T H E S I S

Hydrogen Peroxide as a Preservative of Milk

by

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upon gradution from the

K A N S A S S T A T E A G R I C U L T U R A L C O L L E G E

1907.

INTRODUCTION.

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Since Prof. Leze wrote in Journal d'Agriculture Practique about hydrogenperoxide as a preservative of milk, the public has been very much aroused. Scientific and dairy papers presented quotations directly or indirectly from his article. Experiments were performed by M. M. de'Waele, Sugg and Vandevelde. In conclusion these gentlemen said "an absolute sterilization is obtained by using hydrogenperoxide in excess and the excess may be neutralized by blood serum previously passedthrough a Chamberland filter".

The objects of the following experiments were to find out whether or not an absolute sterilization cam be obtained from hydrogen peroxide, as above mentioned gentlemen said, to find out what bearing it has on adulteration of milk, and to find out whether this is a practical thing to be used in dairying.

Blood serum was not used in the following experiments to neutralize excess of hydrogen peroxide, for it was found in a preliminary experiment to be unnecessary.

Preliminary Experiment.

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The acidity of hydrogen peroxide solution was determined by titrating it against standard sodium hydroxide.

It was so small a fraction of a per cent that its presence would not give any more than the experimental errors. Therefore it was neglected.

The strength of the hydrogen peroxide solution was determined by a standard solution of potassium permanganate. The standard solution of potassium permanganate was made by the following method: A weighed amount, corresponding to $\frac{N}{10}$, of C. P. Potassium permanganate was dissolved in water. Against this solution, a solution of a weighed amount of piano wire dissolved in dilute sulphyric acid, was titrated. By calculation, the strength of potassium permanganate was found to be .09474 normal.

Knowing the strength of potassium permanganate solution, the strength of hydrogen peroxide solution was found to be 1.9 per cent, or more exactly, 19.2413 grams of hydrogen peroxide in 1000 cc. of solution.

The standard $\frac{n}{2}$ sodium hydroxide solution was made by titrating against a standard hydrochloric acid whose strength was ascertained by silver nitrate. This standard solution of sodium hydroxide was employed throughout the experiments.

Three 1/2 litre bottles were sterilized, and 500 cc milk obtained at the dairy barn of the College, fresh from a cow, were put into the bottles. The milk was cooled, immediately, to 20° C. Acidity of milk was ascertained by titrating the milk against the standard potassium hydroxide solution.

20 cc of hydroben peroxide solution were added to each

of the two bottles, A and B, and nothing was added to the third bottle, C. An equal amount of hydrogen peroxide was added to each of A and B, for as this was a preliminary experiment, it was necessary to see whether or not the hydrogen peroxide preserved milk, and not to see what amount of it was to be used. To accomplish this purpose it was better to have duplicates.

Milk from each lot was tested for its acidity at 3:00 P. M. every day until all coagulated. The general condition of the milk was also noticed.

Gas was given off from bottles A and B. The gas appeared to be oxygen which apparently, came from decomposition of hydrogen peroxide. This was mostly given off on the second and third days.

Milk in bottle C was coagulated on the third day, while all the others were in perfect condition and remained sweet. Daily acidity test is shown in the following table:

Date	A	B	C
Jan 21	.18	.18	.18
22	.18	.1755	.225
23	.189	.171	.225
24	.18	.135	.8325
25	.18	.1575	.99
26	.18	.171	.945
28	.247	.297	1.0485
29	.198	.1445	1.0315

30	.18	.2925.	.99
31	.585	.6615	.99

Milk in bottle A became coagulated on eleventh day and that of B on tenth day, while the milk in bottle C, to which no hydrogen peroxide was added, became coagulated within three days. It can be noticed on above table that the acidity of milk in bottle A remained perfectly constant with one exception, Jan 28, on which day every one tested higher acidity. It was due to a change in the distilled water. When milk was tested for its acidity distilled water was added in order to dilute the milk, so as to see the indicator better. Unfortunately breakage occurred in the still on the previous day. On Jan. 28 it was repaired and distilled water was obtainable. But water itself showed acid test, and this was not noticed until the next day. It should, therefore, test higher for acidity.

