

ARVILL BITTING

EXPERIMENTS ON THE
SPOILAGE OF TOMATO
KETCHUP

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Spoilage of Tomato Ketchup**

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A. W. Bitting

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LETTER OF TRANSMITTAL

*U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., July 15, 1908.*

Sir: I have the honor to submit for your approval a report made by Inspector Bitting of experimental work on the spoilage of tomato ketchup, the conditions contributing thereto, methods of prevention, the action of preservatives, and the length of time that the product will keep under varying conditions of manufacture and temperature, both before and after opening. Every effort has been made to conduct the work in a practical way, and the results obtained can not fail to be of interest and profit both to the manufacturer and consumer. I recommend that this report be published as Bulletin No. 119 of the Bureau of Chemistry.

Respectfully,

*H. W. Wiley,
Chief.*

Hon. James Wilson,
Secretary of Agriculture.

INTRODUCTION

The tomato, *Lycopersicum esculentum*, is supposed to be native to South or Central America. The large fruits commonly used grow only under cultivation, but the variety with small, spherical fruits, known as *L. cerasiforme*, has been found on the shore of Peru and is considered by De Candolle¹ as belonging to the same species as *L. esculentum*. Though grown extensively in Europe, there is nothing to indicate that it was known there before the discovery of America. The tomato was introduced into China and Japan at a comparatively recent date. De Candolle is of the opinion that the tomato was taken to Europe by the Spaniards from Peru and was later introduced into the United States by Europeans. Tomatoes were brought to Salem, Mass., by an Italian painter in 1802,² who is said to have had difficulty in convincing the people that they were edible. They were used in New Orleans in 1812, though as late as 1835 they were sold by the dozen in Boston. After 1840 they came into general use in the Eastern States, but it was later than this before tomatoes were used freely in the Western States, many persons having the impression that, since they belonged to the nightshade family, they must be unwholesome. The extent to which tomatoes are used at the present time shows how completely this prejudice has been overcome.

The name *Lycopersicum* is from two Greek words, meaning a wolf, and a peach, the application of these terms not being apparent; the name of the species, *esculentum*, is from the Latin, meaning eatable. The common name "tomato" is of South or Central American origin, and is believed to be the term used in an ancient American dialect to designate the plant,³ but its meaning is unknown. The English call the tomato "love apple," which in French is "pomme d'amour."

The tomato is considered a typical berry, the ovary wall, free from the calyx, forming the fleshy pericarp, which incloses chambers filled with a clear matrix containing the seeds. The fruit measures from 1 to 5 inches in diameter, and is red, pink, or yellow when mature.

The plant sports freely, producing many varieties, which differ mainly in the size, shape, and quality of the fruit. The varieties bearing small fruits are *L. cerasiforme* and *L. pyriforme*, each bearing a two-celled fruit, the former being round, and somewhat larger than a cherry, and the latter pear-shaped. These small tomatoes are used ordinarily for preserves and pickles.

The word "ketchup" is adopted in this bulletin as the form which ought to be given preference. The derivation of the term is not definitely known. The spelling "catchup" given in some of the leading dictionaries appears to be based on the erroneous idea that the first syllable "ketch" is a colloquial form of "catch." Several authorities derive the word from the East Indian or Malayan "kitjap," because "ketchup" was originally a kind of East Indian pickles. Some give the word a Chinese origin, while others assert that it comes from the Japanese. A majority of the manufacturers employ the word "catsup," a spelling for which there does not appear to be any warrant.

¹ Origin of Cultivated Plants, 1890.

² Webber, H. J., Yearbook, U. S. Department of Agriculture, 1899.

³ U. S. Dept. Agr., Exper. Sta. Record, 1899-1900, 11: 250.

PROCESS OF MANUFACTURE

The making of tomato ketchup consists essentially in reducing tomatoes to pulp, removing the skins, seeds, hard parts, and stems, adding salt, sugar, condiments, and vinegar to suit the taste, and cooking to a proper consistency. The methods and practices of the various manufacturers differ, and the difference between the best and the poorest procedure corresponds to that between the best and the worst ketchup. No single factory has all of the best methods at every step of manufacture. Some perform certain details well and are negligent in others. In some, large amounts of money are spent on equipment to improve a particular point considered advantageous by the trade, while other details essential to the making of a good-keeping ketchup are disregarded. A statement of the best practice as observed at a number of factories, together with some facts obtained from experiments, will be given.

SELECTION AND PREPARATION OF STOCK

The tomatoes should be home-grown, of a red variety having the minimum of yellow and purple color, be picked when ripe, and delivered to the factory promptly without mashing. All tomatoes should pass over an inspection table, the rotten and otherwise unfit fruit should be discarded, and the green tomatoes should be returned to crates to ripen. The stems should be removed when the best color is desired, and the tomatoes should be thoroughly washed to remove dirt and mold. Dumping a crate of tomatoes into a hopper of dirty water and playing a gentle spray of water on part of them merely wets the skin and makes them appear bright.

