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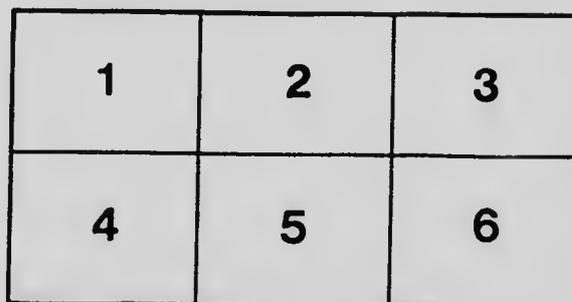
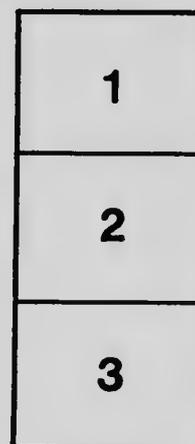
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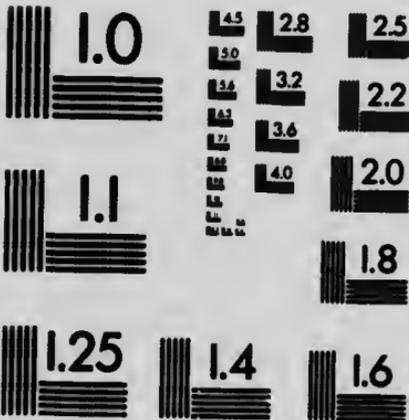
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## BUTTER PRESERVATIVES.

BY H. H. DEAN, PROFESSOR OF DAIRY HUSBANDRY  
AND R. HARCOURT, PROFESSOR OF CHEMISTRY.

Butter is composed of fat, water, curd, and a small amount of mineral matter. Fat is the most important constituent, and forms 84 to 87 per cent. of the butter. Butter fat is an extremely complex substance, composed of fatty acids in combination with glycerine. It differs from other fats, such as lard, tallow, etc., in that it contains a larger number of these glycerides. Besides the glycerides of the insoluble and non-volatile acids found in all fats, butter contains notable quantities of the glycerides of soluble and volatile acids. Some of these acids have a decidedly disagreeable odor, and, if by any means the glycerides containing these acids are decomposed, very strong rancid odors are developed. Furthermore, some of the fats are unsaturated compounds, which more or less rapidly combine with the oxygen of the atmosphere and thus set in motion changes which may not only destroy the pleasant aroma of good butter, but may also produce the disagreeable rancid smell common to bad butter.

The amount of curd in butter is not large, and, while it readily undergoes putrefactive changes, does not appear to directly affect the keeping quality of the butter.\* It serves, however, as food for the micro-organisms which cause the change and thus tends indirectly to produce bad flavors.

It is thus evident that the constituents of butter in their natural state are all delicate substances, some of which, or a combination of the whole, produce the peculiar aroma of good butter, and that the bad flavors are produced partly, at least, through the decomposition and oxidation of these substances. Most of these changes are doubtless due to the action of ferments which also produce compounds of an unpleasant nature. In addition to this, butter may have undesirable taints due to improper feeding of the cows, lack of care in treatment of the milk and cream, and to carelessness in the manufacture of the butter. Many of the faults of butter, due to these various causes, can be overcome. It is only by exercising the utmost care in every detail, from the production of the milk to the manufactured butter, that an article of the desired quality can be secured. But all butter, no matter how carefully it is made, will go "off flavor" in a comparatively short time.

\*College Report, 1902, page 39.

The most common substance added to butter as a preservative is salt. The use of salt, together with the practice of storing butter in such a manner as to exclude air and light to prevent oxidation of the unsaturated fats, and at a low temperature to retard the action of ferments, has been, on the whole, fairly successful in retaining the good qualities of butter. In our export trade, however, new conditions are arising, and the dairyman has now to cater to a market which demands practically a saltless butter. To meet these new conditions he is compelled to cease using the only preservative with which he is familiar. Further, many creameries are not provided with cold storage plants, and are thus not able to use even this method of lengthening the commercial life of butter. Under these conditions it is not strange that butter-makers have commenced to use some of the brands of preservatives which are now so extensively advertised, especially when their use is advised by the wholesale dealers to whom they sell.

#### CHEMICAL PRESERVATIVES.

It is only in comparatively recent times that the real nature of fermentation, decay, and all such cases has been clearly understood. From time immemorial foods have been preserved by drying, smoking, placing in strong brine, in alcohol, or in vinegar, but it was not until after the work of Pasteur and others had shown that fermentation and decay are primarily caused by minute organisms, and that these organisms could not grow without moisture, in salt solutions, alcohol, or vinegar, that the true nature of these methods of preserving foods was understood.

Concurrently with the development of the science of bacteriology the study of chemistry has made known many chemical compounds which will destroy or retard the growth of these organisms. Many of these, such as bichloride of mercury, sugar of lead, etc., while powerful preservatives, are very poisonous, and for obvious reasons could not be utilized as food preservatives. In order to be used for this purpose, a substance must be almost without taste or smell, it must not be so poisonous as to cause any immediate or serious results to the health of the consumer, it must be comparatively cheap, and yet so strong in its action on the lower organisms that only a small amount need be added to the food which it is desired to preserve. It is evident that the presence of small quantities of such substances in food would not be noticed by the consumer. In this they differ from the old preservative agents, such as sugar, salt, etc., which are condimentary in character, and reveal themselves by taste to the consumer.