Milk in bottle B, however, varied every day in its acidity. For the first four days the acidity lowered every day. On the fourth day it tested only .135 per cent, but it came up again on the next day and gradually increased until it got sour and coagulated.

Milk in bottle C tested .225 per cent in its acidity on the second day, and remained in the same condition until the third day on which day it coagulated. On the fourth day the acidity ran high up to .8325 per cent. Leaving acidity tests of the 28th and the 29th days for the

same reason as stated above, the maximum acidity of .99 per cent was reached on the fifth day and remained constant.

Test for presence of hydrogen peroxide was made by two methods. For the first, dilute sulphuric acid, starch paste, zinc iodide, and very dilute copper sulphate solution were used. This method, however, proved itself to be a failure in presence of milk, for these reagents gave a blue color which was the reaction for hydrogen peroxide with these reagents, regardless of whether hydrogen peroxide was added to milk or not. New milk, perfectly free from hydrogen peroxide gave a deep blue color. For this reason the use of those reagents was abandoned. The second method, titanium dioxide solution in sulphuric acid, was used. This proved itself to be the best. This gives deep yellow coloration to be in presence of hydrogen peroxide but no change in color of milk if hydrogen peroxide is absent. The yellow color is due to the formation of titanium trioxide.

$$H_2O_2 + TiO_2 = H_2O + TiO_3 \text{ (yellow)}$$

with this method it was possible to detect the presence of 15 parts of hydrogen peroxide in 10,000,000 parts of milk.

On the last day of this experiment the milk from bottles A and B was tested for hydrogen peroxide, but no trace of hydrogen peroxide was left in the milk.

Summarizing results:

1. Hydrogen peroxide has something to do with the keeping quality of milk.

2. Hydrogen peroxide decomposes in milk without the aid of blood serum.

3. Solution of titanium dioxide in sulphuric acid may be used for detection of hydrogen peroxide in milk with satisfaction.

The Amount of Hydrogen Peroxide for Preservation of Milk.

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It has been found out that hydrogen peroxide has a certain property of preserving milk. Then it was necessary to find the proper amount of hydrogen peroxide for preservation. The greater part of the time was devoted to this experiment. The preservative power of hydrogen peroxide and practicability of using this chemical in dairying depends largely upon the amount to be used.

Experiment I.

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Strength of hydrogen peroxide	1.9 per cent.
Condition of milk	Morning's milk, cooled and kept in refrigerator until afternoon.
Temperature of milk	7° C.
Temperature of room	23 1-2° C.
Acidity of milk	.108 per cent.

Milk was placed in two 500 cc bottles for every day's testing and ten 100 cc bottles for different lots. Bottle A and bottle B were filled with 500 cc of milk. To A 5 cc of hydrogen peroxide were added and to B nothing was added. They were tested for acidity every day. Bottles I, II, III, IV, V, VI, VII, VIII, were filled with 100 cc of milk each and .2, .3, .4, .5, .6, .7, .8, and .9 cc of hydrogen peroxide solution were added respectively. Bottle IX was filled with 100 cc of milk pasturized at 75° C by steam. Bottle X was filled 100 cc of untreated milk. Bottles from I to X were not opened until the milk in bottle A became sour. On the fourthe day the milk in bottles A and B became sour. On the same day all the bottles were opened and the milk was tested for acidity. On the next day all the milk became coagulated. The amount of hydrogen peroxide per litre of milk, number of days the milk remained sweet at room temperature, and acidity on fourth day are given in the following table. The amount of hydrogen peroxine per litre of milk was calculated from the strength of the solution and number of cc used for 100 cc of milk.

