The Effect of Preservatives on Health and Digestion.*

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The question of the use of preservatives in food products is one of foremost importance. Not only is it a question which concerns the public health, but also one which concerns the character of commerce.

That food must be preserved is self-evident. It would not be possible nor desirable that every food should be consumed the moment it is ready for consumption. The various industries in which humanity is engaged, the development of means of transportation which bring all climates and all countries together, the use of food in long voyages of discovery, in mining camps, in the army and navy, as well as its general use in many other instances, make it necessary that it should be preserved.

Many foods, and those of the most important character, are self-preserved—for example, the cereals, nuts, ripe beans and peas. Other forms of food are preserved naturally for a greater or less length of time, such as fruit, berries, eggs and meats. Still other forms of food begin to decay soon after they are perfected; fish and oysters are types of this character of food.

Modern civilization demands that food shall be manufactured and preserved and made more or less ready for use. In these processes, from the earliest times well-known methods of preservation have been practised. The removal of water from a food product is a method of preservation which has been practised from the earliest times. The use of certain condimental substances, such as salt, sugar, vinegar and wood smoke, has also been practised from the earliest periods of history for preservative as well as condimental purposes. During the last hundred years the sterilization of food by heating and the exclusion of the germs there-

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from have been practised on a large scale and is still one of the safest and most approved methods of preservation.

Since the development of the method of making artificial cold, cold storage has played a very prominent part in preserving food products. It may be said that no reasonable objection can be made to any of the above processes provided they are conducted in a rational way and for a reasonable length of time. For the past fifty years, however, there has grown up a system of food preservation based on the use of so-called antiseptics, that is, chemical products which of necessity must be colorless and without taste or odor and which have the power of paralyzing or destroying the fermenting germs which cause food to decay. It is this class of preservatives to which attention is directed at the present time. The more common of these are well known, such as boric acid, borax, salicylic acid, benzoic acid, sulphurous acid, formaldehyde, etc. Concerning the use of these bodies the greatest difference of opinion prevails. Many manufacturers and a number of physiologists and chemists claim that the use of these bodies is in no way detrimental and that their use should not be restricted. There is another large class of experts who claim that the addition of such antiseptics to food is reprehensible and that their use should be restricted or even prohibited.

It was for the purpose of determining these points of difference between experts that the experimental work of the Department of Agriculture on food preservatives was undertaken. The results of one series of experiments of this kind have been collated and are almost ready for publication.

In these experiments borax and boric acid were added to food, beginning with small and gradually increasing to large doses per day. The small doses were ½ gram (7½ grains) and the large doses were from 3 to 4 grams (45 to 60 grains) per day. These experiments were carried on during a period of about nine months and the results which were manifested are as follows:

Boric acid and borax in gradually increased doses, with a maximum of from 3 to 5 grams per day, cause a disturbance of digestion and health manifested in loss of appetite,

a loss of weight, a feeling of uneasiness and sometimes of illness in the stomach, a fulness in the head which often developed into a dull and persistent headache, a general disturbance of the metabolic functions of digestion and many other disturbances which were of a markedly unfavorable character.

When borax and boric acid are administered in small doses, namely, ½ gram (7½ grains) per day over a long period of time, similar symptoms in a less acute form are developed in the majority of cases. In one instance, where small quantities of borax were given for fifty days, there was a gradual but not pronounced loss of weight, a gradual and, in some cases, pronounced failure of appetite, a somewhat well-developed feeling of uneasiness in the stomach and a dull but persistent headache, all of which symptoms disappeared within a period of ten or fifteen days after the administration of the borax was discontinued.

In the consideration of the action of preservatives of a mineral nature, such as borax and boric acid, it must be remembered that the animal, as well as the plant, possesses a certain mineral hunger. In other words, mineral substances play a double role in animal and plant nutrition. First, they may serve as real food, necessary to the formation and nutrition of the tissues. In the second place, they are necessary to the functional activity of the various organs of the body, irrespective of any part they may take in direct nutrition.

The necessity of saline solutions in the blood is known to every physician and physiologist. If the blood were deprived of all of its saline constituents, the circulation would be impeded, restricted or stopped, and death would result. In cases of collapse in disease saline injections in the blood are often used as a restorative measure. These salts in solution stimulate the heart's action, and undoubtedly are active in the osmotic operations of the cells. This is one of the facts which show the intimate relation existing between physical chemistry and physiology.

