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PRESERVATIVES AND OTHER CHEMICALS IN FOODS

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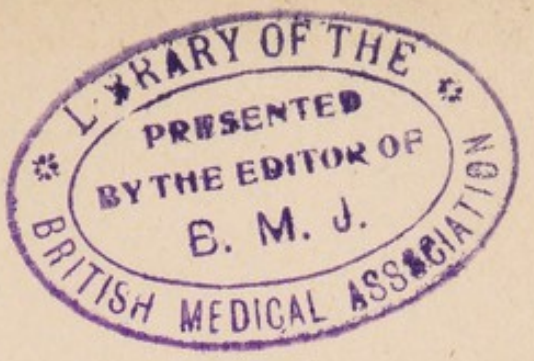
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PRESERVATIVES AND OTHER CHEMICALS IN FOODS: THEIR USE AND ABUSE
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PRESERVATIVES AND OTHER CHEMICALS IN FOODS: THEIR USE AND ABUSE

BY

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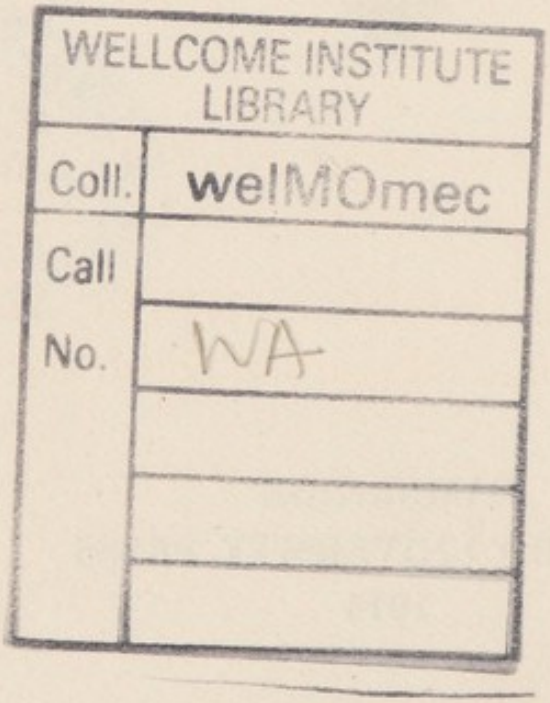

HARVARD HEALTH TALKS

PRESENTING the substance of some of the public lectures delivered at the Medical School of Harvard University, this series aims to provide in easily accessible form modern and authoritative information on medical subjects of general importance. The following committee, composed of members of the Faculty of Medicine, has editorial supervision of the volumes published:

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PRESERVATIVES AND OTHER CHEMICALS IN FOODS: THEIR USE AND ABUSE

PRESERVATIVES AND OTHER CHEMICALS IN FOODS: THEIR USE AND ABUSE

THE practice of preserving perishable food materials for longer or shorter periods is by no means a modern innovation. The applications of heat and cold represent old family methods which have only been extended and improved in the modern canning and cold storage industries. The drying of fruits, fish, and meats is a practice of very ancient origin. The use of salt for similar purposes doubtless antedates all historical records. The use of sugar, either alone or together with acetic acid in the form of vinegar, and with various spices, is an old contrivance. The application of creosote obtained crudely from the smoke of incompletely burned wood materials is the

ancient forerunner of some of the modern packing-house processes. This process was probably accidentally discovered in connection with crude attempts to use artificial heat for drying purposes.

Concerning the value and legitimacy of these old family methods there is comparatively little difference of opinion. It is generally understood that salt meat is less good than the fresh article, that dried apples do not make the best apple pie, that chipped dried beef is not an adequate substitute for a fresh piece of steak; but for all that, these various substitutes for the fresh materials are accepted as more or less indispensable articles of food. The only reason probably why no one attempts to invoke the law as a protection for the people against these embalmed or mummified food products is that the people have been familiar with them from time immemorial, and know, or are supposed to know, how to use them.

PRESERVATIVES IN FOODS

The cause of the decay of food materials, as is of course now very generally known, is the presence of bacteria in them. With the discovery of these organisms (the study of which has since developed into the science of Bacteriology) it became clear that the way to prevent the decay of organic materials is to exclude the bacteria or to kill them. And as to exclude them mechanically from foods is practically impossible, the problem of preserving foods became the problem of rendering foods unfit for bacteria to live in.

The underlying principle on which the art of preserving perishable organic materials is built is thus a contribution of the science of Bacteriology, and became clearly understood during the latter half of the nineteenth century. With the advent of that science and the development of the miscroscope, began the battle against the countless hosts of microorganisms which were found to invade practically everything fit for human food,

and which were thought to be also the cause of all diseases. The investigations which followed brought out rapidly and systematically the potency and relative efficiency of a great many chemicals in destroying the different forms of these new enemies, which made up in number what they lacked in size.

