93	62.43
Composition of feces:						
Weight (grams)	101.00	108.00	103.00	116.00	96.34	91.00
Water content (per cent)	77.35	79.45	77.87	78.34	76.78	76.46
Dry matter (grams)	23.00	22.00	23.00	25.00	22.00	21.00
Urine:						
Volume (cc.)	970.00	1,085.00	1,062.00	1,170.00	1,191.00	1,309.00
Microscopic sediments (per cent figures for relative occurrence)[b]	.....	.....	.....	63.6	70.00	72.7
Sulphur (as SO_3) (grams)—						
Neutral	.231	.202	.193	.246	.279	.217
Inorganic	1.859	1.872	1.822	2.035	2.001	2.089
Ethereal	.143	.141	.146	.143	.143	.141
Total	2.232	2.215	2.161	2.424	2.423	2.446
Metabolism (percentage results):						
Nitrogen—						
Nonmetabolized (feces)	9.67	9.27	9.71	9.94	8.81	8.62
Metabolized (urine)	82.92	81.50	80.54	85.02	82.62	85.74
Phosphoric acid—						
Nonmetabolized (feces)	30.93	29.27	31.78	33.24	29.12	30.32
Metabolized (urine)	59.71	64.43	63.06	60.46	64.88	64.60
Sulphur—						
Nonmetabolized (feces)	12.26	11.06	12.70	12.54	10.96	10.98
Metabolized (urine)	78.35	73.78	78.41	79.34	76.61	81.96

[a] Omitting Nos. 8 and 9; formaldehyde added to milk 48 hours before administration.
[b] Summary for Nos. 1-12, omitting Nos. 8 and 9.

GENERAL CONCLUSIONS.

A general study of all of the data leads to the conclusion that the admixture of formaldehyde with food is injurious to health, even in the case of healthy young men. It is fair to conclude, therefore, that in the case of infants and children the deleterious effects would be more pronounced. The metabolic functions are disturbed in a notable way, both by the retardation of the nitrogen and sulphur metabo-

lism and the acceleration of phosphorus metabolism. There seems to be a tendency to an increased absorption from the alimentary canal, especially in the cases when the formaldehyde had stood in contact with the milk, and hence it is fair to presume that, in so far as the digestive action in the intestinal canal is concerned, transforming solid food into soluble materials which may enter the circulation, there is evidently a stimulating effect produced.

There are, however, many varying conditions which must be considered in properly interpreting the data. The uniformly increased absorption of the proteid elements of the food, and also of the sulphur and phosphoric acid, accompanied in the first two instances by a decrease in the metabolized elements excreted, and in the last instance, namely, phosphoric acid, by a pronounced increase in metabolism, makes the explanation of the data rather difficult. Attention should be called to the fact that while the variations from normal metabolism are not very wide the individual data are remarkably uniform and consistent.

The conditions which are noted in the case of the proteins would lead one to expect a gain in the body weight. This expectation, however, is not realized for either class of subjects, although the losses in weight are so slight as to be practically negligible. The ratio of the food weight to the body weight was uniformly maintained throughout the experiment, and hence if no variations in metabolic activity had occurred a fair presumption would have been that the body weight would remain constant. That the change of weight was slight in view of the disturbances of the metabolic functions may be accounted for by the inhibiting or retarding influence of the preservative upon the nitrogen and sulphur katabolism or by the slight increase in water in the urine and feces. It can not be maintained, however, that a retarded katabolism is beneficial to health. On the contrary, a more rapid renewal of the tissues within the limits of healthy activity would be more likely to preserve a normal condition. The old tissues can not be expected to functionate as perfectly as those which are newer, and hence, within reasonable limits, a change of the tissues of the body must be considered as necessary to a healthy condition and the maintenance of a normal vitality.

The medical data indicate plainly that formaldehyde, even when given in small quantities, is an irritating substance to the mucous membrane, and therefore the normal organs are at first actively stimulated to rid themselves of the irritating foreign substance. It is not strange, therefore, that this preservative had a marked stimulative action on those organs and cells secreting the various digestive juices. It is evident that when the digestive and excretory organs of the body

are excited to unusual activity by such an extraneous body, having neither food nor condimental value, they act in self-defense, and it would be wholly illogical to conclude from this increased excitation that these bodies were helpful to digestion and conducive to health. The nature of the investigation made it impossible to determine whether any organic change took place in the various organs affected, but it may be assumed that any such change which these organs had undergone in the limited time was not sufficient to disturb in any notable way their normal functions, which they would perform until the continued administration of the drug produced disease due to the excessive stimulation.