Common salt is the most frequent and most abundant of the saline constituents of the blood, but the alkalinity of the blood is not due, of course, to common salt, which is a

neutral substance. The existence of alkaline carbonates or other alkaline salts is necessary to the vital functions. While it is true that the digestion in the stomach takes place in an acid solution, it is likewise true that any excessive acid must be neutralized and enough of alkali added in the small intestine, in order that the further digestion of the food may properly take place. That saline bodies other than common salt or the alkaline carbonates may be useful, however, in the performance of the vital functions cannot be denied, though it might be difficult to demonstrate their absolute necessity. Hence the introduction of saline bodies, which may or may not be of an antiseptic character, may, within certain limits, have a favorable influence upon health and digestion. At the same time it should not be forgotten that all excess of such bodies imposes upon the excretory organs an additional burden, which, while it might not impair their efficiency even for a number of years, might finally induce a condition of exhaustion which would be followed by serious consequences. Especially is this remark true of the kidneys, which appear to be a general clearing-house for all the surplus of saline matters ingested in the foods.

Are Minimal Quantities of Preservatives Permissible?—It is admitted by all who have examined the subject in a critical way, even by the users of preservatives, that in certain maximum quantities the limit of toleration is reached in each individual and positive injury is done. But it is also well recognized that many, if not all, of the usual foods when used in large excess produce injurious results. The many cases of disease produced by overeating, or by eating improperly prepared or poorly cooked foods, or by eating at unusual times, are illustrations of this fact. Upon this basis and upon the further statement that, when used in extremely small quantities, the preservatives in question cannot be regarded as harmful, is founded the principal argument in favor of the use of the preservatives, aside from the fact that the foods themselves are kept in a better and more wholesome state.

It is only proper to give to this argument full consideration and not to brush it aside as illogical and irrelevant. It is evident that any attempt to determine experimentally the

effect of extremely minute quantities of any preservative, even when used continuously, would not be likely to lead to any definite result. In the foregoing data we have illustrations of the fact that even large quantities of the preservative employed—larger by far than would probably ever be found in any food product—do not always act in such a way as to permit of definite interpretation. The claim, therefore, that the use of such preservatives is justified when the amount is extremely small, and when even these small amounts are used only at intervals, and not continuously, is worthy of careful consideration.

An illustration which is pertinent may be taken from the particular preservatives with which the foregoing experiments have been made, namely, boric acid and borax. One of the food products to which these preservatives are very commonly added is butter. This statement should not be taken to imply that in butter prepared for domestic use in this country borax is found to any considerable extent. When butter, however, is to be transported over long distances, and necessarily kept a long while, the addition of borax is very frequently practised.

The dietetic data which have been accumulated in the course of this experiment show that the quantity of butter consumed daily varies from 30 to 70 grains. Suppose, as a maximum, we say that the quantity of butter consumed in any one case daily is 100 grams, and that it contains 1 gram of boric acid, or an amount of borax equivalent thereto. The maximum quantity of boric acid used in a day in this case would be 1 gram. In point of fact, however, it would rarely, if ever, reach this amount, but even in those cases where butter is eaten freely probably half a gram would be about the maximum quantity consumed. Further than this, 1 per cent. of boric acid, or its equivalent in borax, in butter is a very large quantity. Probably, as a rule, not more than one half of 1 per cent. is employed. In this case the quantity of boric acid likely to be consumed by any one individual in a day would be reduced to one-quarter gram.

In the case of meats preserved by borax, although larger quantities are eaten than of butter, it is not likely that any larger quantities of borax would be consumed. Thus it

appears that those who habitually eat butter and meat preserved with borax might be consuming half a gram or a little more of boric acid per day. But preserved meats are not regularly eaten, and hence the quantity mentioned is likely to be overestimated. It would be unwise to affirm in a case of this kind, in the light of the data obtained by the experiments, that such a minimum consumption of borax, and especially when not a continuous one, would prove deleterious within any reasonable time of observation. The question then arises, Does the absence of such proof or the impracticability of obtaining it serve as a justifiable excuse for the use of this preservative?