The chief early use of such chemicals was their application in medicine as antiseptics rather than as preservatives of food materials. Corrosive sublimate, silver nitrate, carbolic acid, boric acid and borax, benzoic acid and benzoates, salicylic acid and salicylates, formaldehyde, hydrogen peroxide, iodoform, together with a great many other less familiar substances, became known as germicides and antiseptics, i. e., as substances possessing the property of killing more or less effectively the various microörganisms, or at least of preventing their development and multiplication. The medical antiseptics are of course also

" preservatives," and the application of the milder antiseptics to perishable food materials for purposes of preservation was not long in coming, and was easily found to be not only more convenient, but also far more effective for the preservation of all kinds of food materials than the more primitive methods of the housewives.

Unfortunately the application of these new methods for preserving food was not left where it belonged, with critical and disinterested scientific investigators, but was seized upon by alert men whose chief interest was of the pecuniary kind. The outcome might have been foreseen. The investigation along this line which their interests called for resolved itself into the simple one of finding the smallest percentage of this or that antiseptic which would prevent the decay of some particular food product, and trusting to luck that the chemical used might prove

harmless to the consumer. By means of greater liberality with the antiseptics, which are cheap, the enterprising manufacturer also succeeded in preparing food products for the market from materials already so decayed as to be unsalable in their original condition. With characteristic optimism the manufacturer doubtless believed, or hoped, that such decayed materials containing a mixture of dead bacteria and their decomposition products, when joined with the antiseptic and sufficient spices, would turn out to be good food as well as good money makers.

Unfortunately the most difficult, — in fact the only difficult problem,— to solve in connection with the use of these newer chemicals as food preservatives is the question as to their effect on the health of the consumer. By the national Pure Food and Drug Act of 1906, as interpreted under the rules and regulations

formulated by Dr. Wiley and his associates, any food article which contains some "added poisonous or other deleterious ingredient which may render such article injurious to health" is adulterated. But in the absence of specific and adequate evidence to the contrary, it follows practically as a matter of course that chemicals which are effective in killing or in preventing the development of bacteria must be injurious to the more highly organized and more sensitive living cells which go to make up the human body. As Dr. Wiley would put it, the drugs and chemicals now used for preserving food are poisons, and the sale of food containing poison must be stopped. By this Pure Food and Drug Act which represents the culminating point of Dr. Wiley's long, untiring and honorable fight for pure food, the products containing the modern preservatives have become outlawed, and the zeal of manufacturers to preserve everything

that might once have been fit for human food was checked — at least in some measure.

The manufacturers involved reacted promptly to the stimulus of the Pure Food and Drug Act as interpreted by the Department of Agriculture. After having for a generation used all the ingenuity and all the chemical skill which they could command, to elude and to fool when they could not defy Dr. Wiley and his chemical detectives, they now began to clamor vigorously and effectively for the kind of investigations which should have been sought before they began to go into the business of doctoring the food of the people with chemicals of unknown or disputed poisonous character. The magnitude of their business was sufficient to command attention, and the federal government appointed a committee of scientific experts, the so-called Referee Board, to determine the poisonous or deleterious character of the chemicals used.

The situation which has thus arisen, and which has been forced on us by commercial interests, is not altogether a happy one. Scientific investigations of permanent or incontestable validity can rarely be made to order. They must all stand the fire of criticisms and counter-experiments and can be accepted as final only after a substantial agreement has been reached.

The clamor for prompt investigations, definite conclusions, and final decisions made by manufacturers of foods adulterated in the sense of the Pure Food and Drug Act is easily understood. They can appeal to the courts for further action on any decision which may prove unfavorable to them.

Dr. Wiley and the Department of Agriculture are in part responsible for the present anomalous situation. In turning out reports and bulletins purporting to prove by means of " poison squads " that certain chemicals used in the pre-

paration of foods have rendered such foods demonstrably injurious to health, they assumed a burden of proof which there was no need of assuming in such concrete fashion. By means of such reports and by many extravagant speeches, Dr. Wiley undoubtedly aroused public interest in the subject of pure, unadulterated food; but in claiming to have proved by direct feeding experiments the injuriousness of certain foods containing preservatives, benzoate, borax, sulphites, etc., he led the public to believe that it is comparatively easy for scientific men to furnish such proof and thus paved the way for the manufacturers' demand that the Government should engage other high-grade, unbiased experts to determine the facts.

The Referee Board appointed by President Roosevelt to pass judgment on various preservatives and chemicals used in foods thus came into existence under very unfavorable circumstances. A con-

siderable part of the people and of the press had accepted Dr. Wiley's results and interpretations as final, and were extremely suspicious and hostile toward the new Board appointed at the request of dealers in adulterated and "poisonous" food materials.