In the case of phosphoric acid, the increased katabolic activity is difficult of definite interpretation, though it is established beyond doubt that such an effect is produced. The formaldehyde may exert a selective action for those proteid bodies high in phosphorus, rendering them insoluble, but in this case there would be an excess of phosphorus in the feces, which is not found. Or the formaldehyde may induce a change in the process of digestion whereby the phosphorus of the food is changed into a soluble and easily excreted form without passing through the tissues of the body. This might easily be the case if in the process of digestion the glycerol-phosphoric acid formed is transformed into soluble inorganic salts, which are readily excreted. Whatever may be the explanation, the changes indicated in normal metabolism, accompanied as they are by the development of the symptoms described, can only be considered as prejudicial to health.

The general tendency to produce a slight decrease in the temperature of the body, assuming for the moment that the data warrant the conclusions that such a condition of affairs existed, might well be due to the inhibition of cell activity shown by the retardation in the breaking down of tissues. The normal functions of the body would doubtless be disturbed by such a condition, aside from the irritating and other disturbing influences exerted by the ingested drug.

The tendency of the preservative to produce albumin in the urine, while not well marked, is at least worthy of mention. The fact that only slight changes take place in the body weight is sufficiently explained by the data and can not be urged in favor of the exhibited preservative.

The final conclusion, therefore, is that the addition of formaldehyde to foods tends to derange metabolism, disturb the normal functions, and produce irritation and undue stimulation of the secretory activities, and therefore it is never justifiable.