At the present time the chief chemical compounds, other than salt, sugar, and alcohol, used in the preservation of foods are as follows :

1. Boric or boracic acid and borates.
2. Formalin or formaldehyde.
3. Salicylic acid.

4. Sulphurous acid and sulphites.
5. Benzoic acid or benzoates.
6. Fluorides.

The boron preservatives are apparently the most commonly used, and are preparations of boric acid and borax, with or without admixture of other preservative ingredients, such as salt, saltpetre, sugar, sodium carbonate, etc. They are used largely in milk, cream, and butter for preserving meat food generally, and to a smaller extent in beverages.

Formalin is a 40 per cent. solution of formaldehyde. As a preservative it is used chiefly in milk. In concentrated solutions it has a strong irritant odor, but when added to milk in quantities sufficient to retard fermentative action, it cannot be detected by taste or smell. The addition of formalin to milk is undoubtedly objectionable, as it interferes with digestion.

Salicylic, sulphurous, and benzoic acids and the fluorides are apparently used to some extent in dairy products, but more commonly in meat, fruit, vegetable preparations, beverages, etc. Salicylic acid is a powerful preservative, but it has a sufficiently characteristic taste to prevent it being used except in very minute quantities as a butter preservative.

Nearly all the preservatives now on the market are advertised as being "entirely wholesome," or that "its ingredients are all as healthful as salt," "capable of keeping the various articles of food perfectly sweet and fresh for any length of time, without the use of ice," etc. They are sold under a great number of fancy names, which, as a rule, give no clue to their real nature. On account of the perishable nature of foods, it is obvious that a substance having the properties claimed for the various commercial food preservatives would be of incalculable value. At the same time, we must recognize the fact that authorities differ as to the correctness of these claims, even for the boron compounds, which are possibly the least harmful of all the newer preservatives. While it would be very convenient to preserve foods by their use, it is important that nothing be added to foods which is toxic in itself, or which interferes even to the slightest extent with the process of digestion. This last point is especially important in dealing with the food of children and invalids.

The preservatives now in use may be divided into two classes: those which are undoubtedly injurious, such as formalin, the fluorides, salicylic and sulphurous acids, and those whose toxic action is disputed. The boron compounds belong to this latter class, and because of their extensive use in preserving dairy products, are of especial importance to dairy-men.

Numerous methods have been made to ascertain whether the use of boric acid or borax in small quantities was or was not injurious, but no definite conclusions have been reached. Many distinguished English, German and French scientists have performed elaborate experiments with

dogs, rabbits, guinea pigs, and human beings, and have come to opposite conclusions. The most elaborate experiment of this nature was recently conducted by Dr. H. W. Wiley, Chief Chemist of the Bureau of Chemistry, Department of Agriculture, Washington,\* in which twelve young men, under close supervision, were given definite amounts of boracic acid and borax with their regular food. Dr. Wiley thus sums up the results of the effect of these preservatives upon the general health of the young men :

"The most interesting of the observations which were made during the progress of the experiments was in the study of the direct effect of boric acid and borax, when administered in food, upon the health and digestion. When boric acid, or its equivalent in borax, is taken into the food in small quantities, not exceeding half a gram (7 1-2 grains) a day, no notable effects are immediately produced. The medical symptoms of the cases in long-continued exhibitions of small doses, or in large doses, extending over a shorter period, show in many instances a manifest tendency to diminish the appetite and to produce a feeling of fullness and uneasiness in the stomach, which in some cases results in nausea, with a very general tendency to produce a sense of fulness in the head, which is often manifested as a dull and persistent headache. In addition to the uneasiness produced in the region of the stomach, there appear in some instances sharp and well-located pains which, however, are not persistent. Although the depression in the weight of the body and some of the other symptoms produced persist in the after periods, there is a uniform tendency manifested after the withdrawal of the preservative toward the removal of the unpleasant sensations in the stomach and head above mentioned."

"The administration of boric acid to the amount of 4 to 5 grams per day, or borax equivalent thereto, continued for some time results in most cases in loss of appetite and inability to perform work of any kind. In many cases the person becomes ill and unfit for duty. Five grams per day may be regarded then as the limit of exhibition beyond which the normal man may not go. The administration of 3 grams per day produced the same symptoms in many cases, although it appeared that a majority of the men under observation were able to take 3 grams a day for somewhat protracted period and still perform their duties. They commonly felt injurious effects from the dose, however, and it is certain that the normal man could not long continue to receive 3 grams per day."

"In many cases the same results, though less marked, follow the administration of borax to the extent of 2 grams and even of 1 gram per day, although the illness following the administration of borax and boric acid in those proportions may be explained in some cases by other causes, chiefly grippe."

"The administration of borax and boric acid to the extent of one-half gram per day yielded results markedly different from those obtained with

\*Bureau of Chemistry, Department of Agriculture, Washington, Bulletin No. 84.

larger quantities of the preservatives. This experiment, Series V., conducted as it was for a period of fifty days, was a rather severe test, and it appeared that in some instances a somewhat unfavorable result attended its use. On the whole the results show that one-half gram per day is too much for the normal man to receive regularly. On the other hand it is evident that the normal man can receive one-half gram per day of boric acid, or of borax expressed in terms of boric acid, for a limited period of time without much danger of impairment of health."

"It is, of course, not to be denied that both borax and boric acid are recognized as valuable remedies in medicine. There are certain diseases in which these remedies are regularly prescribed, both for internal and external use. The value which they possess in these cases does not seem to have any relation to their use in the healthy organism except when properly prescribed as prophylactics. The fact that any remedy is useful in disease does not appear to logically warrant its use at any other time."

