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THE USE OF FOOD PRESERVATIVES.*

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Inasmuch as the succession of seasons, the intervals between harvests and great distances from sources of supply compel man to store and transport many food products, and since these are more or less perishable, the desirability and the necessity of artificially preserving these foods from decay and from putrefaction are apparent; and certain agents have been used for this purpose from prehistoric times. Common salt, or sodium chlorid, has priority in point of time, and potassium nitrate, or saltpeter, has the sanction of long-continued use, although I am not sure that the unrestricted use of the latter is altogether free from harm. Primitive man, in all probability, learned from observation that meat exposed to the smoke of his campfire did not become putrid so quickly as meat not so treated. Sterilization and canning are of comparatively recent introduction, but now of wide application. Refrigeration finds frequent new adaptations and the machinery employed in securing it has been developed and improved from year to year.

The relatively new science of bacteriology has demonstrated that the processes of decay and of putrefaction are due to the growth and multiplication of low forms of life and that the preservation of foods depends on the exclusion or retardation of the growth of bacteria. The rapid development of chemistry has led to the discovery and inexpensive preparation of a long list of chemical bodies possessed of more or less powerful germicidal properties, and the purveyors of food products have not been slow to utilize these scientific discoveries. Some of these chemicals used in the preservation of foods are, to say the least, questionable in their effects on the life and health of the food consumer. This fact has induced sanitarians to invoke the passage of legal enactments to control and to regulate their employment, and many of the states of the Union now have what are known as pure food laws and have provided officials whose function it is to enforce them. Courts of justice, in the execution of these laws, frequently call in medical men who have given especial attention to these matters and ask from them information concerning the harmfulness or harmlessness of the chemical compounds employed by dealers in foods. In this way it has happened that medical men are frequently asked to serve as experts in deciding questions involved in the administration of the pure food laws.

From his knowledge of the human body in health and disease, and of the effects of various chemical compounds on physiologic processes, the medical man is supposed to be qualified above others in giving testimony along these lines.

The questions that may arise legitimately in trials for the violation of the pure food laws are many and varied. In part they are chemical, inasmuch as the nature of the compound employed and the various reactions into which it may enter, when brought into contact with the fluids and tissues of the body, must be comprehended and explained to a jury made up of men who, as a rule, have had no training in chemical science. In part the questions are bacteriologic, for it must be known whether or not the substance has any germicidal properties and, if it has, if it acts on all bacteria alike. Is it effective to the same extent on aerobic and anaerobic germs, and on the relatively harmless and the toxicogenic? Much hinges on this question, as I will attempt to show later. The questions likely to come up also involve physiologic and pathologic knowledge. Food preservatives, if largely used, will be consumed not only by the healthy and robust, but by those with every form of disease, both acute and chronic. The dyspeptic, the neurotic, the diabetic, the nephritic, as well as the healthy man, must be considered in deciding whether or not a given chemical compound should be permitted as a food preservative. The infant and the aged, as well as those in the prime of life, are involved. If formaldehyde is to be permitted as a milk preservative it must be remembered that it will be largely consumed by infants, and not only by healthy infants, but by those suffering from gastrointestinal disturbances; by the dyspeptic and rachitic as well as the vigorous. If salicylic acid is to be used as a beer preservative, it must be borne in mind that it will be consumed not only by the man who takes an occasional glass, but also by the one who is given to frequent and deep potations. The food preservative that receives legal sanction must be harmful to none of these, for it is the duty of the state to protect all alike, and because a man is killing himself by excessive beer drinking is no reason why his death should be hastened by the addition of salicylic acid to his favorite drink.

One question which the expert should always ask himself, even if it be overlooked by both prosecution and defense, may be stated as follows: Is the substance in question a real preservative or only apparently such? If this question could be scientifically answered it would at once settle the claims of a considerable number of the preparations now in use. A true food preservative is a substance which when added to food in the fresh state keeps it in a wholesome condition for a considerable period of time. This is true of common salt, salt-

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peter, and of certain constituents of wood smoke. It is too much to expect that preserved food shall be as toothsome, as easily digested and as easily assimilated as the same food in the fresh state, and although this is accomplished with certain foods and with certain preservatives it can hardly be expected in all cases. Bacon is believed to be fully as pleasing to the taste, more easily digested and quite as readily assimilated as fresh pork, but this is not true of corned beef, nor of preserved fruits and vegetables.