The first report published by the new committee of scientific experts involved the important question of the effects of benzoates and benzoic acid on the human system.

Conclusions of the Referee Board, 1909

(1) "Sodium benzoate in small doses (under five-tenths of a gram per day) mixed with the food is without deleterious or poisonous action and is not injurious to health.

(2) "Sodium benzoate in large doses (up to four grams per day) mixed with the food has not been found to exert any deleterious effect on the general health, nor to act as a poison in the general ac-

ceptation of the term. In some directions there were slight modifications in certain physiological processes, the exact significance of which modifications is not known.

(3) "The admixture of sodium benzoate with food in small or large doses has not been found to injuriously affect or impair the quality or nutritive value of such food."

Four grams of sodium benzoate, the "large" quantity which according to the Referee Board may be taken daily with impunity, would be contained in four and a half pounds, or two and a half quarts of food, carrying two-tenths of one per cent of the chemical. According to the present federal regulations no more than one-tenth of one per cent of sodium benzoate is allowed.

It is no reflection on the Referee Board to say that this report must be regarded as a valuable contribution to the important question involved, rather than as a

final settlement of it. Among scientific men opinions are still divided, and I think they will continue to be divided for some time to come, on the question as to whether benzoic acid and benzoates are or are not deleterious to health.

Dr. Wiley had reached entirely different conclusions in the report published by the Department of Agriculture the year before (1908).

Dr. Wiley's General Conclusions, 1908

" From a careful study of the data in the individual cases and of the summaries of the results, it is evident that the administration of benzoic acid, either as such or in the form of benzoate of soda, is highly objectionable and produces a very serious disturbance of the metabolic functions, attended with injury to digestion and health.

" As in the case of boric acid, salicylic acid, and sulphurous acid, this injury manifests itself in a number of different

ways, both in the production of unfavorable symptoms and in the disturbance of metabolism. These injurious effects are evident in the medical and clinical data which show grave disturbances of digestion, attended by phenomena which are clearly indicative of irritation, nausea, headache, and in a few cases vomiting. These symptoms were not only well marked, but they were produced upon healthy individuals receiving good and nourishing food and living under proper sanitary conditions. It is only fair to conclude, therefore, that under similar conditions of administration of benzoic acid or benzoate of soda in the case of weaker systems, or less resistant conditions of health, much more serious and lasting injury would be produced.

" It was also noticed that the administration of benzoic acid and benzoate of soda was attended with a distinct loss of weight, indicative of either a disturb-

ance of assimilation or an increased activity in those processes of the body which result in destruction of tissue. The production of a loss of weight in cases of this kind must be regarded as indicative of injurious effects.

" The influence of the benzoic acid and benzoate of soda upon metabolism was never of a character indicative of a favorable change therein. While often the metabolic changes were not strongly marked, such changes as were established were of an injurious nature. It is evident that the administration of these bodies, therefore, in the food tends to derange metabolism in an injurious way.

" An important fact in connection with the administration of these bodies is found in the efforts which nature makes to eliminate them from the system. In so far as possible the benzoic acid is converted into hippuric acid. There is a tendency usually manifested, however, to retain the benzoic acid in the body for a

notable length of time, and this is much more marked in the case of benzoate of soda than in the case of benzoic acid.

" While the administration of both these bodies, therefore, is undoubtedly harmful, the injurious effects are produced more rapidly in the case of benzoic acid than they are in the case of benzoate of soda; the data, however, will show that the total harmful effect produced in the end is practically the same in both cases, hence there appears to be no reason for supposing that the administration of the preservative in the form of benzoate of soda can be justified by any argument relating to the less injurious effect thereof upon health.

" The occurrence of microscopic bodies in the urine is undoubtedly increased under the administration of benzoic acid in both forms, thus showing conclusively the tendency to stimulate the destructive activities of the body.

" Coming to the final consideration of

all of these different phases of the subject, there is only one conclusion to be drawn from the data which have been presented, and that is that in the interests of health both benzoic acid and benzoate of soda should be excluded from food products. This conclusion is reached independently of any consideration of the conditions which, it is alleged, surround the processes of manufacture, and which result in the demands of manufacturers to be allowed to continue the use of these substances. This is a subject which must be discussed from an entirely different point of view and has no bearing whatever upon the general conclusions which have been reached, namely, that both benzoic acid and benzoate of soda are bodies which, when added to foods, are injurious to health."

The Referee Board reached conclusions diametrically opposite to those expressed

in the above general summary of Dr. Wiley's report, yet made no comments or criticisms on his findings. I have no desire to supply such criticisms or to try to harmonize these two reports published by the Department of Agriculture. I venture to repeat, however, what I said before: "Scientific investigations of permanent or incontestable validity can rarely be made to order. They must all stand the fire of criticisms and counter-experiments and can be accepted as final only after a substantial agreement has been reached."