"It appears, therefore, that both boric acid and borax, when continuously administered in small doses for a long period, or when given in large quantities for a short period, create disturbances of appetite, of digestion and of health."

In 1899 the British Government appointed a departmental committee of experts to investigate the whole question of the use of preservatives and coloring matters in food.\* This committee examined many witnesses, and certain members performed a large number of experiments. The conclusions arrived at by the committee relating to the use of preservatives in dairy products are of sufficient interest to be quoted here in full:

"The medical evidence, speaking generally, comprises for the most part opinion arrived at after a general consideration of the issues involved, but such opinion was not always based directly upon fact. The physiological evidence consists of the citation of the results of more or less exact physiological experiments. But, unfortunately, in the majority of cases the conditions under which the experiments have been made have only partially imitated those conditions which obtain in the actual taking of preservatives by the human subject to all ages for indefinite periods of time."

"Further, even supposing that we were to assume that the physiological experiments which have been laid before us did imitate with sufficient exactness the actual conditions obtaining in the inquiry in question, they would certainly do so only in so far as relates to the use of one preservative during a given period of time. The facts, however, show that in ordinary life what actually occurs is the simultaneous ingestion of more than one preservative. A further condition almost impossible of imitation by the physiological investigator is the consumption of these preservatives by all classes of invalids and by suckling. The absolute effect of these substances upon sucklings is at present unknown, and it is also

\*Report of the Departmental Committee appointed to enquire into the use of Preservatives and Coloring Matters in the Preservation and Coloring of Food—1901.

practically impossible to infer with accuracy from facts at present ascertained what would be the effect of, for instance, formic aldehyde upon a patient suffering from uraemia."

"A factor still more subtle in its influence upon the question before us is idiosyncrasy. Certain individuals are extremely sensitive to certain drugs, and it appears that among these drugs must be reckoned at least one of the agents used as a preservative. Although legislation covering all possible idiosyncrasies would be too complicated to be practical; nevertheless, it must be pointed out that as matters are at present, an individual possessing idiosyncrasy with regard to the poisonous action of boracic acid would not be able to profit even by his own experience. For since the addition of this substance to foods is not declared he might be continually made ill by the repeated involuntary consumption of articles of food containing it."

"The actual material upon which to base trustworthy conclusions not existed heretofore, in that the declaration of preservatives, and also a regulation of and notification of the amount thereof present in any preserved food must be regarded as a necessary preliminary to any accurate observations or statistics upon the subject. Had declaration of preservatives been in force during recent years, we should probably now have been in possession of medical evidence more directly based upon fact than that which we have had laid before us."

"Notwithstanding the fact that trustworthy data as to actual injury are but few, there is evidence pointing to the probability that such injury does at times accrue. We cannot overlook the danger to which the uncontrolled use of drugs in the food of the population may be likely to give rise."

"Compounds of boracic acid have not been proved to be more hurtful than saltpetre to the consumer, yet saltpetre has been used from time immemorial in curing bacon, etc. The modern use of borax and boracic acid has enabled producers to dispense with a large proportion of common salt formerly necessary, thereby rendering bacon far milder to the palate, and protecting it from taint and fly-blow."

"After very carefully weighing the evidence we have come to the conclusion that as regards the trade in fresh and cured meat, fish, butter, margarine, and other food substances in the consumption of which but small quantities of the antiseptic are taken into the system, there exists no sufficient reason for interfering to prevent the use of boron preservatives. Even butter, of which the imports from all countries except Denmark frequently contain boracic acid, is not consumed in such quantities by individuals as to convey more than a very moderate daily amount of the drug into the system. The evidence satisfies us that the amount of preservative corresponding to 0.5 per cent. of boracic acid is sufficient for the purpose of preserving butter."

"But the circumstances and considerations affecting the milk traffic are very different. Milk, a very perishable substance, peculiarly liable

to bacterial contamination, forms a very large proportion of the daily food of the public. The nutrition of infants and young children depends greatly on the purity and abundance of the milk supply; and, seeing how frequently milk is prescribed for invalids and convalescents, it is of the utmost importance that it should not be the vehicle of any unsuspected agent. While it is possible that milk containing boracic acid in sufficient quantity to act as a preservative (say 30 grams to the gallon) might be consumed to the amount of four or five pints a day, without harmful results by most healthy children or adults, there is evidence pointing to an injurious effect of boracised milk upon the health of very young children."

"Moreover, there exists at present no guarantee against the addition of excessive amounts of preservative to milk. In 1896 the Medical Officer of Health of Birmingham estimated the amounts of boracic acid in a number of milk samples. Of these, one-half showed boracic acid in a proportion not exceeding 21 grains per gallon; in one-fourth the proportion varied between 21 and 42 grains per gallon; while in the remaining fourth it ranged from 42 up to 126 grains per gallon. Professor Blyth instanced a sample of milk, purchased in Marylebone, containing boracic acid in the proportion of no less than 80 grains to the pint. This occurred in December 1899, and the witness assured us that from time to time he had found an equally high proportion in milk samples taken in summer."

"Clearly such random use of any drug in a food calls for regulation. At present milk may be subjected to several successive treatments with preservative before it reaches the consumer. The farmer or producer sometimes applies it, so does the wholesale purveyor, so does the retail dealer; lastly the domestic use of preservatives is increasing, and has become very general, and hence the milk may receive a fourth dose before it reaches the unsuspecting consumer."