A true food preservative must keep the substance to which it is added in a wholesome condition, so that it can be consumed by persons in every physical condition of life without impairment of health or danger to life. It is not the function of a food preservative to impart to the food a deceptive appearance and to make it look better than it actually is. The law takes special cognizance of this point, and plainly forbids all articles of this class, and I am sure that this law is wise. This excludes all meat preservatives that restore the color and fresh appearance to partially decomposed meats. Moreover, it is not the function of a true food preservative to simply preserve the fresh appearance while putrefactive changes go on, at least without marked and sufficient hindrance. To prevent the development of those bacteria that produce odoriferous substances while the more toxic bacteria that develop no telltale odor continue to grow and multiply does not comply with the requirements demanded by a food preservative that asks for legal sanction. It follows from this that we should be informed not only in a general way concerning the antiseptic properties of the substances in question, but we must know something of its specific action on toxicogenic as well as non-toxicogenic bacteria. To retard the multiplication of the lactic acid bacillus and thus to prevent the souring of milk, while colon bacilli continue to multiply uninterruptedly, is not the function of a true food preservative. Such food preservatives are wisely condemned by legal enactment. They take down the danger signal but do not remove the obstruction in the road.

Some esthetic individual might contend that the red lights along the street do not look well on a dark night, so he removes the lanterns, but leaves the stone piles and open ditches to wreck vehicles and endanger lives. Should such a man be considered a benefactor to his race, or a dangerous lunatic?

From experiments made in my laboratory, I can state that the addition of formaldehyd to milk in quantities varying from 1:25,000 to 1:50,000 retards the growth of the lactic acid bacillus and thus delays the souring of milk, while it has but little effect on the multiplication of colon and typhoid bacilli. The most ignorant mother knows enough not to give her babe sour milk, but even the most intelligent mother might give the formaldehyd milk, laden with its poison-producing bacteria, because, so far as she can judge by appearance and taste, it is all right. The man who adds formaldehyd to his milk takes down the danger signal but does not remove the danger. Is he a philanthropist or is he guilty of manslaughter when the child fed on this milk dies? In cases of this kind, it matters not whether the preservative is directly, and in and of itself, harmful to the human body or not, its use should be prohibited. I am by no means sure that formaldehyd in the quantities in which it is used in milk is, in and of itself, of great harm to the body of man, but I am convinced that its use in milk, especially in

that fed to infants, is very properly condemned by the laws of many states. Bacteriologists have found that sodium sulphite is possessed of but feeble germicidal properties, and yet we know that practically it does preserve the color and delay the development of putrefactive odors in meat for a relatively long time. It is more than probable that a careful investigation of this apparent contradiction will show that this substance, like formaldehyd, retards the growth of the non-toxicogenic rather than of the toxicogenic bacteria. However, this point deserves patient and prolonged investigation, and the laboratories of our agricultural colleges might carry out many series of experiments along this line, varying the conditions from time to time, taking into consideration the character of the food employed, the species of bacteria present, the temperature, time, etc. There is opportunity here for research that may prove not only instructive but of practical value.

So-called preservatives that remove the danger signal and leave the danger untouched should be condemned whether it can be shown that the substance employed is a poison or not. Even the most inert body belonging to this class should not be used, and certainly not in food fed to children, so large a proportion of whom die from milk poisoning.