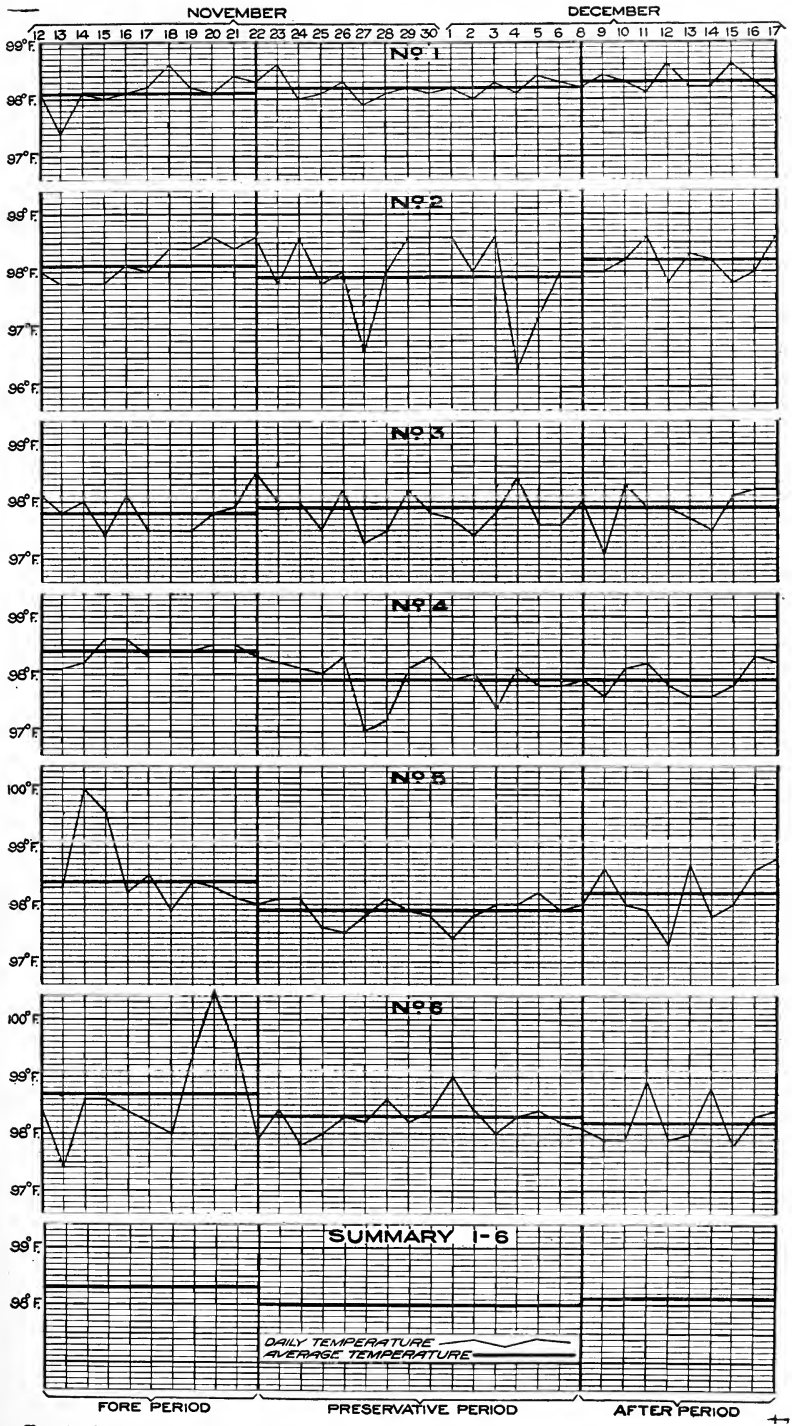

FIG. 1.—Daily and average temperature record for Series IX, Nos. 1 to 6, and summary.

[Cir. 42]