"There is this further objection to the use of preservatives in the milk traffic, that they may be relied on to protect those engaged therein against the immediate results of neglect of scrupulous cleanliness. Under the influence of these preservatives milk may be exposed without sensible injury to conditions which otherwise would render it unsalable. It may remain sweet to taste and smell and yet have incorporated disease-germs of various kinds, whereof the activity may be suspended for a time by the action of the preservative, but may be resumed before the milk is digested"

The following are the recommendations of the committee which were based upon the conclusions they arrived at from their experiments and from the evidence brought before them:

"(a) That the use of formaldehyde or formalin, or preservatives thereof, in foods and drinks be absolutely prohibited, and that salicylic

acid be not used in a greater proportion than 1 grain per pint in liquid food and 1 grain per pound in solid food. Its presence in all cases to be declared."

"(b) That the use of any preservative or coloring matter whatever in milk offered for sale in the United Kingdom be constituted an offence under the Sale of Food and Drugs Act."

"(c) That the only preservative which it shall be lawful to use in cream be boracic acid, or mixtures of boracic acid and borax, and in amount not exceeding 0.25 per cent., expressed as boracic acid. The amount of such preservative to be notified by a label upon the vessel."

"(d) That the only preservative to be used in butter and margarine be boracic acid or mixtures of boracic acid and borax, to be used in proportions not exceeding 0.5 per cent., expressed as boracic acid."

"(e) That in the case of all dietic preparations intended for the use of invalids or infants chemical preservatives of all kinds be prohibited."

"(f) That means be provided either by the establishment of a separate Court of Reference, or by the imposing of more direct obligation on the Local Government Board to exercise supervision over the use of preservatives and coloring matters in foods, and to prepare schedules of such as may be considered inimical to the public health."

It is evident that Dr. Wiley and the British Committee agree regarding the harmfulness of even the boron compounds when taken into the system in large doses. But, while Dr. Wiley contends that the continued use of small amounts for a long period will "create disturbances of appetite, of digestion and of health," the British Committee concludes that "there exists no sufficient reason for interfering to prevent the use of boron preservatives when used in fresh and cured meat, fish, butter, margarine, and other food substances in the consumption of which but small quantities of the antiseptic are taken into the system." Dr. Wiley's conclusions were reached after a comparatively long study of cases under direct medical supervision; the Committee's conclusions were reached from experiments of much shorter duration, and from the fact that although preservatives were found to be used quite extensively, very few cases of sickness had been traced to them.

To gather further information on this point and to ascertain what effects the small amount of preservative commonly placed in butter would have on the system, it was suggested that experiments be carried on with the students in residence at the College. A table of twelve men, from 18 to 22 years of age and in good health, eagerly volunteered for the work. All they were asked to do was to use the butter provided regularly and to report if they felt the least pain or any unusual sensation develop. The butter prepared for this experiment contained one-half of an ounce of salt per pound and one-half per cent. of borax. For twenty-six days during the fall term the twelve men used practically three pounds of butter per day and would, consequently, have consumed, provided all preservative was retained in the butter about .5 grams of borax per

day. No ill effects were felt by any of the men. After the Christmas vacation the experiment was resumed, and, at the time of writing, has continued for fifty days, without any noticeable injurious effects. This experiment was not so accurately carried out as those of Dr. Wiley; it was intended only to test the effect of the preservative on the health of the men in a general way; but it tends to prove the conclusion arrived at by the British Commission.

On the other hand, while it is doubtless true that some, possibly the large majority of people may use boron preservatives without feeling any unpleasant effects, others may be seriously affected. Further, if preservatives of various kinds are used in a number of food substances and in beverages, it may happen that in the aggregate a large enough quantity be taken into the system to be harmful.

With the present available information regarding the effects of the so-called chemical preservatives on the human system, it is apparent that it would be unwise to recommend their use except in cases where the necessity is clearly manifest, and where it can be demonstrated that other methods of preservation are not applicable. Milk and cream certainly do not come under this list; for it has been abundantly demonstrated that with proper care these substances can be placed in the consumer's hands in good condition. Long experience has also proven that it not necessary to use preservatives in butter intended for home consumption. With export butter the case is somewhat different. It does not reach the consumer so quickly, and has to be shipped long distances, sometimes under very trying condition. Moreover, the trade demands a practically saltless butter, thus preventing the use of the preserving material used in the home trade. It is evident, however, that only boron preservatives should be used, and then in the smallest amount necessary to preserve the butter.

Another point that cannot be too strongly emphasized is that preservatives do not improve the butter; they simply preserve for a longer time the flavor developed in the fresh article. The flavor is influenced by many conditions in the production of the milk, care of the milk and cream, and in the manufacture of the butter, and is practically settled before the preservative is added. The preservative only helps to retain the particular flavor developed, and cannot be used to overcome slovenliness or carelessness in the manufacture of the butter.

During the last few years various brands of butter preservatives have been extensively advertised throughout the Province. Naturally, considerable interest is being taken in them, and many requests have come to us for exact information regarding their nature and use. To answer these questions more definitely, we decided to collect and examine a number of the commercial preservatives now on the market and to study their preserving or keeping properties when used in butter. The general plan of the work at the Dairy was as follows: The regular churning, which usually consists of 200 to 300 pounds of butter made

from pasteurized cream, was divided into several lots,—one for each preservative tested. The small lot of fresh butter was taken from the large "Success" churn and placed in a small "Simplex" churn for working. After placing the butter in the churn the preservative was sifted over the butter, and distributed as evenly as possible. The worker attachment was then put in motion and the butter was given the usual amount of working—18 to 19 revolutions of the worker. In those experiments where salt was used with the preservative, the two were weighed separately and then thoroughly mixed before adding them to the butter. All the different preservatives were plainly labelled and after weighing were placed on papers marked with the name of the preservative. The boxes and prints were numbered at the time and a record made of the preservative together with the distinguishing number so that there could be no mistake and no mixing of the different lots. Every known precaution was taken that each lot should contain the preservative intended for it and no other. In all the summer experiments, one pound print wrapped in parchment paper, and one 28 lb. box were marked and placed in the refrigerator for scoring. The boxes were lined with heavy parchment paper which had been previously soaked for at least 24 hours in a brine and formalin solution. Every precaution was taken to prevent mould or unnecessary deterioration of the butter. Four lots were made from ripened cream and two from sweet cream. In all cases the cream had been previously pasteurized at a temperature of 180 to 185 degrees F.