The report of the Referee Board published in 1909, and embodying the favorable conclusions cited concerning benzoate of soda, elicited much hostile criticism. One statement assiduously circulated in the press was to the effect that investigations conducted in Germany under the auspices of the German Government had verified Dr. Wiley's conclusions with regard to the deleteri-

ous effects of benzoates and benzoic acid. The German report was finally published a few months ago (December, 1913). A somewhat free but true translation of the non-technical conclusions reached by the German investigators is as follows:

General Conclusions of the Royal Department of Public Health, Berlin, 1913 [1]

1. "A single sufficiently large dose of benzoic acid (benzoate) produces vomiting in animals capable of vomiting [dogs]; it is difficult to produce general symptoms of poisoning in such animals [by means of a single dose].

"By the daily administration of benzoic acid for several successive days a characteristic form of poisoning revealed by sudden attacks of epileptic-like cramps is obtained. These attacks are preceded for hours or days by occasional light prodromal symptoms, and

[1] The bracketed phrases are not contained in the original.

they are followed by ataxia [lack of co-ordination] and hallucinations. In many respects (the prodromal appearances, the course of the cramps, and accompanying symptoms) the attacks resemble epilepsy in man.

"By further continuation of the administration of benzoic acid the poisoning results in death through paralysis of the central nervous system.

"A picture resembling so closely a disease cannot be produced experimentally [so far as we know] by any other well defined chemical.

2. "The amount of benzoic acid required to produce toxic symptoms, by repeated doses, is relatively large; with dogs weighing from five to eighteen pounds, seven grams of sodium benzoate was necessary. In no case could any symptoms be obtained with less than seven grams. The effective amount of sodium benzoate, about four-tenths of a gram per pound of body weight, is also

the *lowest* toxic dose. Smaller amounts than this toxic dose even though they be very nearly as large could be administered indefinitely, certainly for weeks or for months, without producing benzoic acid poisoning. In some cases the minimum toxic dose was found to be considerably greater than the amount indicated above. In the case of some dogs (weight five to eighteen pounds) eight to eleven grams of sodium benzoate had to be given before any toxic symptoms were obtained. Therefore, notwithstanding the fact that the experimental conditions were kept uniform, the lower limits of demonstrable toxicity are subject to considerable individual variations above the lowest limit indicated (four-tenths of a gram per pound of body weight).

" There is no difference in the effects whether benzoic acid or sodium benzoate is used.

3. " In the case of rabbits no difference was found between acutely toxic

effects and the effects resulting from repeated administrations of the drug [rabbits cannot vomit]. A definite minimum toxic dose for rabbits could not be found. The effective dose varied considerably and lay between seven-tenths gram and one and one-tenth gram benzoic acid per pound of animal."

According to this report four-tenths of one gram of benzoic acid per pound of dog, or seven-tenths of one gram per pound of rabbit, is necessary to produce the characteristic symptoms of benzoic acid poisoning, and smaller amounts produce no demonstrable effects of any kind. The smaller figure (obtained in the case of dogs) would correspond to sixty grams of benzoic acid in the case of a man weighing one hundred and fifty pounds. The Referee Board concluded that four grams per day is harmless.

It will be observed that the German report does not deal with the effects of

benzoic acid on man, and results obtained with rabbits and dogs do not necessarily prove anything with reference to definite quantities which would be injurious to man. The purport of the German investigation must, however, be intended to elucidate the effects of benzoic acid on man, since the Royal Department of Public Health cannot be supposed to contemplate regulations for the protection of rabbits and dogs.

Among all the preservatives of recent origin there is probably no one more likely to prove practically harmless to human beings than benzoic acid and benzoates. It is well known that certain food materials, as for example, cranberries and to a lesser degree many other fruits, contain notable quantities of benzoic acid, or rather substances which give rise to benzoic acid in the human system. In fact practically all foods contain substances which are transformed first

into benzoic acid and then into hippuric acid within the system. We invariably find considerable quantities of hippuric acid in urine, and hippuric acid is simply benzoic acid in combination with glycocoll, one of the decomposition products of albumin. From hippuric acid we can easily recover again the benzoic acid. It may be interesting in this connection to note that cows' urine was once the source for the hippuric acid of commerce. In the course of twenty-four hours a horse eliminates from half a pound to a pound of benzoic acid in the form of hippuric acid.

