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Bulletin No. 87.

January, 1906.

Department of Bacteriology.

Oregon Agricultural Experiment Station.

CORVALLIS, OREGON.

CANNING FRUIT AND VEGETABLES, PRESERVING FRUIT JUICES.

By E. F. PERNOT.

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1906
Oregon Agricultural College Press
Corvallis, Oregon

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Canning Fruit and Vegetables.

BY E. F. PERNOT.

The art and science of canning fruit, vegetables and other perishable food stuffs, is to preserve them, as near as possible, in their natural condition.

The material should retain its original flavor, color, odor and structure; in fact, when a can is opened, its contents should be unchanged from the condition in which nature produced it.

Unfortunately, the problem has not been wholly solved, although much work has been done and will yet be done to accomplish this end.

The present method of canning on a commercial scale, has forced the adoption of an extremely high temperature, in order to destroy the spores of organisms which act as decomposing agents on the material. The temperature ordinarily used is from 230 degrees to 250 degrees F., and the length of time which this high temperature is maintained is from 20 to 30 minutes.

This processing answers the purpose for some kinds of material, such as: meat, fish, bivalves and certain vegetables, especially fish, in which it softens the bones to about the consistency of paraffine, rendering the smaller ones edible, but for fruit and most vegetables it is detrimental, for it destroys the delicate tissue, causing the material to become "mushy," especially when transported long distances; the plant albumen becomes coagulated and much of the flavor is destroyed by the driving off, or volatilization of the essential oils; this is more pronounced in some vegetables than in others. The commercial canned goods have a very different odor and flavor from the fresh material, which is mostly due to the extremely high temperature at which they are processed.

With the aim in view, of possibly raising the quality of canned goods, experiments with different temperatures, in canning, and a study of detrimental organisms, has been carried on for two years, and the results, both good and bad, are herein recorded.

Micro-organisms, not unlike all other plants, possess the power of self-preservation and of perpetuating their kinds; one is by means of producing spores, or seeds, which are very resistant; while others, which do not produce spores, have a resisting power nearly equal to that of spores.

In the latter-mentioned, the germ itself, which is termed the vegetative cell, it is usually destroyed by an exposure, for a few minutes, to a temperature of 160 degrees F., while its spore would resist boiling heat for a much longer time.

In canning material for food the spore-bearing varieties usually cause the most annoyance, and the object of this experiment was to find a means of destroying both germs and spores, at a temperature not injurious to the structure, flavor or color of the material being canned.

The operations consisted of cleaning the cans by means of a brush, using hot water to which an alkaline washing powder had been added; this removed any trace of acid soldering flux, or free lead or tin; after cleaning, the cans were steamed over a steam jet, to remove any dirt or impurity which might remain.

The vegetables, such as peas, beans, asparagus, etc., were well washed and placed in the cans, completely filling them; water was then added to fill the interstices, cap placed in position on can and soldered, leaving the vent open; the cans were then placed in a wooden steam chest and heated until the thermometer registered a temperature of 165 degrees F., in the center of the cans; this temperature was maintained for fifteen minutes.

The cans were then removed from the chest and vents immediately closed by soldering.

After being allowed to stand for twenty-four to forty-eight hours, the cans were again heated as before, and the operation repeated for the third time; after which, the content of the can was sterile.

This is sterilizing by intermittent pasteurization, the principle of which is to destroy the vegetative cells by the first heating; most of the spores then germinate into cells during the first intermission and are killed by the second heating; should any spores remain after this second heating they

germinate during the second intermission and are destroyed by the last heating.

In this way vegetables and fruit may be sterilized in cans, leaving them practically in their natural condition.

Fruit containing pits could not be preserved in this manner without first removing the pits, as there would be danger of their germinating when kept in a warm atmosphere.

Perhaps this method of canning could not readily be adopted by establishments where large numbers of cans are filled daily, owing to the additional expense and space required in handling them three times; yet, this would be partly counterbalanced by the requirement of less fuel for steam production, and using not so expensive retorts; still it would be too expensive for ordinary commercial goods which are placed on the market at such low figures; but for a high-priced first-class article, the superior quality would warrant this additional expense, and we could have upon the market a grade of goods far above those ordinarily found.