#### THE PRESERVATIVES.

The commercial preservatives were secured from the different firms or their agents. We wrote all the Canadian firms whom we could hear of as selling goods of this class in Canada. We explained the nature of the work we intended doing and asked them to send us a sample of their regular goods. Most of the firms cheerfully donated sufficient for our work. The borax, boracic acid and sodium fluoride were purchased from chemists. The salt was a portion of that from our regular supply.

Each of these preserving substances was submitted to a close chemical examination, the results of which are given below. The number of the chemical preservatives will be used to designate these substances hereafter.

No. 1 Commercial borax containing chlorine equivalent to 1.64 per cent. of sodium chloride or common salt.

No. 2. Practically pure boracic acid.

No. 3. A commercial preservative containing 3.75 per cent. of common salt, balance boracic acid with a small amount of borax.

No. 4. A commercial preservative containing 5.41 per cent. of common salt, 9 per cent. saltpetre, balance borax and boracic acid.

No. 5. A commercial preservative containing 6.5 per cent. of common salt, balance borax and boracic acid.

No. 6. A commercial preservative containing 10 per cent carbonate of soda, balance borax and boracic acid.

- No. 7. Common salt, practically free from impurities.  
 No. 8. A commercial preservative containing 27.48 per cent. of common salt, balance borax and boracic acid.  
 No. 9. Practically pure sodium fluoride.  
 No. 10. A commercial preservative containing 1.60 per cent. of salt, balance borax and boracic acid.

Preservatives 8 and 9 were used only in September experiments. No. 10 was used only in December. The quantity was either one-quarter of one per cent. or one-half of one per cent. In the two experiments of July 26 and 27, one-quarter of one per cent. each of borax and boracic acid was used, and one-half per cent. of the commercial preservatives. When salt and preservatives were mixed, one-quarter of one per cent. of each was used. When salt alone was added the rate was 3-4 of an ounce per pound of butter or about 4 1-2 per cent.

#### THE TREATMENT OF THE BUTTER.

Immediately after the butter was worked and packed or printed, it was taken to an ice cold-storage where the temperature was about 40 degrees F. The lots made July 14, 21, 26 and 27, were scored the first time on July 30th. The July lots were scored the second time on September 13th and again, together with the September lots, on October 4th. All the July boxes and the boxes made on September 13th were taken out of the refrigerator and sent to Montreal on October 17th. They were placed in cold-storage on arrival at Montreal and were scored November 2nd, 1904, by Messrs. A. W. Woodard, official referee, Vaillancourt, Olive, Ayer, and LeClair. The samples were known to these judges by numbers only. It was not possible for them to know what kind of preservative had been used in the several packages.

#### THE JULY BUTTER SCORES.

As the flavor is of the most important quality in butter this was the chief point noted in the experiments. Unless something special was observed, no other point than flavor was judged. The Commercial Preservatives are indicated by number only. The same number will be given in all the scorings.

Preservatives.	Flavor 45. Av. First Scores.		Flavor 45 Av. Second Scores (45 days later).	
	Prints.	Boxes.	Prints.	Boxes.
1. Borax .....	41.6	41.5	41.7	37.7
2. Boracic Acid.....	42.0	41.5	41.0	36.2
3. Commercial Preservative.....	42.0	41.6	41.5	35.5
4. " " .....	42.1	41.6	41.5	37.5
5. " " .....	42.1	41.3	41.7	37.0
6. " " .....	42.0	40.8	41.2	37.2
7. Common Salt.....	42.2	41.2	37.5	35.2

It will be noticed that the lots of butter in pound prints seemed to have held their flavor for 45 days better than did the lots in boxes, although all were in the same refrigerator. The greatest depreciation was in the lots where common salt and No. 3 preservative were used, and the least in the cases of Nos. 1 or borax and 6.

#### ONE-HALF AND ONE-QUARTER OF ONE PER CENT COMPARED.

The maximum quantity of preservative recommended by the manufacturers is usually one-half of one per cent. In order to compare one-half and one-quarter of one per cent. and also 1-4 per cent. mixed with salt as to effectiveness in preserving butter, these two quantities were used in some of the experiments. The following table gives the average of the Montreal scores which were made on November 2nd, about 3 1-2 months after the first lots were made and six weeks after the making of the freshest lot.

Preservative.	Av. Scores for Flavor. Max. 45		
	½%	¼%	¼% pre. and ¼% salt.
1. Borax.....	40.2	40.5	36.7
2. Boracic Acid.....	34.5	39.5	37.5
3. Commercial Preservative.....	39.9	41.0	39.0
4. " ".....	38.8	41.0	39.7
5. " ".....	39.2	41.0	40.4
6. " ".....	39.8	41.7	39.2

The scorings indicate that one quarter of one per cent. of preservative is as effective as one-half of one per cent. under the conditions named, in fact the averages for flavor were higher in the lots to which one-quarter of one per cent. was added due no doubt to the fact that the lesser amount does not impart the "preservative flavor" which most of the judges commented upon, as will be seen farther on. The addition of one-quarter of one per cent. of salt to the preservatives appeared to lower the average scores.