Inquiry into the effect of the substance in question on the digestive fluids and processes is legitimate in considering the claims of any food preservative, and in making this inquiry it must not be forgotten that the preservative, if permitted, will be taken by those with every degree of digestive impairment as well as by the most vigorous. Neutralization of the free hydrochloric acid of the gastric juice is a matter of no little importance, as every physician who has made many analyses of gastric contents can appreciate, and the action of the substance on the digestive enzymes is probably of still greater importance. The digestive organs are the laboratories in which the nutritive parts of the food are fitted for absorption and assimilation; and interference with the normal processes of the alimentary canal mean, sooner or later, disaster to every organ of the body. The most general and superficial knowledge of chemistry suffices to indicate that sodium sulphite will neutralize the free hydrochloric acid of the stomach, and a simple calculation, based on the amount of this substance which may be found in the food, will show the volume of acid that may be neutralized. It matters not whether the acid radicle of the sodium sulphite is split off in the stomach as the anhydrid or immediately combines with water to form sulphurous acid, the effect is practically the same. I was somewhat startled recently, however, to learn from the testimony of an expert that the stomach is a tank always filled with free oxygen, and that this immediately converts the sodium sulphite into sodium sulphate, which, as all must admit, in the quantity employed can be of little effect, even on the dyspeptic. The investigation of the effects of preservatives on the digestive processes should be made outside the body, where they can be exactly determined. They should be made with each ferment and then with combinations. Numerous studies of this kind have been made with some food preservatives, for instance with formaldehyd, and it seems to be well established that this substance markedly interferes with the action of some of the digestive enzymes. The defense frequently attempts to belittle testimony showing the retardation of the digestive processes by the substance in question, and the expert is asked what harm

it will do to have some of the acid of the gastric juice neutralized by the little sodium sulphite in a Hamburg steak eaten once a week? This question is an attempt to mislead and to convey to the jury the impression that the matter is of but trifling import and that the expert is trying to build a fortress of straws. However, if a man has sodium sulphite in his meat, alum in his bread, and formaldehyd in his milk, it may seriously be questioned if his gastric juice, or what little he has left of it, will suffice to convert the proteids of his food into peptones.

The question of the possible poisonous action of the preservative must always be considered and is frequently of primary importance. There seems to be great diversity of opinion among medical men concerning what constitutes a poison. Some appear to think that before a chemical compound can be classified as a poison it must be capable of causing death in the quantities used in food, or that at least it must visibly and grossly disturb the health of man in a few hours. If it fails to do this it is not a poison, or at least in the quantity employed it should not be so designated. I have regarded this question quite differently and I will attempt to give, in a few words, my ideas on this point. The bodies of animals, including man, are made up of cells, that are alive and perform duties, the proper performance of which is necessary to the well-being of the whole of the individual. These cells are essentially chemical compounds and those substances which combine with these cells chemically in such a way as to cause their destruction or to render the performance of their normal functions impossible are poisons. Therefore, a poison may be defined as a substance that destroys or impairs cell function by virtue of its chemical constitution. The cells of the different organs vary more or less in chemical composition and consequently a compound may react with a liver cell more readily than it does with a muscle, bone, or nerve cell. In this way poisons are, to a certain extent, selective in their effects, their selective action being dependent on the readiness with which they react with the chemical constituents of different cells. A substance that combines with and consequently interrupts the function of the cells of the respiratory center in the brain causes the speedy death of the individual, while those substances that destroy blood, liver or kidney cells are slow poisons inasmuch as the life of the individual may survive the destruction of a large number of these cells, but those of one class are just as truly poisons as those of the other. Potassium chlorate reacts with the hemoglobin of the blood, converting it into methemoglobin, and if the number of red blood cells destroyed is sufficiently great to impair the action of the other cells, especially those in the vital centers of the brain, death of the individual occurs. On the other hand, if the number of injured blood cells be not so great, life is not destroyed but health is impaired.

Chloroform, ether and other anesthetics combine with and temporarily paralyze the nerves of sensation. Ethyl alcohol, besides its effects on the nervous system, leads to alterations in hepatic cells, and cirrhotic changes are induced; while methyl alcohol finds its special affinities in the ganglion centers of the retina and in the optic nerve. Many of the metals have their most marked effect on the renal cells and some have a special action, apparently, on connective tissue cells. In the pathologic laboratory, potassium bichromate is employed on animals for the specific purpose of developing nephritis. There are other illustrations, but these, I hope, will

suffice to make clear my position. All poisons are such because they destroy or impair the action of certain cells of the body and the immediate effect on the life of the individual depends on the kind and number of cells put out of commission.