Each and every kind of material to be canned requires treatment peculiar to itself. All kinds of fruit and vegetables cannot be placed in cans and sterilized with equally good results, without previously preparing them.

Some vegetables, especially, are much benefited by blanching, as practiced in some canneries, as it removes dirt and all gummy substances which teem with bacteria; the strong, crude taste is also removed, making the material much more delicate.

Blanching consists of dipping the vegetables into boiling water, to which a small amount of salt has been added, until they are softened, then quickly cooling in cold, running water, where they regain their firmness.

Prior to canning the different fruits, they are treated in various ways. They may merely be placed in cans, then covered with boiled water, sealed and sterilized, or, syrup may be added instead of water, the syrup varying in strength from 30 per cent. to 40 per cent. sugar.

A proper degree of ripeness of the fruit and vegetables is an immensely important factor to be considered in canning products which are intended to be first-class.

Corn and peas, under-ripe, go too much to liquids when heated, leaving empty, untempting hulls in the can; besides this, very young corn and peas are more watery, not having acquired their flavor, nor nutritive value, and they are highly susceptible to fermentation.

Corn, cut from the cob, can remain in bulk but a very short time without fermenting or souring, especially in warm weather, for nature's protection from the action of organisms has been removed and an ideal culture medium exposed.

The same may be said of peas. A fermentation, so slight as to be undetectable, means an enormous multiplication of the organisms which cause it, with a corresponding loss of some valuable constituent of the food, and a production of ptomaines detrimental to the can or to the digestive tract of the consumer.

On the other hand, if corn and peas are over-ripe they become farinaceous, lose their delicate flavor and form a turbid liquid in the cans, so that, the same good judgment used in selecting material for the table, should be exercised in the matter of canning.

Canning being the process of preserving food in its succulent form by destroying germs which infest it, and of protecting it from further invasion, it necessarily follows that cleanliness is essential and that only sound and pure material should be used.

The water or syrup used should be sterile in order to avoid adding many varieties of germs which are not already in the material.

These germs are the lowest forms of plants; they are infinitesimally small, and their spores yet smaller, so that their actual size cannot be conceived.

Water, which is apparently pure, frequently contains fifty thousand of them to the cubic centimeter.

The amount of water necessary to complete the filling of a two-and-one-half pound can of material is about two hundred cubic centimeters; this would add to the contents of the can ten million more germs unnecessarily; besides the danger of introducing varieties which might carry toxic products; therefore, all liquids should be boiled before they are added

to perishable material, even a salt brine should be boiled before using.

We find upon investigation that all material used for canning contains organisms; there are many varieties, some are saprophytic only utilizing the material after life is extinct or growth ceases; while others are parasitic, growing upon living matter; each vegetable appears to have some organism which makes that particular vegetable its normal habitat.

A green pea aseptically taken from a freshly opened pod and placed in a fermentation tube containing suitable culture media, generally gives rise to a strong bacterial growth, or fermentation, with the production of gas; this growth is much more pronounced when the pea contains a young weevil larvæ.

Most of the peas so tested caused a growth always accompanied by the production of gas.

The medium used was the juice from crushed pea pods diluted with water and sterilized in the autoclave at 240 degrees F., for 30 minutes.

There seems to be no doubt but that the presence of weevil larvæ in fresh peas injure their keeping qualities after being picked, and make them more difficult to preserve in cans.

To produce a first-class article, peas must be canned soon after they are shelled, as they are very susceptible to fermentation accompanied by the production of heat.

Green corn has also its parasitic and saprophytic organisms which are similar to those in peas, some being identical.

The culture medium used for growing those from corn, was water in which sweet corn was boiled after being crushed, then filtered and sterilized.

Organisms, taken from swelled corn and pea cans, grew equally well in either of the media.

In fermentation tubes containing bouillon with 2 per cent. grape sugar, they grew fairly well, but not so luxuriantly and produced less gas.

The only variation detected in the organism, when grown in different material, was in its morphology.

When taken from an old can of spoiled corn, the bacilli were much more curved than those taken from spoiled peas; the same peculiarity occurs when artificially grown in corn

or pea media.

In all the swelled cans that were opened, both of corn and peas, the same organism was found.