#### RIPENED VS. SWEET CREAM BUTTER.

In order to compare the effects of the preservatives and salt on butter made from ripened and sweet cream the scores of the four lots made from ripened cream and of the two from sweet cream are given separately with the following average results in flavor for both prints and boxes.

Preservative.	Flavor 45 Ripened Cream Butter			Flavor 45 Sweet Cream		
	Dairy Scores	Montreal Scores	Average	Dairy Scores	Montreal Scores	Average
1. Borax.....	40.7	39.7	40.2	41.0	39.5	40.2
2. Boracic Acid.....	40.4	37.8	39.1	40.6	39.0	39.8
3. Commercial P.....	40.3	39.9	40.1	40.8	40.0	40.4
4. " ".....	40.7	39.3	40.0	41.3	40.0	40.6
5. " ".....	40.6	39.7	40.1	41.1	40.0	40.5
6. " ".....	40.3	39.8	40.0	41.0	41.2	41.1
7. Salt.....	38.6	33.8	36.2	40.7	40.0	40.3
8*. Commercial P.....	40.5	42.0	41.5	41.5	†	41.5
9*. Sodium Fluoride....	36.0	40.0	38.0	37.0	†	37.0

\* Used only in Sept. expts.

† Not sent to Montreal.

Two points are brought out in these scorings.

1. The average for flavor was higher in the lots made from sweet cream both in the Dairy and Montreal scores. This was specially so in the samples where common salt alone was used.

2. There was not much difference in the average scorings for the different preservatives other than for salt and sodium fluoride, although the latter was given a comparatively high score at Montreal. It will also be noticed that the borax lots have averaged about the same as did those in which commercial preservatives were used.

One-quarter per cent. borax and one-quarter per cent. boracic acid, one-half per cent. commercial preservatives, and three-quarters of an ounce of salt compared. One experiment only.

Preservative and amount.	Flavor Max. 45	Flavor Max. 45	Flavor Max. 45
	Average Daily Scores	Av. Montreal Scores	Average Of All
1. Borax $\frac{1}{4}$ %.....	40.7	39.5	40.1
2. Boracic Acid $\frac{1}{4}$ %.....	40.2	39.0	39.6
3. Commercial P. $\frac{1}{2}$ %.....	40.5	40.0	40.2
4. " " $\frac{1}{4}$ %.....	41.2	40.0	40.6
5. " " $\frac{1}{2}$ %.....	41.0	40.0	40.5
6. " " $\frac{1}{2}$ %.....	41.0	41.2	41.1
7. Salt $\frac{3}{4}$ oz.....	40.7	40.0	40.3

In this experiment preservative No. 6 seems to have given the best results, although there is not so very much difference in the average scorings of all the lots including salt. With the sweet pasteurized cream the salt appears to have given nearly as good results as the preservatives.

#### DETAILED SCORING OF THE LOTS SENT TO MONTREAL.

As previously explained, all the July lots and one of the September lots were sent to Montreal and were scored by the experts on November

2nd. The following table gives the details of the scores together with the judges comments on each lot.

REPORT OF SCORES ON BUTTER SENT TO MONTREAL AND SCORED, NOV. 2, 1904.