We know that the human organism is prepared to take care of and render harmless those small quantities of benzoic acid and benzoic acid compounds which occur in food products or which are formed within the body; we know how this is accomplished and are reasonably sure as to the particular organ which does it. We also know that the

mechanism by means of which the poisonous benzoic acid is converted into the harmless hippuric acid is an extremely efficient one, and that it is capable of taking care of relatively enormous quantities of benzoic acid. In this case, as in a great many others, the normal animal organism is abundantly capable of performing the function which it must regularly perform in order to survive. From this point of view it can be argued, and it has been argued with considerable force, that the human organism is abundantly capable of rendering harmless reasonable amounts of benzoic acid or benzoate which are added for purposes of preservation to certain articles of our food. In my opinion this point of view is going to prevail, and the strife will resolve itself into a controversy over how much benzoic acid shall be permitted to go into our daily food.

But we ought to be exceedingly cautious about accepting any definite figure,

certainly any large figure, as representing the permissible amount of added benzoic acid in our food. The very fact that we are in possession of an efficient process for converting poisonous benzoic acid into harmless hippuric acid indicates that there is a necessity for doing so. It suggests that even the small quantities of benzoic acid which we get with unadulterated food, or produce within ourselves, might be deleterious to health except for the saving hippuric acid forming process. And because that "factor of safety" is a large one with respect to the normal benzoic acid content of our food it does not follow that we can encroach on it with perfect impunity. What the effect of a general, regular encroachment on it would be cannot be determined by a few relatively short feeding experiments. It is known that while certain chemicals may be taken in substantial quantities for a month or a year without producing

demonstrably injurious effects, nevertheless the continued use of the same substances, even in smaller quantities, will eventually undermine the health. Perhaps the final solution of the benzoic acid problem could be best obtained directly from the people at large. If they were to consume benzoic acid as knowingly as they consume, for example, sodic carbonate in soda biscuits, or caffein and theobromine in coffee and tea, it would not require more than a decade or two before we should have a well defined and well founded public opinion on the subject, at least in the medical profession.

For centuries we have consumed the preserved food materials which our mothers used to make, and there is, in my judgment, absolutely no basis for the assumption that some of the concoctions which they prepared are less injurious to health than the corresponding products made from equally good materials and preserved by the help of ben-

zoic acid. It is a mistake to assume that within certain classes of preserved foods we have the choice between those which are injurious and those which are entirely wholesome. For example, there is at present no evidence to lead us to believe that the cinnamon, oil of cloves, and other similar ingredients used by our mothers are wholesome as compared with benzoic acid. In fact both cinnamon and cloves are said to contain benzoic acid.

It must not be overlooked, however, that the free use of vigorous chemicals in the home in the form of condiments and preservatives is a different thing from a similar use of the same chemicals by manufacturers, because their interest in the welfare of the consumer is subordinate to other more immediate interests. Nor should it be forgotten that the food manufacturers have already in a large measure crowded out the home industries so that preservation of food in the home is rapidly becoming a lost art,

while the consumption of preserved foods is constantly increasing.

I have dwelt at some length on the benzoic acid question because this chemical represents to my mind the most promising among the different newer chemicals which have been used for the preservation of food materials, and if it were to be entirely excluded on the basis of the experience so far obtained, I would unhesitatingly also eliminate from articles of food every other chemical or drug mixture, whether new or old, excepting sugar and common salt. Smoked meats of all kinds certainly contain more dangerous chemicals than benzoic acid.

It is perhaps not superfluous to state that the approval of a limited use of benzoic acid or sodium benzoate for the preservation of good but perishable food materials does not imply approval of similar preservation of decayed materials; or of materials which are regularly

consumed in large quantities, as for example, milk; or of foods which do not need any chemical preservatives, as for example, most canned goods. The substitution of benzoic acid for cleanliness in the preparation of food is doubtless a real and practical temptation to manufacturers of cheap foods, however much they may be disposed to deny it.

The other common preservatives such as formaldehyde, salicylic acid, boric acid and borax, sulphurous acid and sulphites can be passed over much more briefly. Not a single one of them can be defended as an ingredient of human food on the same basis as benzoic acid. So far as we know the human organism does not produce them and has not had to deal with them as natural ingredients of any common food product and has not developed any special mechanism or process for rendering them harmless. In the case of these preservatives we have

no evidence save that of experience derived from their comparatively recent use, and of the few experiments which have accumulated since they became known as preservatives.

It is, however, extremely difficult, — in fact almost impossible, — to determine experimentally in a short time, with any degree of certainty, whether a comparatively mild chemical is or is not injurious to health. As I have already indicated, the fact that considerable quantities of a chemical can be taken for months at a time with apparently perfect impunity does not prove that that chemical does not impair the health and shorten life, if taken from childhood to the end of one's career.