It is an obligate anaerobe, *i. e.*, one which grows only in the absence of air; it readily forms long, oval spores which are situated near the end of single rods, and are very resistant to heat, its microscopical appearance and cultural characteristics are identical with *bacillus spinosus*, as described by Sternberg and Chester.

Cultures and smear preparations show that the organism is on the material before it is placed in the can, but there is nothing to indicate that it has a parasitic existence, or that it causes any injury to the plant while growing.

This organism produces gas while growing in the can and thrives best in the presence of its own gas.

One of its spores, having not been killed by the heat used in sterilizing, will eventually grow, and its vegetative cells multiply, producing gas to such an extent as to swell the can and ruin the material as an article of food.

Some of the cans in this experimental work gave no signs of deterioration for six months or more, after which time they began to swell, while others swelled after a few days.

This indicates that the spores, instead of being killed by the heat used, were only attenuated to such an extent as to be able to recover their vitality, and germinate long afterwards.

Upon this one point hinges the most essential factor in successful canning; no matter what process or temperature is used, *the spores must be destroyed beyond all possibility of germination.*

The liquid in a can transmits the heat more readily than does the solid, hence the necessity of obtaining a reading of the temperature of the most dense part of the material in the can content, and unless they are subjected long enough to the proper heat, they will not be destroyed.

All of the tomatoes, green beans, wax beans, cauliflower, asparagus and cherries, canned by this method, kept perfectly, and are what may be considered the highest grade of canned goods. They have retained their natural color, flavor

and texture; the beans, when taken from the cans, may be broken as when they are fresh.

Some beans were canned in glass jars, but these jars can hardly be recommended owing to the difficulty of keeping them tightly sealed while heating the second and third time.

The beans taken out one year afterwards, were of the finest quality.

In this work some cans were filled with peas and some with corn, without adding water, so as to reduce weight and lessen shipping expenses; they were sterilized intermittently in the same manner as the others, but proved to be a failure, owing to an imperfect transmission of heat caused by the absence of water.

The canned corn and peas were a failure both years, even a temperature of 212 degrees F. for twenty minutes, three successive days, failed to sterilize all of them; the only explanation for this is that corn and peas carry the bacilli previously mentioned, spores of which are so resistant to heat that they are not killed by the first heating, but are so attenuated as to prevent their germination in the intervals between the heatings, consequently they remain in the can as living spores and germinate after they have overcome the injury received by the heat.

Other lots were heated once to 240 degrees F. for thirty minutes and have all kept, but the material is of an inferior grade.

Considerable work was done to ascertain the thermal death point of this organism and its spores.

Sterilized test tubes containing corn and peas, taken from spoiled cans, were placed in the autoclave and heated to different temperatures for various lengths of time, beginning with 160 degrees F. for ten minutes and increasing to 200 degrees for thirty minutes for three successive days.

After removing from the autoclave a portion of the material was placed in fermentation tubes containing sterile media, by the aid of a sterile platinum loop; the tubes were then incubated, and in time gave a strong bacterial growth. Even some of those which were heated to 200 degrees for thirty minutes.

The temperature was determined while heating in the autoclave, by removing the regular thermometer and replacing it by a long, slender one, which passed through a cork into a test tube containing some of the same material as was being heated.

The tests were repeated with the same results by the use of a water bath and thermometer.

The samples tested, which were known to contain spores, (determined by smear preparations) nearly all survived the heating, while most of those which only contained the vegetative cells, were killed; this seemed to correspond with their behavior in the cans.

After some kinds of commercial material has been canned for a long time, it is found that there is a change in the flavor, which is often due to the actions of enzymes.

These enzymes are soluble or chemical ferments, sometimes produced by bacterial action on the material before it is canned, and are sometimes a natural part of the material.

The reaction is similar to the ripening of cheese or the aging of wine, and is not always detrimental to the product.

On the other hand, such material as canned minced clams, improve by age.

When they are freshly canned by a high temperature the heat contracts the fibre, forcing out the liquid, leaving it like minced rawhide, a condition in which it is very indigestible; but the longer the cans are allowed to stand the more the liquid is re-absorbed by the fibre, softening it to its normal condition.