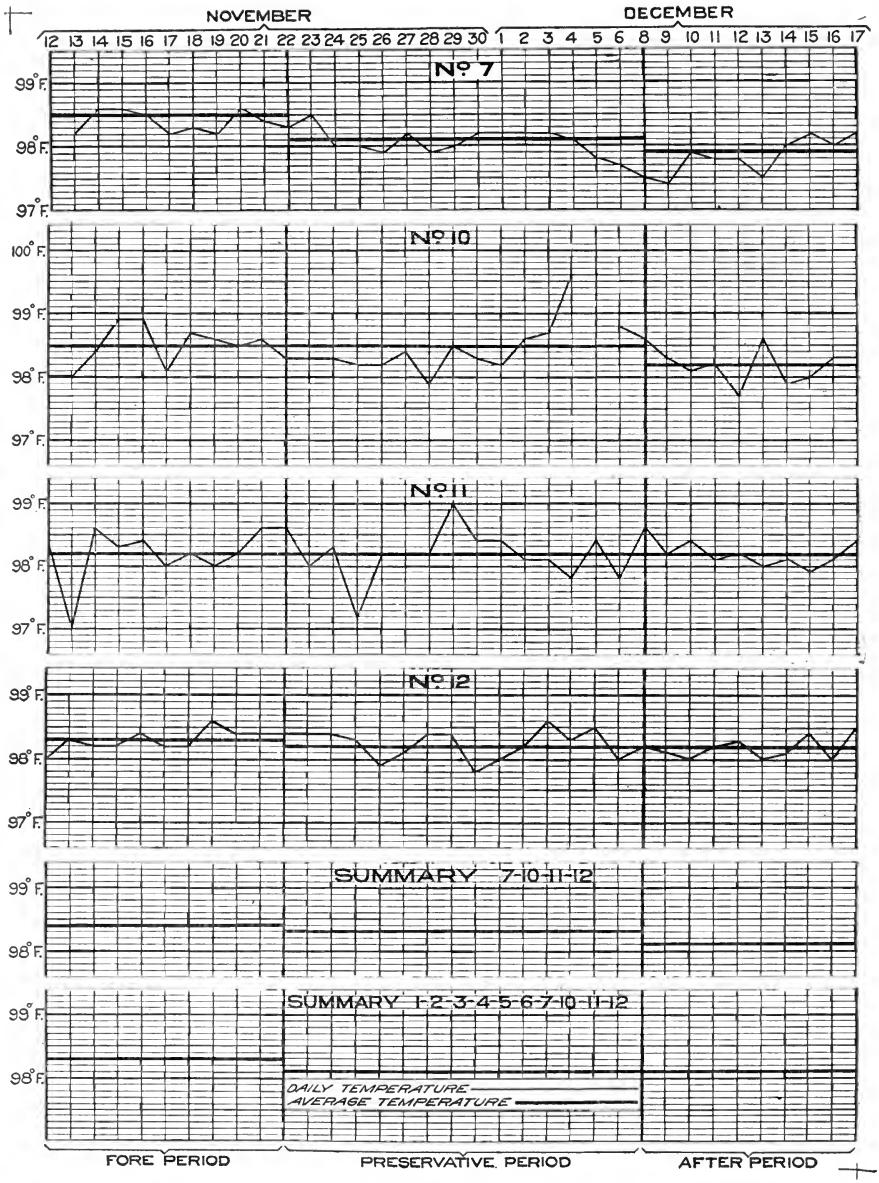

FIG. 2.—Daily and average temperature record for Series IX, Nos. 7 to 12, excluding Nos. 8 and 9, and summary for the entire series.

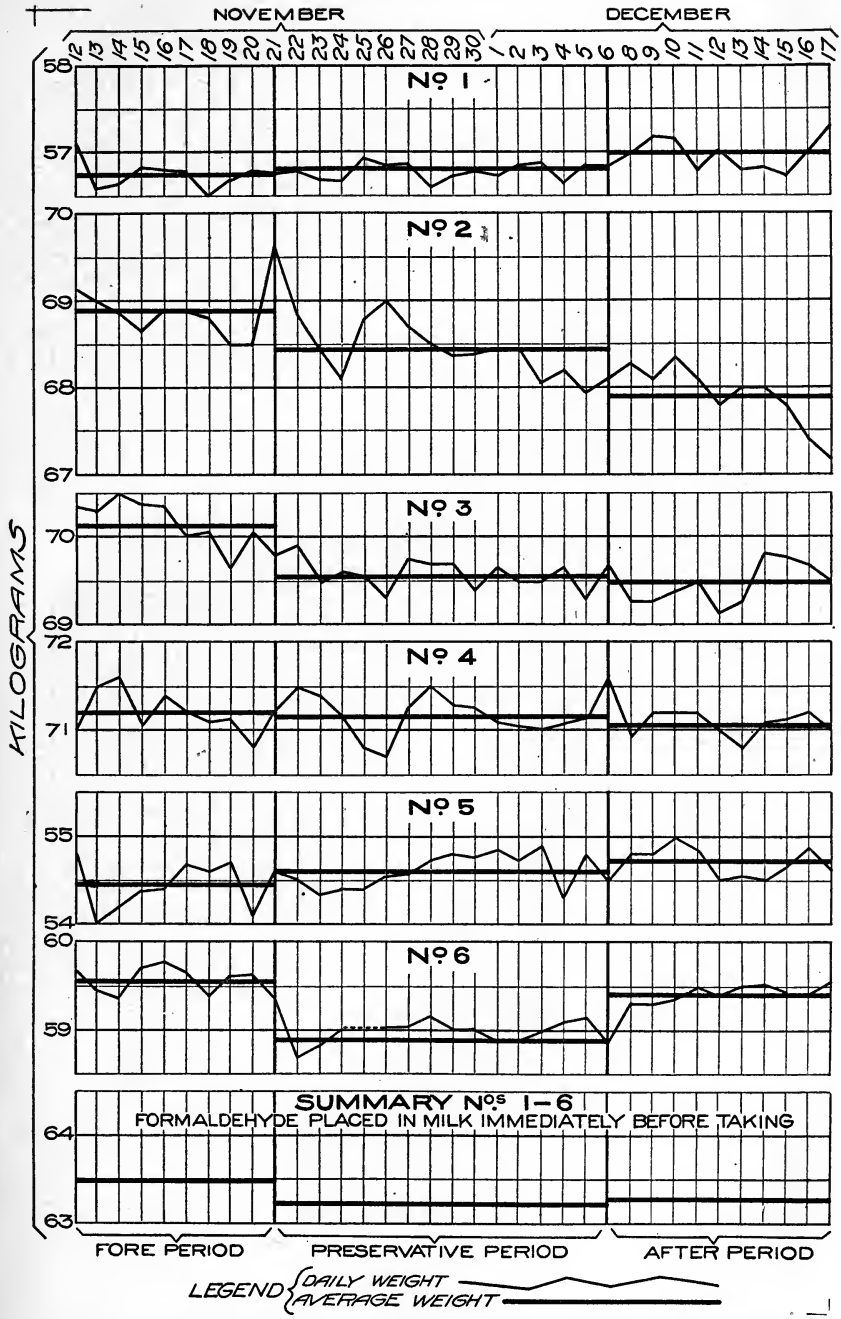

FIG. 3.—Daily and average body weights for Series IX, Nos. 1 to 6, and summary.