No. of bottle.	Amt. of solution used in 100 cc milk.	Amt. H_2O_2 in 1000 cc milk. gms.	Acidity on fourth day. per cent.	No. of days the milk remained sweet.
I.	.2	.038	.225	3
II.	.3	.057	.225	3
III.	.4	.076	.180	4
IV.	.5	.095	.1575	4

V.	.6	.114	.1575	4
VI.	.7	.133	.1575	4
VII.	.8	.152	.1440	4
VIII.	.9	.171	.1260	4
IX.	Pasteurized (at 75°C.	.none	.1395	4
X.	none	none	.7425	3
A.	50 cc in 500 (cc of milk.	.190	.6300	3
B.	none	none	.775	3

The result was very unsatisfactory. This shows, however, that the amount used in this experiment was too little to preserve milk. No. VIII. had the least acid on the fourth day, yet it became coagulated as bad as the others. No. IX., which was pasteurized with heat was the next. A, which contained the most hydrogen peroxide was the worst next to the untreated milk. This may be explained easily. No. A was opened every day, hence the bacteria may have gotten into the milk from the air. As all the bottles were opened on the fourth day, it was suspected that all the milk might also have been contaminated. Therefore, another set of experiments of the same nature, but of a different plan was carried out.

Experiment No. 2.

Strength of Hydrogen Peroxide Solution 1.9 %.

Condition of milk. Morning's milk cooled tol2°C.

Ascidity of milk .1035 %.

The experiment was carried on the same manner, but this time twelve 100 cc and two 500 cc bottles were used. The

100 cc bottles were not opened until all the milk became coagulated. The results was a failure as all the milk without exception became coagulated on the third day. The amount of hydrogen peroxide used varied from .019 gms. to .209 gms. in 1000 cc of milk. Data will not be given for they have no figures worthy to be discussed.

Experiment 3.

Strength of hydrogen peroxide solution	2.577 %.
Condition of milk	Fresh from cows.
Acidity of milk	.1125%.
Room temperature	23° C.

This experiment was conducted on the same plan as experiment No. 2, but the hydrogen peroxide solution was changed and the milk was taken directly from the Diary Barn of the College. The amount of hydroge peroxide varied from .0258 gms. to .5154 gms. per 1000 cc of milk. But all the milk became coagulated on the third day, as before. These three experiments show that the amount of hydrogen peroxide used was not sufficient to preserve milk. Therefore the use of such a small amount of hydrogen peroxide was abandoned and the same kind of experiments were conducted with larger amounts of hydrogen peroxide.

Experiment 4.

Strength of hydrogen peroxide solution	2.577 %.
Condition of milk	Morning's milk directly from Dairy Barn
Acidity of milk	.162 %.
Room temperature	23.5° - 24° C.

The amount of hydrogen peroxide used in this experiment varied from .2577 gm. to 1.5462 gms. Bottles were not opened until the milk became coagulated in order to avoid any contamination. Bottles were opened as soon as milk became coagulated. Them milk was tested for its acidity. The results of this experiment is given in the following table:

No. of bottle	Amt. of H_2O_2 in 1000 cc milk. gms.	Acidity on third day. per cent	Acidity on fourth day. per cent	Acidity on fifth day. per cent
I.	.25770	.495		
II.	.38655	.3285		
III.	.51540		1.395	
IIII.	.64425		1.250	
V.	.77310		.9225	
VI.	.690195		1.1790	
VII.	1.D 3080		1.4400	
VIII.	1.15965		1.2500	
IX.	1.27850			1.0105
X.	1.40735		1.1475	
XI.	1.53620			.900
XII.	none	1.2825		
A.	.51540		.810	
B.	none	1.350		

On the third day No. I., II., XII., and B became coagulated. Therefore they were opened and the milk was tested for acidity. Untreated milk in No. XII. and B tested for acidity showed about three times as much as that treated

hydrogen peroxide. On the fourth day No. II, II, III, IV, V, VI, VII, VIII, X, and A became coagulated and their acidity was as great as that of the untreated milk a day before. On the fifth day No. IX and XI became coagulated. The result of this experiment threw some light upon the proper amount of H_2O_2 to be used. In order to preserve milk it is necessary to use more than one gram of hydrogen peroxide in 1000 cc of milk. A small variation in amount did not vary the keeping quality of the milk.