No. of Sample	Kind of		Date of Making	Score for Flavor, Max 45.					Remarks of Judges:		
	Cream.	Preservative in Butter.		Individual Scores.							
				(1)	(2)	(3)	(4)	(5)			
1	Ripe	Borax 1/2%	July 14	40	41	40	38	39	40	40.2	Irregular color, gritty, well kept, sweet, pre. flavor Oily, irregular color, gritty. No taste, no smell, little off. Mouldy.
4	"	Borax 1/2% Salt 1/4%	" 21	38	39	40	35	35	36.7		
15	Sweet	Borax 1/2%	" 26	40	40	42	41	40	40.7		
22	Ripe	" 1/2%	Sept. 13	40	37	40	40	41	39.5		
29	Ripe	Boracic A 1/2%	July 14	37	32	39	30	32	34.5	Cloudy to mottled, beginning to mould. Stale, fishy, gritty; pre. taste and smell. Fishy, poor.	
9	"	Boracic A 1/2% Salt 1/4%	July 21	37	41	41	35	37	37.5		
16	Sweet	" 1/2%	" 26	40	40	40	39	41	40	Slightly fishy, mouldy, trifle stale. Mouldy, flavor not accountable for. Beginning to mould, even color. Stale, sweet.	
23	"	" 1/2%	" 27	39	41	40	40	36	39.5		
30	Ripe	" 1/2%	Sept. 13	37	42	40	33	40	38.7	Very little fishy, very little taste pre. Mouldy.	
3	"	" 1/2% Salt	July 14	39	39	40	38	40	39.7		
10	"	" 1/2% & 1/4% Salt	Sept. 13	41	41	40	41	43	41.2	Very mouldy, gritty, very little foreign flavor. Gathered cream, good.	
17	"	" 1/2% Salt	" 26	41	41	40	39	42	40		
24	Sweet	" 1/2%	Sept. 13	40	40	40	35	41	39.4	Slightly stale, very little smell and taste. Slightly fishy, very mouldy.	
31	Ripe	" 1/2%	July 14	41	43	36	42	43	40.4		
34	Ripe	" 1/2% Salt	Sept. 13	35	41	30	37	42	36.6	Mottled color, beginning to mould, cooked taste. Slightly stale, inclined to be fishy.	
4	"	" 1/2% Salt 1/4%	July 21	40	41	40	41	38	39		
11	"	" 1/2% Salt	" 26	40	41	40	38	40	39.7	Slightly fishy, gritty, stale. Spotted, woody flavor, mouldy. Beginning to mould, a little gritty, preservative taste.	
18	"	" 1/2% Salt	" 26	40	41	40	41	38	40		
25	Sweet	" 1/2%	" 26	39	40	40	37	42	40	Peculiar flavor, special taste. Fishy, mouldy, pre. taste. Gritty, woody, poor color, beginning to mould.	
32	Ripe	" 1/2%	Sept. 13	40	43	40	38	40	41.4		
35	Ripe	" 1/2%	Sept. 13	40	43	40	38	40	41.4	Good, good. Fishy, no mould, stale. No mould, stale.	
5	"	" 1/2% Salt 1/4%	July 21	38	41	42	40	42	40.4		
12	"	" 1/2% Salt 1/4%	July 21	40	41	42	39	40	40.4	No mould, well kept. Too much preservative, gathered or old cream flavor, preservative taste.	
19	"	" 1/2% Salt 1/4%	" 26	39	40	40	39	38	39		
26	Sweet	" 1/2%	" 26	40	41	40	41	42	40	No mould, well kept.	
33	Ripe	" 1/2%	Sept. 13	40	41	42	40	41	41.4		
36	Ripe	" 1/2% Salt 1/4%	July 21	39	40	40	38	40	39.2	Good, good.	
6	"	" 1/2% Salt 1/4%	Sept. 13	41	41	40	38	37	37.2		
13	"	" 1/2% Salt 1/4%	Sept. 13	41	43	40	35	40	41.7	Fishy, no mould, stale. No mould, stale.	
20	"	" 1/2% Salt 1/4%	July 21	41	41	40	38	37	37.2		
27	Sweet	" 1/2% Salt 1/4%	" 26	38	40	32	38	37	37.2	No mould, well kept.	
84	Ripe	" 1/2% Salt 1/4%	Sept. 13	41	43	40	35	40	41.7		
7	Ripe	Salt 3/4 oz.	Sept. 13	35	27	29	32	37	32	No mould, well kept.	
14	"	" 3/4 oz.	July 14	35	36	29	35	35	34		
21	"	" 3/4 oz.	" 26	35	33	33	37	31	35.6	No mould, well kept.	
28	Sweet	" 3/4 oz.	Sept. 27	38	41	39	40	42	40		
25	Ripe	" 3/4 oz.	Sept. 13	42	43	41	41	42	42.5	Too much preservative, gathered or old cream flavor, preservative taste.	
86	"	Sodium Fl. 1/4%	" 13	41	41	41	36	41	40		

Judges: (1) Woodard, (2) Vallancourt, (3) Olive, (4) Ayer, (5) Leclair.

- The scorings of the Montreal experts bring out several points :
1. The variation in scores of the five judges is considerable, amounting in one case to as much as eleven points on the flavor.
  2. The average scorings of all the July lots containing preservatives was quite uniform. The extreme variations were 38.1 to 40.1 out of 45. Boracic acid gave the lowest average score and preservative No. 6 slightly the highest.
  3. The lots containing salt at the rate of 3-4 oz. per pound of butter averaged 35.4 out of a possible 45 for flavor. These lots were entirely free from mould, while all the other lots made in July were badly moulded.

#### EXPERIMENT OF SEPTEMBER 14, 1904.

One of our regular churnings of sweet pasteurized cream on Sept. 14th, was divided into eight lots of 28 pounds in each box. To the butter in each was added one-quarter of one per cent. of preservative and the boxes were numbered as in the other experiments, and placed in cold-storage at about 40 degrees F.

The scorings on October 4th, 1904, and March 4th, 1905, were as follows :

Preservative.	Score for Flavor. Max. 45.		
	Oct. 4th, 1904.	Mar. 4th, 1905.	Average.
1. Borax .....	41	34	37.0
2. Boracic Acid .....	42	32	37.0
3. Commercial Preservative .....	42	33	37.5
4. " " .....	42	36	39.0
5. " " .....	42	35	38.5
6. " " .....	42	34	38.0
8. " " .....	42	35	38.5
9. Sodium Fluoride .....	38	37	37.5

In this experiment, the lot made by using sodium fluoride as a preservative was given the lowest score on October 4th, 1904, and the highest score on March 4th, 1905. While sodium fluoride appears to be a very good preservative, owing to its apparent harmful effect on the human system it is not to be recommended. Another point brought out very markedly in this experiment was the fact that all the lots in which borax, boracic acid, and commercial preservatives were used had moulded very badly in the storage, while the box in which sodium fluoride was used, contained no mould whatever.

## A SPECIAL TEST.

On December 6th, 1904, nine pound prints and one 28 lb. box of butter were taken from one of our regular churnings. The objects of this experiment were:

1. To test the effects of one-half and one-quarter per cent. of preservatives and also salt on prints of butter kept in a warm room for about five weeks.

2. To compare the preservatives which we had been using in our previous summer work with a special, imported, commercial preservative which we shall designate as No. 10. We also wished to test this preservative with reference to mould.