Man is a comparatively large animal. In addition, he is provided with an efficient mechanism for eliminating from his system poisonous or useless products which are taken in from without, or which are produced by his own metabo-

lism. It is therefore not particularly remarkable or significant, that chemicals sufficient to kill millions or billions of bacteria can be poured daily through this relatively huge animal for weeks and months without producing a demonstrable effect. That this same big animal may be more or less damaged without the fact being known, demonstrable or detectable, is also a fact that must compel us to hesitate about accepting negative results from feeding experiments with preservatives. If we cannot demonstrate in their earlier stages the presence of tuberculosis, cancer, or general paralysis — to mention only a few progressive serious diseases —it is clearly out of the question that we should be able to say that a given preservative has done no harm, because the person taking it is, or seems to be, perfectly well after having taken it three times a day for a month or for six months. It is important that such experiments should be

made, for in the case of the more pernicious chemicals some hint, some danger signal may be discovered which would serve as a sufficient basis for the definite exclusion of that chemical from any and all articles used as food. Negative results indicate, however, only the absence of gross, demonstrable injury, and do not prove that the chemical investigated is entirely harmless.

So far as concerns the preservatives mentioned, formaldehyde, salicylic acid, boric acid and borax, there is therefore no sound reason as yet why they should be permitted in any article that is used as a food. By this I do not mean that they should necessarily be forever excluded. On the contrary it is possible that any one or all of them may be found in the course of time to be unobjectionable or relatively so. The propriety of using boric acid or borax in such a peculiar food product as cheese, for example, is fairly debatable, and the same may be

said concerning the use of sulphurous acid and sulphites in the drying of fruits. All the chemicals mentioned are now suspicious characters, but it is possible that their effects on the human system are not such as to warrant their complete exclusion from all articles of food.

There is, I think, only one way to get at the facts with regard to the various chemicals which have been used for the preservation of foods, and that is by trying them and keeping track of the results. To try them properly, on a sufficiently extensive scale and for a sufficiently long time, is, however, more of a task than can be undertaken by private investigators; for it is only by their continuous use for many years under competent supervision and control that we can hope to attain adequate information for final conclusions. Work of this sort should be done and could very well be done at large government institutions,

as for example among certain classes of prison inmates. I do not know how many life prisoners or long term prisoners may be available, but there must be an abundance of them. They would make better subjects than students on whom to try out a substance like boric acid. This not because they are prisoners whose fate or health is of comparatively little consequence, but because they represent a body of persons whose mode of life is essentially uniform and whose health record could easily be kept for a long period of years. I am well aware that this suggestion will impress many persons as heartless and brutal, but such an experiment would be a mild and humane one when compared with the unrecorded boric acid experiments which have been made by manufacturers, on all kinds and conditions of people. Prisoners are unfortunate in not being able to render any useful service to society. Probably not a few would be

willing to coöperate in prolonged feeding experiments, similar to the short ones conducted by Dr. Wiley and by the Referee Board. Acceptable reward in the way of well prepared food of sufficient variety would attract volunteers. If additional inducement were necessary, shortened term of service would probably appeal to many. And in the face of the fact that every civilized country is prepared to sacrifice thousands of its most virile citizens for the honor of its flag (and its foreign trade), the sentiment against endangering the health of a handful of men in the interest of all mankind is not particularly intelligent.

Primitive man must have learned what was safe to eat on the basis of costly experience, and it is still only by experience and experiments that we can hope to solve the new problems, which have arisen out of the discovery that it is possible to preserve perishable food materials by means of a variety of cheap,

but more or less dangerous chemicals. While we may well hesitate to commit ourselves one way or another on a problem of so great importance from the standpoint of economics and of health, we must recognize that it is a problem which must be solved, and that it cannot be solved by mere argument and discussion.

While there is still abundant room for differences of opinion as to the legitimate (or useful and safe) employment of chemical preservatives, the addition of dangerous chemicals to food products for no other purpose than to hide inferiority is a practice which, from the standpoint of the consumer, has nothing to recommend it. Take for example the notorious case of bleached flour which has been before the courts for the last four years. One of the natural and more or less reliable indexes to the baking quality of flour is its color. The only

purpose of the bleaching was to make the flour from dark wheat look as white as the best patent flour. To accomplish this purpose had been the aim of commercial chemists for many years, and they finally succeeded. The reward for their success was contributed by the consumers of the bleached flour at the rate of from fifty cents to a dollar extra per barrel.

This " artificially aged " flour, as its owners and defenders liked to call it, was produced by mixing the flour with a very poisonous gas called nitrogen peroxide. The flour absorbed this gas as a sponge absorbs water and instantly became white. The millers themselves, and in fact the leading attorney for the millers, had probably never been thoroughly informed as to the nature of their bleaching process. The nitrogen peroxide which they used was prepared in their mills electrically, and they endeavored to make out that they had simply mixed the flour with air which had been electrically

purified, somewhat in the same way as a thunder storm is held to purify the atmosphere. What they were really using, however, was nitrogen peroxide, which is equivalent to a mixture of nitric acid and nitrous acid, both very poisonous. The addition of the bleaching agent had to be regulated with great care, for if too much was introduced the flour turned yellow and became wholly unfit for food. This fact was interpreted by the promoters of the process and their attorneys as a natural and effective protection for the consumer!