Experiment 5 did not show any significance result. It is, therefore, ommitted here.

Experiment 6.

It having already been found that a small variation in the amount did not have much effect upon the keeping quality of milk, a wider variation in the amounts of hydrogen peroxide was employed in the present experiment. The following result was obtained:

Day on which milk became coagulated and acidity reached as stated.	Amount of H_2O_2 used in 1000cc milk.	I. %	II. %	III. %	IV. %	V. %	VI. %
		.2577	.5154	.7731	1.0308	1.2785	none
Third		.2385					.351
Fourth			1.72				
Fifth				.64			
Sixth					.765		
Seventh						----------	
Eighth						.395	

The result is rather interesting, for every increase in .25 gms. kept a day longer, with an exeption of No. 5

which kept milk two days longer than No. 4, which contained about .25 gm of hydrogen peroxide less than No. 5. This peculiar result will be discussed under "decomposition of hydrogen peroxide in milk and its preservative power."

Experiment 7.

From experiment 6 it has been learned that more than .5 gm. of hydrogen peroxide kept milk sweet longer. That is to say more than .5 gm of hydrogen peroxide was the proper amount to preserve milk. But as the results show, it is not the proper amount to preserve milk for indefinite time. Five bottles were taken and different amounts of hydrogen peroxide were added. The following table shows the result of this experiment:

	I.	II.	III.	IV.	V.
Amount H_2O_2 in 1000 cc	.5154	1.0308	1.5362	1.5362	none
No. days kept sweet.	4	13	20	20	3

No. 5 which was untreated became sour, within three days as usual, and No. 1, which contained .5154 gm. of hydrogen peroxide, kept one day longer than usual. No. 2 which contained about one gram of hydrogen peroxide kept milk sweet for thirteen days, while No. 3 and 4, which contained more than 1.25 gm of hydrogen peroxide in 1000 cc of milk kept sweet for more than twenty days. This experiment was not carried on longer than twenty days, because this period is long enough to keep milk.

A test for hydrogen peroxide was always made in every experiment and it was, without exception, true that when

milk got sour, there was no test for hydrogen peroxide, but as long as hydrogen peroxide remained, milk never became sour. In case of No. 3 and No. 4 in the last experiment the milk reacted for hydrogen peroxide clearly with titanium indicator on last day.

Summary.

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From above seven experiments, following conclusions may be drawn in regard to the amount of hydrogen peroxide to be used:

1. Less than .25 gm of hydrogen peroxide does not keep milk sweet any perceptively longer time than untreated milk under the same conditions.

2. Increase in amount of hydrogen peroxide .25 gram above .25 gram keeps milk sweet about one day longer until the total amount reaches to one gram.

3. From one gram on, a little increase in amount of hydrogen peroxide keeps milk sweet a great deal longer. A little difference in amount below one gram does not have very much effect on keeping quality of milk. Below.25 gram, there is almost no difference in the keeping quality.

4. When more than 1.25 grams of hydrogen peroxide were used a part of it remains in the milk for a long time and keeps the milk sweet.

5. The proper amount of hydrogen peroxide to be used to preserve milk will be from .25 to 1.25 or more, to one litre of milk. If commercial hyrodgen peroxide solution contain

2.5 per cent of hydrogen peroxide, it is necessary to add 10 cc to 50 cc of the solution to 1000 cc milk, ie., approximately one to five per cent.

Decomposition of Hydrogen Peroxide in milk and its Preservative Power.

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It was noticed that when hydrogen peroxide was added to milk, a great deal of gas was formed. Small bubbles were given off from milk for several hours. This gas was found to be oxygen, which must have been formed from the decomposition of hydrogen peroxide.

$$2\ H_2O_2 = 2\ H_2O + O_2$$

Hydrogen peroxide decomposes very quickly in the presence of organic matter, especially blood serum. When hydrogen peroxide was added to albumin of egg it decomposed so vigorously that the albumin foamed up like a beaten egg. This proved that in the presence of albumin, hydrogen peroxide decomposes very quickly. Milk contains albumin, therefore, hydrogen peroxide decomposed readily.