PULPING

The clean tomatoes should be conveyed to the steaming tanks and subjected to steam heat until the skins burst and the meat softens. After a short heating the tomatoes should be run through a “cyclone” where the skins, seeds, etc., are removed and they are rubbed to a pulp. To remove very small particles and fiber, the pulp may be run through a sieving machine at once; or, if ketchup of the smoothest possible kind is to be made, this procedure should be delayed until after the cooking. The pulp is collected in a receiving vat, and only such an amount should be provided in advance as will keep the kettles full, as it is better to stop the tomatoes before going to the washer than to have the pulp stand for some hours. In common practice, however, the pulp is either sent to the cooker at once, or it is allowed to stand and partially separate. If tall casks are used for this separation the solids will rise to the top and the clear watery portion is drawn off at the bottom, or the pulp may be strained through cloth bags. The object of this separation is to secure greater concentration of the solids, retain a brighter color, and shorten the time of cooking.

COOKING AND SEASONING

The cooking may be done in copper kettles, as shown in figure 3, though these are being superseded by enamel tanks containing silver-plated coils in order to secure the brightest color. By using the latter the discoloration due to the splashing of the contents against the walls of the copper vessel is avoided, and economy of space is secured. Whole or ground spices, or acetic acid or oil extracts of the spices may be added to the pulp in such proportion as the particular brand demands. The spices most used are cloves, cinnamon, mace, and cayenne pepper; but paprika, pepper, mustard, cardamon, coriander, ginger, celery, and allspice are used by some manufacturers. When whole spices are used, it is the practice to suspend them in a cloth bag or a wire basket and to take them out after boiling. They tend to darken the color of the ketchup, a result considered undesirable by some. The ground spices are used sparingly, with the exception of cayenne pepper. The acetic acid extracts of spices are used because they are economical and give a brighter red color than is obtained with the whole spice. The oil extracts produce no discoloration, but they are the most expensive and give an objectionable flavor. Hungarian sweet paprika is now quite largely used and adds to the color as well as to the flavor. Sugar, salt, and vinegar are added in such proportion as may be desired, and in some brands onions and garlic are used.

EVAPORATION AND FINISHING

The pulp is evaporated rapidly to such consistency as the grade and price will warrant, the reduction in volume being from 40 to 60 per cent. This is accomplished in about forty-five minutes. The cooking is not continued longer than is necessary, as each minute added to the cooking darkens the finished product.

If the pulp has been run through the sieving machine before cooking, the batch may be drawn off into the receiving tank for bottling. If the finishing be done after cooking, the pulp is run into a receiving vat, finished as quickly as possible, and drawn into the tank for bottling. The ketchup may be kept at a high temperature – 200° to 206° F. – in the receiving tank by means of a small steam coil, or it may be drawn to the bottling machine through a steam-jacketed tube. Finishing after cooking yields a slightly smoother ketchup than sieving before cooking; but it necessitates handling, reduces the temperature, and increases the chances of infection.

BOTTLING

The bottles should be thoroughly cleaned as ketchup will not keep if placed in bottles which have been merely rinsed to remove the straw; if the ketchup is not to be given an after process the containers should be sterilized. In the experimental work cork stoppers gave the best results and these should be sterilized in a paraffin bath at 250° F.

PROCESSING

An after treatment or process is given to bottled goods either in a water or steam bath, the important point being that the center of the bottle be raised to the desired degree of heat. If the ketchup is thin this can be effected quickly, but if it is thick and heavy the heat penetrates the ketchup with surprising slowness. In a thin ketchup the temperature may be raised from 140° to 190° F. in eighteen minutes or less when the surrounding heat is 195° F; but in a heavy ketchup it may take an hour or more to accomplish the same result. It is therefore very important that the ketchup be processed immediately after it is corked, before it has time to cool. The rate at which the heating is effected for different goods can be determined by sealing a thermometer in the cork and recording the readings.

CHARACTER OF PRODUCTS

FIRST-CLASS PRODUCTS

The factory at which the experiments were conducted has sanitary buildings and surroundings, the floors are of concrete for flushing, and the pipes used in conducting the pulp to the kitchens are porcelain-lined to prevent discoloration from the iron and to insure cleanliness. The tubes which carry the ketchup from the kettles to the receiving tank, finishing machine, and bottler are silver-plated. Not all of these measures are necessary to make a good ketchup, but they show the care exercised in making an article of good appearance and of the finest quality.

The conditions under which ketchup is made and the care with which the work is done at some of the better factories is equal to that used in the manufacture of any food product. Whole selected fruit is used, cleanliness is maintained at every point, the best grades of spices, vinegar, granulated sugar, and salt are added for flavoring, and the bottles are carefully washed. The ketchup put up under such conditions will have a bright natural color, will remain good as long as the container is unbroken, and will continue in that condition for some time after opening if kept at a fairly cool temperature.

INFERIOR PRODUCTS FROM “TRIMMING STOCK.”