After some preliminary seizures of bleached and over-bleached flour by the Government, a legal contest over the subject was begun in Kansas City, the center of the bleached flour district, in 1910. The millers and the owners of the patented bleaching process lost their case, but promptly appealed. In the course of time the circuit court reversed the decision, and in the course of more

time the United States Supreme Court decided that the trial judge in Kansas City had made an error in his charge to the jury, and ordered a new trial.

The fatal legal error committed by the trial judge according to the Supreme Court decision consisted in interpreting one paragraph of Section 7 of the Pure Food Law as meaning that any article of food which contains added poisonous or other added deleterious ingredient is adulterated, whereas the paragraph in question says that any food article which contains " any added poisonous or other added deleterious ingredient *which may render such article injurious to health* " is adulterated. Notwithstanding the fact that " other parts of the charge (to the jury) seem to recognize that in order to prove adulteration it is necessary to show that the flour may be injurious to health," the Supreme Court decided that the charge was " misleading " and ordered a new trial.

The decision of the Supreme Court has been interpreted as virtually nullifying altogether the Pure Food Law. It has been construed to mean that the Government is now compelled to prove by more direct evidence than heretofore that a given food product containing a given added ingredient is poisonous or injurious to health, because of the presence of the added injurious substance, — in other words, that the Government must be able to produce demonstrably injurious effects by feeding experiments with the adulterated food. If that is the consequence of the decision, the Pure Food Law is indeed " dead."

The amount of the poisonous substance, nitrogen peroxide, in bleached flour is very small, and is not sufficient to render such flour, or bread baked from such flour, poisonous in the ordinary meaning of that term. The amount present is entirely too small to produce any such violent effects. Such is prac-

tically always the case in the application of dangerous chemicals to food products. The amounts present are always so small that it is practically impossible to secure concrete and legally convincing instances of any one being made sick from the consumption of the food. Dr. Wiley may have been able to secure such concrete results in the early period of his crusade against the manufacturers of adulterated foods; but, thanks to his efforts, the manufacturers have learned to be more careful, and now it is no longer possible to " poison " a person by means of reasonable amounts of adulterated food. This is the opening of escape into which the attorneys for the defense always try with all their skill to steer the jury. Every expert is challenged to tell how many persons he has seen, or has treated, who had become ill from eating the product involved in the suit.

It is, I believe, a generally accepted precept of pharmacology that the poi-

sonousness of a drug or chemical is always as much a question of the amount, as of the kind of substance used. There is no known chemical poison whose effect is so deadly that a person cannot take a little of it without suffering any serious consequences. If this were not so, such poisonous chemicals could not be used for medicinal purposes.

While this is unquestionably the correct position, so far as producing demonstrably injurious effects in a relatively short time is concerned, it is, I think, not a theoretically sound position, when it becomes a question of the consumer's being called on to take the drug or chemical to the end of his days. Here it is not a question of being poisonous, but rather of being merely injurious to health. And here we are, in my judgment, bound to take the position that any substance known as a poison must be assumed to be injurious to health, even when taken in the smallest doses,

unless we have definite and specific reasons for believing that it fails to have *any* effect when the dose is minute. Hydrochloric acid, common salt, and possibly acetic acid, benzoic acid, and alcohol might be named as substances which are poisonous in large amounts, but which may be regarded as harmless if the amounts taken are sufficiently minute. In the case of most dangerous chemicals it is, I think, neither safe nor sound public policy to assume that they may be made ingredients of our daily food even though the quantities used may be small as compared with the doses capable of producing demonstrable results. So long as failing health before old age is as common as it is, we cannot afford to extend the benefits of reasonable doubts to any poisonous or deleterious ingredients added to our food.

The bleached flour decision does not necessarily imply that the Government must prove the consumption of an adul-

terated food product the cause of the consumer's sickness. The phrase " may render such article injurious to health " can just as well be interpreted as throwing the burden of proof on the manufacturer of foods containing added chemicals. In fact, I think that the Bureau of Chemistry made a mistake in ever assuming the burden of proof, as Dr. Wiley did in so many of his bulletins on chemicals in food products. In the interests of the public it should be enough to show that adulterated foods contain added poisonous or deleterious ingredients, and to insist that the presence of such admittedly injurious substances of necessity renders the product containing them injurious to health, unless the defendant can show that in the case of his particular adulterated product the injurious added chemical in the quantities used cannot render the product injurious to health.