Experiments were carried on to find out how long it takes to decompose hydrogen peroxide in milk at the ordinary temperature. .19 grams of hydrogen peroxide was added to 1000 cc of milk and mixed thoroughly, and milk was tested for hydrogen peroxide with titanium indicator, every hour. For the first two hours the indicator showed very deep

coloration. From the third hour on, the color became fainter every hour. From the eighth hour it was very difficult to distinguish the color. On the tenth hour there was no indication of hydrogen peroxide present. A great deal of gas was given off on the third hour.

Next .51 gram of nydrogen peroxide was taken into 1000 cc of milk and the time of decomposition was ascertained. It took about twenty four hours to decompose all. One gram of hydrogen peroxide in 1000 cc milk did not disappear for twelve days, while when more than 1.25 grams of hydrogen peroxide were used, it remained in the milk for more than twenty days.

The time required for decomposition of hydrogen peroxide depends greatly upon the temperature. If the temperature is high, it decomposes very quickly. When the temperature was high, one gram of hydrogen peroxide disappeared within five days.

An experiment was conducted with albumin of egg to see what effect hydrogen peroxide has on albumin. When a small amount of hydrogen peroxide was added, all decomposed at once, leaving no trace of hydrogen peroxide and there was no coagulation of albumin. But when a great amount of it was added hydrogen peroxode remained in albumin, and the albumin became cloudy.

From the above results together with previous results, the following conclusions may be drawn:

1. Within a short time, hydrogen peroxide decomposes in the presence of albumin to a certain extent.

2. Excess of hydrogen peroxide remains in milk and attacks albumin of milk, perhps also other milk constituents, as fat. This will be discussed under "Effect of Hydrogen peroxide on Milk Constituents".

3. Preservative power of hydrogen peroxide depends entirely upon free hydrogen peroxide remaining in the milk.

4. Hydrogen peroxide does not destroy the life of bacteria as claimed by some, but check the growth of the same.

5. Milk remains sweet when treated with hydrogen peroxide as long as free hydrogen peroxide remains in the milk.

The Effect of Hydrogen Peroxide on General Quality of Milk.

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The effect of preserved milk on senses of taste and smell was carefully considered. For as milk is a food, it must not have any disagreeable taste or smell.

It has been found that if milk is exposed to sunlight, especially after it has been treated with hydrogen peroxide, it becomes disagreeable in taste and smell. For this reason the milk was kept in the dark. The preserved milk has a metallic taste if free hydrogen peroxide was present. Even after all hydrogen peroxide disappeared, the preserved milk had an indescribable taste and the proper flavor of milk,

together with the bad flavor, disappeared. It was a remarkable effect of hydrogen peroxide that all the original flavors, good and bad, were completely destroyed, and gave a peculiar flavor to the milk.

Preserved milk together with untreated milk, was given to a few students to see whether or not they could detect the preserved milk from the unpreserved milk. They could hardly tell the difference. Some, however, said that the preserved milk was diluted. Professor Erf and Assistant Wilson, detected it every time.

The result of this experiment may be summarized as follows:

Common people cannot very easily detect preserved milk if it is properly handled and all the hydrogen peroxide has disappeared, but experts can detect preserved milk at once.

Preserved Milk for Condensing.

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It is necessary to use first grade milk for condensing. Any defects of milk show up very clearly when it is condensed. Milk to which 1.5 gm. of hydrogen peroxide was added for every 1000 cc, was kept for ten days. Then it was condensed. The result was interesting.

For consensing preheating of milk is necessary in order to coagulate albumin which causes trouble in vacuum condensing chamber. With preserved milk there was no coagulation of albumin on preheating. When it was placed in

vacuum flasks for condensing it did not form as much foam as new milk. These results suggest some change in albumin of milk.

The product tasted rancid very strongly and no one of the Dairy Husbandry Department cared to taste or smell. This shows that changes also took place in fat of milk. These points will be discussed fully under, "The Effect of Hydrogen peroxide on Milk Constituents."