The question of dose can not be left out of consideration in the study of poisons, because a certain relatively small number of cells, in most organs of the body at least, can be destroyed without any appreciable result. Moreover, the quantity or dose given determines, to some extent, the cells affected; thus the introduction of from 5 to 10 grams of sodium sulphite into the stomach of a rabbit at one dose causes death in a few minutes, while the administration of the same substance in much smaller quantities just as certainly kills but a longer time is required. When a large single dose is given, some of the unchanged sulphite reaches the brain, and the cells of the respiratory center are so injured that respiration stops and death occurs almost instantaneously.

When smaller doses are given all the sulphite is used up before it reaches the brain, especially in the walls of the stomach and in the blood. Digestion and assimilation are impaired, emaciation follows and in time death ends the process. Is not sodium sulphite just as truly a poison in one case as in the other? But it is asked, is not nearly everything a poison if given in sufficient quantity? and the expert is frequently asked if common salt is not a poison in large doses; it may kill, but it is not a poison. The injection of concentrated solutions of salt or of sugar, or even of distilled water directly into the blood may kill by altering the specific gravity of the plasma, but these are not poisons. If the stomach of a rabbit is filled with a saturated solution of common salt speedy death results, but this is due to physical causes and to the absorption of water, and is not due to the chemical combination of salt with the cells of the body. Broken glass or splinters of steel taken into the stomach may kill the individual, and molten metal poured into the throat would have a like effect, but these are not poisons, because their injurious effects are due to physical and not to chemical causes.

Should the fact that a substance is a poison prohibit its use as a food preservative? Admit that a substance is a poison and it must also be admitted that its use as a food, or in a food, must be sanctioned by long-continued custom or must be regulated by law. I think that this is the holding of eminent jurists in all parts of the civilized world. I believe that the higher courts of Pennsylvania have held that it is sufficient to show that the substance is a poison and that it is not necessary to show that the quantities employed are dangerous, and this decision is certainly a wise one. In cases of trial for murder by the administration of poison, it has been generally held that it is not necessary for the chemist to recover from the body a poisonous dose, but simply to show the presence of poison. People in general are not legally qualified to administer poison to others. Members of the medical profession only are legally qualified for this purpose, and it is for this reason, in part at least, that the state assumes the right to specify within certain limits the qualifications of the physician.

If sodium sulphite is a poison, and if the only safeguard in its use as a food preservative is in the amount added to the food, shall this be left to the vendor, who is ignorant of the chemistry and toxicology of the compound and whose sole object is to make his goods look

more attractive to the buyer? If this compound is to be legally sanctioned as a food preservative, the law must determine in what quantities it may be employed and it must select qualified men to mix the preservative with the food. The statutes specify the qualifications of the physician who prescribes and of the pharmacist who prepares this and other poisons when given as medicines, and is it not of more importance that the addition of poisons to our daily foods should be conducted under similar safeguards? Medical experts may differ in opinion concerning the classification of a given compound as a poison, but if the court be convinced that it is a poison, and that the possibility of doing harm with it depends on dosage, it is not probable that its usage will receive legal sanction. Poisons should be sold only under strict legal restrictions; the experience of all ages has demonstrated the wisdom of this. The cases of poisoning with chromate of lead, so admirably worked up some years ago by Stewart of Philadelphia, will illustrate what harm the cupidity of the vendor and the ignorance of the user may accomplish. The fact that the substance in question has been largely employed in medicine, and sometimes with beneficial results, is often brought out in court. In my opinion, testimony of this kind is of but little value and is capable of being misinterpreted. The physician, in order to cure a syphilitic lesion, very properly takes the risk of doing harm to the kidneys by the administration of mercury, but this does not indicate that mercurial compounds are harmless or that they may properly be used as food preservatives. This point leads to such absurdities that I am ashamed to pursue it further, and yet in two cases tried in Pennsylvania recently medical men have used it in defense of food preservatives. Along the same line is the question of poisonous dose, and the expert finds in some medical book that the medicinal dose is much greater than the amount one would take at a meal, or in one day, or possibly in one week. In regard to this point, it is only necessary to state that there is probably no poisonous drug that has been in use for 10 years or longer for which you can not find in some book the medicinal dose given at a figure considerably beyond the limit of safety.