The bleaching of flour with nitrogen

peroxide is a conspicuous example of the heroic measures that are taken for the essentially useless purpose of modifying the natural colors of food products. It is conspicuous, however, only because the food material involved is the most important of all food materials, and because the chemical used happened to be one of which the poisonous character had never been disputed. It is unique in no other respect. The practice of applying to food products any and all highly colored chemicals, from the innocuous caramel through the entire realm of the numerous coal-tar products (the aniline dyes) down to arsenic, is a practice which, however general and however clever it may be, is without intrinsic merit and might very well be prohibited. That practice rests on the assumption that the people are and will remain as gullible as little children to whom painted glucose seems something almost, though not quite, too good to eat.

The Referee Board issued a bulletin a short time ago (1913) with reference to the inexcusable practice of coloring certain vegetables, such as peas, beans and asparagus with the germicide, copper sulphate. For hundreds of years the people of Europe have carefully tinned their copper cooking utensils to avoid being poisoned by the green copper compound, verdigris; though it must also be admitted that in certain sections of Europe vegetables have been cooked in untinned copper vessels in order to make the cooked food green. The Referee Board finds that the copper is absorbed and accumulates in certain tissues, and that even such small amounts of copper as one one-hundredth of a gram may have deleterious action and must be considered injurious to health.

Silver salts are stronger germicides than the salts of copper, yet the candy makers have defeated before the courts the endeavor of the Government to ex-

clude metallic silver coatings on candy. The Government was of course unable to sustain the burden of proving that the silver as used is deleterious to health, and the manufacturers were given the benefit of the doubt.

The process of educating the mass of the people to the point where they cannot be deceived into accepting color as a substitute for flavor must of necessity be a slow one. The attractiveness of the " fresh green color " of canned peas and beans is gone only to the person who knows something about the copper salts. Highly colored jellies, fruit juices and ices will continue to appear appetizing until one begins to speculate as to how the dyes which they contain will color the digestive tract and how long they will remain there. Whether Mr. Barnum's or Mr. Lincoln's estimate of the people be correct, the market for adulterated food will remain good for a long time, unless the Government succeeds

in closing it. It is clear that the market for fraudulent articles cannot be closed on the basis of the present Pure Food Law.

The outcome of the bleached flour litigation illustrates once more the difficulty in securing appeal-proof legislation where there is a conflict between special interests and the public welfare. A general law like the Pure Food Law, the application of which to special cases must be secured through the courts, is of necessity inadequate, because the courts cannot take cognizance of the intrinsic merits of the case. No matter how useless or preposterous in spirit and purpose a given blending of food and chemicals may be, by the time the case comes before the courts the practice represents certain "rights of property," and against such rights the intrinsic worthlessness or even viciousness of the practice has virtually nothing to do with the decision rendered by the court.

Effective legislation on the use of chemicals in food products can be obtained, I think, only by making the laws regulating their use as detailed and specific as the tariff. Moreover, to prevent conflict between property rights and the interests of the public, and to keep the law from constantly falling "behind the times," it should not consist of a list of prohibitions, but should rather comprise a series of permissions formulated as exceptions, under a general law to the effect that no chemicals or drugs of any kind whatsoever may be added to any article of food. By means of such regulations it would be possible to protect the now helpless public against the boldness, restlessness, and ingenuity of commercial "food chemists" and their employers. Permits for the use of new combinations of proved merit could be issued under some such conditions as now prevail with regard to the issue of patents.

I have not attempted to go into details or even to give a list of the chemicals used in foods, or of the food products with which they are used. I have said nothing about the substitution of cheap chemicals for high-priced natural flavoring extracts, nothing about substituting dilute acetic acid or even mineral acids, for genuine vinegar, nothing about alum or saltpetre, nothing about substituting one pound of the coal-tar product, saccharin, for five hundred pounds of sugar, nothing about paraffin polish on rice, or about painters' shellac on candy — not to mention scores of other well known and strictly objectionable devices.

To sum up the problem of the use of chemicals in foods:

1. We need preserved foods, now more than ever, and there is therefore a legitimate and highly important field for the application of suitable chemicals, (if such preservatives can be found)

to foods which would otherwise be wasted.

2. Benzoic acid and sodic benzoate are the most promising of the modern chemical preservatives, though we are not yet justified in saying that they are strictly harmless.

3. Competent and disinterested experimentation with different chemical preservatives is much needed, and should be encouraged.

4. It is not clear that the use of even a somewhat harmful preservative might not on the whole be desirable in the case of certain products, which, without the use of a preservative, would be eaten in various stages of decay.

5. The use of chemicals in foods for coloring purposes is essentially barbarian, and both this and all unnecessary addition of chemicals to foods for purely commercial ends might with advantage be altogether forbidden.

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