The Effect of Hydrogen Peroxide on Milk Constituents.

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It has been frequently suggested before, that hydrogen peroxide had some power to modify the composition of milk. Experiments were carried on relating to the most important constituents, fat, sugar, and protein. Butter fat was ascertained by the extraction method, sugar was estimated by the optical method, and protien was determined by the Kjeldahl method. The milk was divided into two parts. To one part hydrogen peroxide was added at the rate of 1.25 grams to 1000 cc of milk. To the other part nothing was added. The latter was kept in a refrigerator. After three days the milk was analized for fat, sugar and protien, making triplicate determinations of each. The results averaged from three analyses, as given in the following table:

	Preserved milk.	Untreated milk.
Amt. of H_2O_2 used in 1000 cc	1.25 gm	none.
Specific gravity of milk	1.0319	1.0334
Fat	5.76 %	6.00 %

Sugar	4.30 %	4.40 %
Protien	3.17 %	3.53 %.

The specific gravity of the milk was decreased after the milk was treated with hydrogen peroxide. It can be easily seen, that to add 1.25 gm. of hydrogen peroxide, it was necessary to use 40 cc of solution to 1000 cc of milk. That is to say that the milk was diluted by 4 % of solution. Beside this, there was chance of decrease in solid matter of milk. The decrease of specific gravity was .0015. If there was no loss in solid matter of milk and the milk had simply been diluted with 4 % by solution, resulting specific gravity must be 1.0321, and the decrease must be .0012, instead of .0015. The difference between these two which is .0003, must be accounted for, either in experimental error or decrease in solid matter of milk.

As the milk was diluted 4 % by solution, the actual figures on above table will not show very clearly whether hydrogen peroxide modified the milk content or not. Therefore, it is calculated as though it was not diluted at all, as shown in the following table:

	Milk with H_2O_2.	Milk without H_2O_2.	Difference.
Sp. Gr.	1.0331	1.0334	.0003
Fat	5.99 %	6.00 %	101 %
Sugar	4.47 %	4.40 % increase	.07 %
Protein	3.30 %	3.53 %	.23 %

The decrease of specific gravity cannot be accounted for by decrease of fat, because decrease of fat must increase specific gravity of milk. Therefore, it must be due to the decrease of some other constituents. As latter table shows there was apparently rather an increase of sugar. But there was apparently a considerable decrease of protein. This might have affected the specific gravity. There might have been some change in the ash.

The decrease of fat was .01 % which is very small, and can be accounted for by experimental error. Yet, it is also possible that the hydrogen peroxide assisted the hydrolysis of fat and some of the fat was lost. This seems more likely to be the case. As stated under "Effect of Hydrogen peroxide on Consensing Milk", the condensed milk tasted so rancid. The rancid taste is due to the presence of saponified fat, especially of butylene.

There was increase of sugar, according to the last table. It is impossible to increase sugar in milk by addition of hydrogen peroxide. Therefore, this must be accounted for as an experimental error. Yet is is also possible to explain it in a little different way. As stated before, the milk was kept for three days. The untreated might have undergone some decomposition of bacteria into lactic acid by the action of bacteria, hence a loss of sugar in untreated milk, while hydrogen peroxide checked the growth of bacteria, hence no loss of sugar in preserved milk. This difference of .07 % may, therefore, be account for as loss of sugar