There is another line of testimony sometimes given that seems to me to be of questionable value; an expert testifies that foods containing a certain preservative have been eaten by men in Alaska or in some other place remote from sources of food supply without recognizable harm. Men so situated must eat what they can get; but here at home we are not driven to such a choice. Men in remote places have eaten dogs and have pronounced the repast enjoyable, palatable and nutritious, but this would hardly justify a butcher in sending a canine tenderloin when a beefsteak had been ordered.

The source of one's knowledge concerning the action of poisons is a matter deserving consideration. Lately there has been a tendency on the part of some to question toxicologic knowledge gained by animal experimentation and to offer instead observations of the effects on man. One expert has tested the action of a substance on the lower animals, which he has fed for a certain time and which he has then killed, either by the continued administration of the drug or otherwise, and after death he has made careful macroscopic and microscopic studies of the different organs. From these studies, he has arrived at certain conclusions. The opposing expert states that he has prescribed the sub-

stance in question for malaria or for some other disease to a large number of people and without injury, possibly with benefit. Which kind of testimony is the more scientific and valuable? We will suppose that the action of potassium bichromate is in question. I take this substance because it has not, so far as I know, been used as a food preservative, although a more poisonous chromate, that of lead, has been employed in Philadelphia as a food adulterant. One man testifies that, following the method of Gunzberg, he has prescribed the bichromate to his syphilitic patients and that it has done them no harm. Another says that he has tested the action of this substance on dogs and that he finds it induces certain distinct lesions, especially in the kidneys. Which line of evidence is the more satisfactory, and, after hearing both, to which shall we give the greater weight in coming to a conclusion concerning the action of the bichromate? For one, I should not long hesitate in coming to a decision, and I leave others to decide for themselves, but while they are doing so I beg leave to ask a few questions. Which, the syphilitic or the dog, was in health to start with? To which has the substance been administered most certainly in the quantities claimed? Which has been more completely under the control and observation of the administrator? and, when both die, in which is the cause of death most unquestionable? Moreover, suppose that the kidney lesions are found in both, is it not true that there might be grave and honest doubt as to what caused them in the man? The conditions under which most patients live are too complex for them to serve in our observations concerning the actions of poisons. Dr. Wiley, at Washington, is now testing the action of certain food preservatives and adulterants on men, and, inasmuch as these men are under his control and have their lives regulated by his rules, we may be sure that valuable information will be secured, but toxicologic experiments on men under the most favorable conditions will need to be supplemented by animal experiments. The microscopic lesions induced in the organs can be ascertained in no other way. We must be able to kill the animals after they have received definite quantities of the substance and to study their tissues, both macroscopically and microscopically.

In conclusion, I will state what I believe should be the essentials of a substance before its employment as a food preservative should receive legal sanction.

1. It must be a real preservative, keeping the food in a wholesome condition and not merely retaining the appearance of freshness while bacterial changes continue.

2. In the largest quantities used, it must not materially impair any of the digestive processes.

3. It must not be a cell poison, or if a cell poison in any amount, it must be added to foods only by persons qualified by special training and officially authorized, and foods containing these substances must be plainly labeled and the kind and amount of the preservative used must be made known not only to the buyer but to each consumer.

To Prevent the Tramp Evil.—A striking illustration of the success of the work test on ridding country towns of tramps is furnished by the town of Sherborn, Mass., says the *Medical Times*. Sherborn had 1,446 inhabitants, and during one year it lodged and fed at the town almshouse 1,844 tramps. The overseers of the poor decided to employ tramps in labor for the almshouse and in chopping wood, with the result that in four years there was a reduction from 1,844 to 31.