In contrast with the strictly high-grade product is the great bulk of the ketchup found on the market. The material is not whole ripe tomatoes, but consists of the waste of the canning factory, commonly designated as “trimming stock,” including the green, moldy, broken, rotten, and generally unusable tomatoes, the skins, cores, and stems from the peeling tables, and the surplus juice from the filling machines, all of which may be allowed to stand during the day and be run through the cyclone in the evening. At the end of the season, the frosted and half-ripe fruits may be used. Part of this material can not be considered “sound fruit” as contemplated by the food and drugs act. The pulp is put up in barrels, preserved, and allowed to stand, possibly in the sun, until a sufficient quantity has accumulated for shipment. Old ketchup barrels may be used and be none too clean. As a result, it is not uncommon to see an inch or more of pulp in the bottom of a car at the end of shipment, caused by the blowing out of the barrel heads from fermentation. The sanitary condition of the factory may be poor, the handling of the goods be unclean, the spices be the refuse from the spice houses, the sugar be of the cheapest grade, and the bottles be only rinsed or be used without even that precaution. The ketchup is a concoction so heavily spiced with hot spices that the tomato flavor is lost and might as well be anything else. The color is normally dirty brown.

Between these two extremes are all grades, those for which whole tomatoes, unsorted, are used, those for which trimming stock is worked up promptly during the canning season, and those made from stock of unknown history. Some manufacturers work under good and some under poor sanitary conditions. There can be no doubt that with proper selection and precaution much of the by-product of the canning factory and large quantities of tomatoes which are unsuitable for canning might be used to advantage in the manufacture of ketchup; but it requires a nicety of practice not generally found at this time. The practice sometimes followed of making some ketchup from whole stock and a large quantity from refuse and using the former for advertising purposes, only serves to emphasize the fact that the goods belong to two distinct classes. One of the uses for a very considerable amount of pulp from refuse stock is the making of sauce for baked beans and other canned goods where the true character can not be observed by the consumer.

During the season tomatoes come in at times in larger quantities than can be made into ketchup promptly. The surplus must be worked up into pulp for storage and may be stored in barrels or in tin cans. The pulp stored in barrels will not have as good a color as that put into cans, and the ketchup made from either will not be as bright as that made from whole, fresh stock. The pulp put up in barrels is more liable to spoilage than that put up in cans. The difference in the cost of storage by the two methods is not very great, and some large concerns are using the can exclusively instead of the barrel.

LABELS

The labels on the ketchup bottles have been improved somewhat in the last year as regards exactness in describing the contents. Formerly, according to the labels, much of the ketchup was made from whole ripe tomatoes. The question was, What became of the enormous amount of ketchup which it was known had been made from “trimmings?” On this year’s ketchup the labels make fewer claims, generally merely stating that it is “tomato ketchup,” which is true whether made from whole tomatoes or refuse. The brand is in most cases the guaranty for good quality. It is not safe to judge the quality by the price, for, though usually good quality can not be expected unless the higher price is paid, some of the high-priced ketchup when placed under the microscope has proven to be a very inferior product.

The wide labels on the neck of the bottle are objectionable. Some of these are 2 inches in height, and serve to cover the discolored and spoiled ketchup. As spoilage begins usually in the neck of the bottle, it is difficult to see it when the neck is wrapped with a label, and thus it might easily be overlooked until the main body of the ketchup is affected. The bottles which have the widest labels around the neck are usually the ones provided with one or two large labels on the lower part of the bottle, though some bottles have no other label but the one around the neck. As a rule, however, these are narrow, close to the stopper, and unobjectionable.

In buying ketchup for experimental purposes it was difficult and sometimes impossible to learn its age, as often the grocer does not know it, and at other times he will not tell. It appeared, however, that often the ketchup had been on the grocer’s shelf or in the warehouse from one to four years.

MANUFACTURING EXPERIMENTS WITHOUT THE USE OF PRESERVATIVES

OUTLINE OF THE EXPERIMENTS

During September, 1907, ketchup was made in experimental batches to determine whether it could be manufactured on a commercial scale without the use of preservatives. These experiments were made to determine (1) the keeping quality before opening the container and (2) the length of time the product will keep without spoilage after the bottle is opened.

The ketchup was made in a factory in which the conditions of manufacture and all the surroundings were sanitary; whole, ripe tomatoes, the same as used in the regular grade of canned goods, were used and the formula and process were for a mild ketchup giving the maximum of tomato flavor. Each batch consisted of 50 gallons of finished goods, from which 1 gross of pint bottles was retained for observation.

The term "regular ketchup" as used in these experiments means the pulp of fully ripe tomatoes, to which was added granulated sugar, 80-grain, distilled vinegar, table salt, onions, garlic, whole cinnamon, cloves, mace, and ground cayenne pepper. The pulp was cooked in a steam-jacketed copper kettle for forty minutes and reduced about 50 per cent. The finishing was done after cooking. The regular bottles are pint sizes, washed in hot water, rinsed, and then heated to a temperature of 190° F. for thirty minutes or more. The sterile bottles referred to in the experiments were placed in a steam chamber for twenty minutes at 230° F. The corks were sterilized by a bath in paraffin at about 270° F. All of the work was accomplished quickly to insure a smooth, even product with a bright, clean color. Acetic acid extracts and oil extracts of spices were used in such quantities as would give the same amount of spicing as when the whole spices were employed.

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