in the untreated milk. The decrease of protien was .23%. This may be accounted for by loss of albumin with respect to loss of proteid substances, for although albumin was coagulated by the action of hydrogen peroxide, the nitrogen must be left in the milk in some form. By Kjeldahl's method, it is possible to determine the total nitrogen in milk, but it does not give any particulars of combination of nitrogen. Since all the nitrogen would be converted into ammonia, there should be no difference in the amount of nitrogen and hence no difference in the calculated amount of protein. Therefore, this difference is more likely to be an experimental error than anything else. If this be the case, it will be necessary to find out where this error has occurred. As often stated before, albumin was modified by the action of hydrogen peroxide, hence it is possible that the coagulated albumin was precipitated out. When the sample was taken, this precipitated albumin may not have been mixed well with the milk. In this way some of the precipitated albumin might have failed to show its presence and caused the loss of nitrogen, consequently the loss in proteids. Suppose the percentage of albumin in milk to be .4 %, where 3.4 % of total albuminoid present. If all the albumin was precipitated and all the precipitates fail to be present in the sample, the loss in total protien might be .4 %, but the actual loss was .23 %. Therefore, all the precipitated albumin did not fail to get into the sample, or it may be possible that all the albumin was not precipitat-

ed.

Summary.

1. The specific gravity of milk will be decreased greatly by diluting milk on addition of solution and little by loss of solid matter of milk.

2. Some of the fats will be hydrolized and the milk will taste rancid, on addition of hydrogen peroxide.

3. There will be no fermentation of milk sugar where enough hydrogen peroxide is used, hence no loss of sugar.

4. Albumin will be modified by hydrogen peroxide.

5. Milk will be greatly modified and it will certainly be adulterated milk.

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Hydrogen Peroxide as a Preservative of Milk,

Viewed from Economic Standpoint.

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It has been found that from ten to fifty cubic centimeters of 2.5% solution to one litre is necessary to preserve milk. Then the cost of one litre of milk will increase from about one to five cents, or practically one to five cents per quart. One quart of milk at this College costs four cents. Then the price must be increased at the rate of 25 % to 125 % its original one. Or in other words in order to get the same profit, milk must be sold at from five to ele eleven cents per quart, if it is preserved with hydrogen peroxide. It is considered by condenseries that the normal price for milk is two cents per quart. Then the price must be raised from 50% to 250%. It is impossible for farmers

to sell their milk at a higher price than they are now selling it. It is unnecessary to keep milk sweet for an indefinite length of time for table consumption. It milk keeps sweet for three days, it is long enough for any ordinary purpose. The experiments which have already been given, show that sanitary milk keeps sweet for three days in an ordinary room very easily. If it is kept in a refrigerator, milk remains sweet for eight to ten days, without the addition of a preservative. This experiment was performed in the refrigerator of the Dairy Department, the temperature of which was 42° F.

Summary.

1. By using hydrogen peroxide the cost of milk will be increased from one to five cents per quart.

2. It is unnecessary to preserve milk for an indefinite length of time. Malk can be kept sweet for the longest desired time for ordinary purposes by means of cleanliness and ice and which are the cheapest and most sanitary.

3. It is a commercial impossibility to use hydrogen peroxide as a preservative of milk with the present price of hydrogen peroxide solution.

Conclusions.

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1. Hydrogen peroxide has power of checking the growth of bacteria.

2. More than .25 gms of hydrogen peroxide is necessary to preserve one litre of milk any length of time. More than

1.25 gm. of hydrogen peroxide are necessary to preserve one litre of milk for a long period of time.

3. The preservative power of hydrogen peroxide depends upon the presence of free hydrogen peroxide. Less than .25 grams of hydrogen peroxide in one litre of milk will be decomposed within 24 hours, and looses the power of preservation at once.

4. The general quality of milk is affected by hydrogen peroxide and becomes inferior.

5. Milk preserved with hydrogen peroxide cannot be used for condensing. The product is rancid.

6. The chemical constituents of milk are modified. Fats are, to some extent, hydrolized. The albumin is modified.

7. Milk is greatly adulterated by hydrogen peroxide. There is no application of preserved milk in manufacturing of milk products.

8. The cost of milk is greatly increased by the use of this chemical. It is commercially impossible to use it.

9. Hydrogen peroxide gives no advantage in dairying.

10. It would be, however, interesting to investigate the true nature of the chemical reaction between hydrogen peroxide and the milk constituents. It would also be interesting to investigate the physiological effect of hydrogen peroxide, for it was claimed in "Pure Products" that hydrated milk is better for sick ones and infants, than new milk.

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