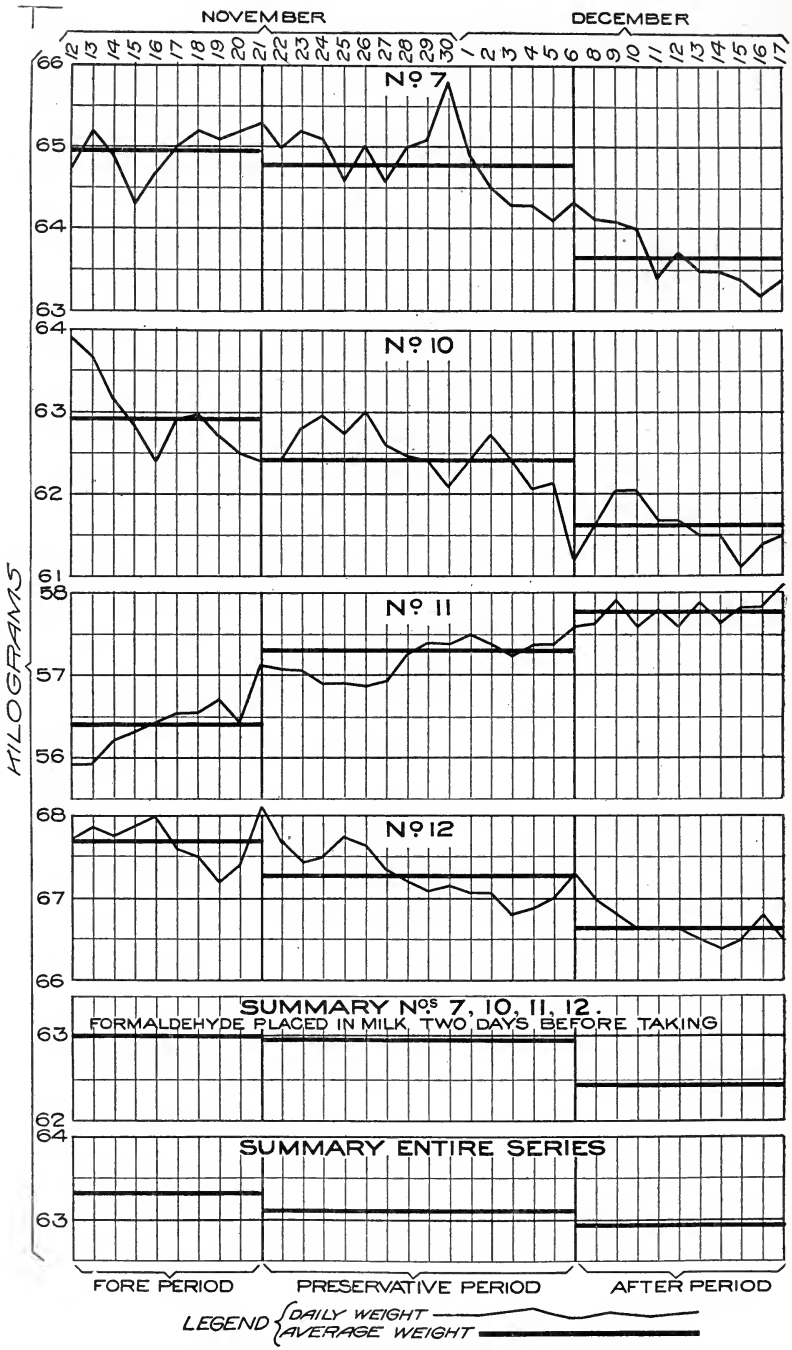

FIG. 4.—Daily and average body weights for Series IX, Nos. 7 to 12, excluding Nos. 8 and 9, and summary, together with the general summary for the entire series.

[Cir. 42]

1931