This question ought not to be decided alone, because the principle of the decision must stand, not only for boric acid and borax, but for every preservative used in foods. In other words, whatever principle is established for judgment as to the use of boric acid in small portions must also be applied to the use of every other preservative used in foods. The principle must also be still further extended, so that whatever may be established as regards butter or meat must be admitted in respect of every other substance used in food. Hence, before admitting the full force of the argument based on minimal quantities, the full significance of such an admission must be considered and the practically unlimited extent of its application acknowledged.

This leads to the discussion of the fact that in the majority of cases the labor of freeing the system from added preservatives falls principally upon the kidneys. In the method of life in vogue in this country the kidneys are already hard-worked organs. Americans probably eat more freely than the citizens of almost any other country, with the possible exception of England. Large quantities of nitrogenous foods are consumed. In the breaking down of the nitrogenous tissues the kidneys are the chief organs for the excretion of the debris. The addition of any further burden, therefore, no matter how minute, is to be deplored. If, however, the principle be admitted that injurious substances may be used in such small quantities as to be practically harmless, then we find the way open for loading upon the kidneys many different functions in addition to

those which they now discharge. If they may be justly called upon to eliminate the small quantities of boric acid added in food, they can not logically be freed from the necessity of eliminating also minute quantities of salicylic acid, saccharin, sulphurous acids and sulphites, together with the whole list of the remaining preservatives, which are eliminated principally through the kidneys. It would be useless to contend that the occasional consumption of small quantities of boric acid in a sausage, in butter, or in preserved meat would produce even upon delicate stomachs any continuing deleterious effect which could be detected by any of the means at our disposal, but naturally it seems that this admission does not in any way justify the indiscriminate use of this preservative in food products, implying, as it would, the equal right of all other preservatives of a like character to exist in food products without restriction.

It appears, therefore, that there is no convincing force in the argument for the use of small quantities unless it can be established that there is only a single preservative used in foods, that this preservative is used in only a few foods, that it will be consumed in extremely minute quantities, and that the foods in which it is found are consumed at irregular intervals and in small quantities. On the other hand, the logical conclusion which seems to follow from the data at our disposal is that boric acid and equivalent amounts of borax in certain quantities should be restricted to those cases where the necessity therefor is clearly manifest, and where it is demonstrable that other methods of food preservation are not applicable and that without the use of such a preservative the deleterious effects produced by the foods themselves, by reason of decomposition, would be far greater than could possibly come from the use of the preservative in minimum quantities. In these cases it would also follow, apparently, as a matter of public information and especially for the protection of the young, the sick and the debilitated, that each article of food should be plainly labeled and branded in regard to the character and quantity of the preservative employed.

Borax and boric acid are regarded by most experts as the

least harmful of the antiseptics usually employed. Whether this is a true view of the matter or not remains to be determined by subsequent experiments. It is evident, however, from the results of experimental work that the miscellaneous and premeditated use of these antiseptics in food is reprehensible. There may be occasions when the use of borax is advisable, as, for instance, where butter must be shipped many thousands of miles before it is used or where meats are to be sent across the ocean, and perhaps in various other instances which render imperative the use of a preserving agent. It follows, therefore, that foods should only be preserved with a view to special use. When they are intended for consumption within a short time and for the ordinary continuance of life, it does not seem necessary that any antiseptic should be used, as the food can be perfectly preserved by unobjectionable methods in some of the ways indicated above. Where foods are prepared for various purposes, such as long journeys, excursions, voyages of discovery, etc., as indicated above, it appears that borax could be employed properly if its use is demanded by those who order the food, and if the food products are plainly labeled as having been preserved by this substance. It is, moreover, evident that eating small quantities of borax in food, occasionally, would not prove of any lasting injury to the ordinary citizen in good health, but the weak and feeble must be protected, and it is entirely within the grounds of reason that even a very small quantity of an antiseptic of this kind would prove very harmful to a disordered stomach.

The safest rule, therefore, to follow is to exclude these bodies from food except when their use is imperative, and then the quantity of the antiseptic employed should be plainly stated in such a way that the consumer may know what he is eating.

Similar experiments to the above have been conducted with salicylic, benzoic and sulphurous acids, but the results of the experimental work have not yet been compiled nor have the conclusions been drawn. This work is to be continued during the coming year, when it is our purpose to determine the effects of formaldehyde and coloring matter, when added to food, upon health and digestion.