In home canning, every matron has her own method, yet all methods resolve themselves into the essential principles of destroying all the organisms and spores, and of protecting the material from further infection. Another essential is, to do this at as low a temperature as possible.

It is within the province of this bulletin to say something of ptomaine poisoning in its relation to canned goods.

The general acceptance of the term "ptomaine" is erroneously construed as being poisons occurring in canned goods and other foods; but it is a broader term, covering all bacterial excretions, and as all material is more or less acted

upon by organisms, it necessarily contains ptomaines.

There are certain varieties of micro-organisms, which produce *poisonous* ptomaines, either while acting alone on material, or associated with others, but they are in the minority, and produce poisons under certain conditions only.

The poisonous ptomaines are toxins, which produce toxic effects when taken into the system with food; these toxic ptomaines or tox-albumens are elaborated by the activities of certain bacteria, while they are growing and feeding upon plant or animal matter, either raw or cooked, and are designated principally by the material upon which the organisms are acting. After these basic alkaloids are once produced they are not easily destroyed by subsequent cooking; hence the danger of partial decomposition of food material, either before it has been canned, or after removal from the can.

There are organisms such as bacillus of cholera, bacillus of tetanus and bacillus of typhoid fever, which form toxic ptomaines while growing in the human body as parasites, but they are not known to produce the same poisons in food material.

These organisms are the specific cause of the diseases mentioned and gain entrance to the human body through various means, but rarely through the ingestion of cooked, or canned food.

Then there are several varieties of putrefactive organisms which produce ptomaine poison in canned meat, head cheese, fresh pork, fish and other animal matter, both raw and cooked.

If when growing in head cheese, or in canned meat which has been long out of the can, these organisms are taken into the stomach of susceptible individuals, the body acts as an incubator, increasing their growth and elaboration of toxine, causing ptomaine poisoning of a more serious character than when only the toxic poison has been taken. Head cheese is particularly conducive to the growth of these germs, because the interstices between the meat are filled with a moist gelatinous substance from pork which seems to favor their growth.

A peculiar feature of ptomaine poisoning is, that the ma-

terial containing a dangerous amount of the poison, or germs which produce it, show but little or no indications of its presence.

Specimens of pork chops and head cheese received at the laboratory and which were known to have caused severe illness in individuals who partook of them, gave no indications of their containing a dangerous poison nor organisms which produce it, neither by discoloration, odor nor breaking down of tissue, yet the microscopical examinations showed the specimens to be permeated with bacilli.

Just why certain varieties of these organisms infest meat sporadically and not more frequently is but mere conjecture.

The cause of ptomaine poisoning may frequently be traced to carelessness, through the utilization of products which are not marketable owing to partial decomposition.

Ice cream has been known to cause ptomaine poisoning because it has been allowed to melt, and after remaining in that condition for some time, is mixed with fresh material and again frozen. Such economy is dangerous, because during the period which it remains in a melted condition an excellent media is offered for the growth of germs which produce toxalbumens, and the subsequent cooking, or freezing, does not destroy the toxins.

Canners are sometimes unjustly held responsible for goods which cause ptomaine poisoning, when in fact it is the consumer's carelessness in allowing germ action to occur in the material after the can has been opened.

On the other hand, some of the canning establishments should be censured, if not punished, for placing upon the market goods which have been processed a second time.

All canneries sustain a loss of a percentage of their goods through one cause or another, either from insufficient heating, or more frequently from defective cans which are not air-tight. When the can is cooling there is a partial vacuum formed, which draws air into it through the leak, and inoculates the material with organisms; putrefaction or fermentation at once begins, and after a time the cans show evidence of decomposition by the liquids oozing out, or by swelling. The latter also occurs when insufficient heat is used to destroy

the spores of organisms previously contained in the material.

By the time the germs have produced enough gas to swell the can, and if they are of certain varieties, sufficient toxic poisons will be produced to render the material dangerous for food.

In some canneries, when cans are noticed to have swelled, they are punctured to allow the gas to escape, then exhausted, sealed and reheated.

The contents of cans which have swelled, should be thrown away and not offered for sale as food.