The prints of butter wrapped in parchment paper were placed directly after making in a room where the temperature ranged from 60 to 70 degrees and remained there until January 13th, 1905, (38 days) when they were scored and afterwards moved to an ice cold-storage, where they remained at a temperature of 30 to 32 degrees F. until March 4th. They were again scored by five of the instructors in the Dairy School. The box was put in the ice storage as soon as made and was not scored until March 4th, 1905. At this date neither the box nor any of the prints had developed any mould. It is probable that the conditions of temperature and moisture in winter were unfavorable for its growth.

The scorings of the various lots as given by one of the writers on January 13th and by five instructors of the Dairy School on March 4th, were as follows:

Preservatives.	Flavor 45. Score, Jan. 13th, 1905.	Flavor 45. Score, Mar. 4th, 1905.	Flavor 45. Score, Average.
1. Borax $\frac{1}{2}$ % (print) .....	35	36	35.5
1. " $\frac{1}{4}$ % " .....	30	25	27.5
4. Com. P. $\frac{1}{2}$ % " .....	30	27	28.5
4. " $\frac{1}{4}$ % " .....	30	25	27.5
6. " $\frac{1}{2}$ % " .....	35	35	35.0
6. " $\frac{1}{4}$ % " .....	37	30	33.5
7. Salt $\frac{1}{4}$ oz. " .....	30	23	26.5
10. Com. P. $\frac{1}{2}$ % " .....	32	35	33.5
10. " $\frac{1}{4}$ % " .....	30	27	28.5
10. " $\frac{1}{2}$ % (box) .....	.....	40	.....

In this, what may be considered a severe test, the lots preserved with borax appear to have given as good or slightly better results than any of the commercial preparations. It would also seem that one-quarter of one-per cent of preservative did not hold the flavor of the butter so well as did the half per cent. and that salt was not nearly so good as the boron preparations. In this one trial the No. 10 commercial preservative did not give any better results than did those tested during the summer.

The box of butter put into cold-storage held its flavor much better than did the prints which were exposed to a high temperature for 38 days.

#### PRESERVATIVES FOR CREAM.

It has been recommended that patrons of cream-gathering creameries be supplied with a preservative to place in the cream to prevent its souring before delivery. A few trials were made of a special cream preservative, between July 16th and 25th. For these trials a large test tube was used having a cotton plug in the open end. The samples were kept at a temperature of 60 to 70 degrees F. in an ordinary room. The amount of preservative was as nearly as possible the proportion as recommended by the manufacturers. The following are some of the results:

July 18, 11.30 a.m. Pasteurized and cooled skim-milk placed in a added. Cream thick and sour 11 a.m., July 18th.

July 18, 11.30 a.m. Pasteurized and cooled skim-milk placed in a test tube and preservative added. Sample sour and thick 10 a.m. on the 20th.

July 20, 10 a.m. Skim-milk from separator which had not been pasteurized or cooled was added to test tube. Milk was separated at a temperature of 90 degrees F. Extra amount of preservative added. 9 a.m. on the 21st, sample sweet but had a bad flavor. On the 23rd at 3 p.m. sample slightly sour. Flavor not so bad as on the 21st. On July 25th, flavor improved and acid developed slightly more but not thick at 10.30 a.m. on the 25th. The sample was thick on the morning of the 26th.

While these trials are not conclusive, they point to the fact that a considerable amount of the preservative would have to be used to keep cream sweet in hot weather, and also indicate that though we may keep a sample sweet by this method, we do not prevent the development of bad flavors which may be more objectionable than simple souring.

#### GENERAL CONCLUSIONS.

1. Powdered borax, in these experiments, has given as good results as the commercial preservatives, although manufacturers of the latter claim that borax is unsuitable as a preservative, as the following quotation from a letter received from one of the firms will show, "We know, from a number of experiments conducted under our personal supervision, provided well-made butter of a delicate flavor were in question the—  
—treated butter must yield a finer flavor than borax-treater butter. Borax, as a matter of fact, is a most unsuitable preservative for butter as any practical butter manufacturer must know, as borax is alkaline in its action and would tend to saponify butter."

We do not find the foregoing results in our experiments, although further work is needed to settle the matter definitely. The borax costs about one-half as much per pound as the commercial preservatives.

2. One-quarter of one per cent. of powdered borax or of the commercial preservatives appears to be sufficient to hold the butter flavor under ordinary conditions, and is not nearly so liable to give the "preservative taste" to the butter. Butter which is likely to be held for over three months or which may be exposed to high temperatures may have one-half of one per cent. added.
3. The results indicated better keeping quality in the sweet cream butter than in those lots made from ripened cream.
4. There was not much difference in the keeping quality of the butters treated with the different preservatives, boracic acid giving the poorest average and commercial preservative No. 6 rather the highest.
5. All the boxes and prints of butter made during the summer to which the borax, boracic acid, or commercial preservatives had been added developed mould very badly, while the samples which were salted were free from mould.
6. Under the severe test of December 6th, none of the preservatives may be considered as having given satisfactory results, although the flavor was very much better in those lots as compared with the lots treated with salt alone.
7. At the present time we are not prepared to recommend the use of milk or cream preservatives.
8. For the home trade, with proper means for pasteurizing the cream and suitable cold-storage facilities, we do not consider that preservatives, other than salt, are needed to keep butter for a reasonable length of time.
9. For the export trade which allows one-half of one per cent. boracic acid in butter it would seem as if this amount might be used to advantage in some cases, but with suitable cold-storage and especially where pasteurization is followed, less than this amount would preserve the butter and be less liable to injure the consumer.
10. Salicylic acid, sodium fluoride, and formalin may not be recommended as butter preservatives. The first one is more or less harmful, and gives an objectionable flavor to butter, while the latter two are considered quite harmful to the human system.

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