The regular vent in cans is usually a small puncture in the center of the cap, which in the process of canning is closed with a drop of solder. A can having more than one puncture frequently marks it as having been reprocessed and therefore dangerous.

There are other causes which permit toxic ptomaines to be produced in canned goods for which the canner is not wholly responsible.

Cans with defective tinning, in time become perforated by acids of various kinds which attack the iron, resulting in punctures of microscopic dimensions through which air passes into the can carrying with it micro-organisms, and the result is a putrefaction or fermentation.

Metal poisoning from eating canned goods is sometimes the result of acid bacterial products, fruit and vegetable acids acting upon the tin, or by lead contained in the solder used in making the can.

Muriate of zinc, (solder flux) occasionally finds its way into cans when carelessly used in soldering the cap, and copper sulphate is used by some canners for the purpose of fixing the green color in vegetables.

Preserving Fruit Juices.

This state is rapidly becoming famous for its production of fruit, especially of apples, and wherever apples are raised in abundance, there is always a percentage not marketable; consequently, there are thousands of bushels annually wasted, whereas the utilization of these waste products would go far toward defraying expenses of maintaining the orchard.

There is no more wholesome beverage than sweet cider, but the question of keeping it sweet without the use of preservatives, has prevented its being more generally used, yet this may easily be accomplished as demonstrated by the experimental work which has been done, and is as follows:

Take clean quart bottles, preferably beer bottles, fill them with cider fresh from the press, leaving all of the neck of the bottle empty for an air space; then place the bottles in a steam chest so that the steam when turned on will circulate freely all around them; next, steam or scald with boiling water, good sound corks, and leave them in water until needed; then, fill one bottle with cider, place it in the steam chest close to the top where a hole is provided to admit a long thermometer which passes into the bottle, so that the mercury bulb reaches about the center; the other end extending above the steam chest will show the temperature of the contents of the bottle.

When all the bottles are in place and door closed, steam is turned on and the temperature of the material raised to 160 degrees F., as indicated by the thermometer which may be seen without opening the door.

This heat is maintained for ten minutes after which the bottles are immediately corked, and corks tied down.

After twenty-four hours, the bottles are again heated to the same temperature, and the operation repeated the next day for the third time.

The air space in the neck of the bottle allows for expansion, which prevents bursting of the bottles.

If the bottles are to be stored in an upright position, the corks should be dipped into hot canning wax after heating the last time. If they are laid down, this is not necessary,

because the fluid keeps the cork swelled and air-tight.

No particular style of steam chest is necessary—the one used in this work was made with a frame of 2x4 studding, to which was nailed matched lumber 1x3; the door was made of the same material, and of the size of one entire side.

The chest measured 72 inches high, 44 inches wide and 39 inches deep.

Steam was admitted to the chest by a $\frac{3}{4}$ -inch pipe passing through the side wall, near the bottom, reaching to about the center; an elbow was placed on the end of the pipe, with the opening down, to distribute the steam by first striking the floor of the chest.

Inside the chest there were three trays with coarse screen wire bottoms, to allow the steam to circulate; it was found necessary to turn on a good head of steam to equalize the temperature throughout the chest.

This treatment will sterilize the cider, or any fruit juice, without changing its flavor, or imparting a cooked taste, and it will keep sweet indefinitely.

If the cider is filtered through felt, or asbestos, in order to remove all suspended matter, the annoyance of having sediment in the bottom of the bottles will be overcome.

It is essential to bottle and sterilize the material as soon as possible after it is taken from the fruit, as there are less yeast cells, and other organisms in it at that time.

After standing twenty-four hours or more before bottling, they will multiply into millions, and not only are there more to destroy, but the enzymes formed during their growth, will not be destroyed by heating, and gradually react on the material, changing its flavor in time.

To do this work on a large scale, it would be advisable to use at least three steam chests, to obviate the necessity of so much handling of the bottles, each chest could remain closed until after the third heating.

For home use, where steam is not available, a wash boiler could be used, it should contain a small amount of water, and be provided with slats to prevent the bottles from touching the bottom; a tightly fitting cover must be used to retain the steam, so that the neck of the bottles will be sterilized.

LIST OF BULLETINS

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Address JAMES WITHYCOMBE,
Director of Experiment Station, Corvallis, Oregon.