

# Pasteurization of Pickle Products\*†

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## Introduction

UNTIL rather recently the preservation of cucumber pickle products was accomplished principally by the addition of sufficient amounts of vinegar, and in certain cases sugar, to properly cured and processed salt stock. The use of heat in the manufacture of pickle products was generally restricted to that phase of processing wherein the salt was removed from the cured stock. However, the introduction and widespread popularity of certain types of pickle made from fresh or partly fermented cucumbers, have made it necessary for the packer to resort to the use of heat, according to a definite procedure called pasteurization, in order to accomplish preservation of these products. It is important to remember that when preservation is brought about by pasteurization the final products must not only remain free of spoilage but also free of undesirable physical and flavor changes which may be brought about by overheating.

In addition to the necessity of pasteurization in the manufacture of fresh or partially fermented cucumber products, attention is called to the advantage of the pasteurization of genuine dill pickles. It has been demonstrated<sup>5</sup> that through the use of this treatment a marked improvement in keeping quality is brought about. For this reason genuine dills are to be included among the list of pasteurized pickle products discussed.

## Classes of Pasteurized Pickle

NO attempt will be made to list all the pickles that require pasteurization during their manufacture. A recent publication<sup>4</sup> lists about a dozen of such products, and mentions the fact that considerable confusion arises from different names for the same product. However, probably most of the pasteurized products are closely related types of dills, varying chiefly as to whether they are unfermented, partially or fully fermented and as to the amount of acid, salt and spice used during preparation. One commonly known pasteurized product that differs considerably from the dill group is the sliced fresh cucumber pickle, also known as old-fashioned pickle or bread and butter pickle. Here the acid content of the finished product ranges from 14 to 15 grains acetic acid (and 16 to 17 degrees Baume<sup>6</sup>); in contrast, the various

types of dills have final acid contents of from 3 to 5 grains acetic acid, for the partially fermented fresh dill, and 8 to 12 grains, for the fully fermented genuine dill. In view of these facts it is well to point out that pasteurization must operate successfully under three principal conditions which are brought about by virtue of differences in the basic preparation of the various pickle products. The first condition is encountered with wholly unfermented products (as fresh dills and sliced fresh cucumber pickle); in this case pasteurization must effectively destroy the organisms present that are capable of fermenting the final liquor. The second condition exists in partially cured products (such as fresh fermented dills); here fermentation is actively underway and large populations of organisms must be killed so as to avoid continuance of the original fermentation in the final product. Furthermore, in this instance, any byproducts of the short fermentation which might cause undesirable changes in the product must be avoided or destroyed. Finally, the third condition exists in the case of wholly cured products (as Polish dills or genuine dills) where the active fermentation is presumably over, but the product must be protected against further growth of organisms or from action of fermentation byproducts that may bring about undesirable changes with regard to firmness of the stock during storage.

Accordingly, as far as this discussion is concerned it is desirable to class all pasteurized pickle products as (1) unfermented, (2) partially fermented, or (3) fully fermented, since they logically fall into one or another of these groups. Furthermore, in the presentation of experimental results at least one typical example of each class will be given consideration.

## Pasteurization Procedure

IT is recognized that pasteurization procedures have been in use by some packers for a number of years; however, these methods have not been made available in the literature or to the industry as a whole. Thus, experimental work carried out by investigators in the field may be somewhat retarded due to the lack of previously published work for a guide. Also, studies should be based on well replicated runs carried out on a commercial or semi-commercial scale prior to releasing information concerning the processes involved. Nevertheless, at this time several publications which have been released by the cooperative group at Raleigh, N. C., are available to the packers.

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These deal with the manufacture of high-quality sliced fresh cucumber pickle<sup>1, 2, 3</sup> and with the pasteurization of genuine dills<sup>5</sup>. In both of these studies it was found that controlled pasteurization at 165° F. for 15 min., followed by prompt cooling, was successful in obtaining a high-quality product from the standpoint of freedom from spoilage as well as retention of most of the original firmness during several months of storage. Other aspects of the above study will be presented later.

In view of the fact that the controlled pasteurization treatment suggested has proved successful for the products just discussed as well as for fresh pasteurized dills, overnight dills, actively fermenting dills, and fresh dill tomatoes, it is hoped that this method will replace procedures requiring higher temperatures or prolonged holding periods at high temperatures. In a recent publication<sup>4</sup> the authors advised the pasteurization of a pickle product at 170° F. for 25 min., although an earlier publication<sup>2</sup> by other workers dealing with the examination of over 2,400 jars of the same product at various stages during manufacture demonstrated conclusively that 160° F. for 20 min. (or 165° F. for 15 min.) was adequate pasteurization. That there would be a difference in cost involved in the two procedures is rather obvious, but what might be overlooked is that the exposure to 170° F. for 25 min. is likely to affect the firmness of the pickle more than would the lower pasteurizing temperature. Such instances of conflicting advice must be somewhat confusing to the packer.

### Factors Involved in Pasteurizing

**T**HERE are a number of important factors to be considered in carrying out the pasteurization at 165° F. for 15 min. This treatment has been arrived at through determinations that have given consideration to the types and numbers of organisms to be killed as well as the possible changes in the physical structure of the pickle. By careful attention to the details of the above pasteurization treatment, it is possible to obtain high-quality products irrespective of what basic equipment is used by the plant operator (i.e., large wooden pasteurizing tanks, small wooden tanks, metal tanks, or continuous pasteurizers).

Some of the details that require attention are: (1) temperature control during the course of heating up to the pasteurization temperature and during the holding period; (2) adequate provisions for circulation of water during pasteurization so as to obtain uniform heating, particularly if pasteurization is carried out on batch lots in jars or gallon cans in crates; (3) prompt cooling following the pasteurization holding period. Of the items listed, probably only the first needs to be discussed here as to possible means for attaining the desired end. Control jars or cans of the pickle can be equipped with thermometers inserted through holes punched in the metal lids and insulated from the metal by corks bored to fit the thermometers. In open pasteurizing tanks, with adequate circulation, control jars placed at the top and bottom of the tank usually give the necessary information relative to the course of heating of the batch. Temperature readings

of the jars and of the water should be made at 10 min. intervals during the temperature rise of the jars up to the pasteurizing temperature and then readings should be made at five min. intervals. In cases where pasteurizing equipment does not allow the use of this arrangement one may be able to obtain the information relative to maximum temperatures attained by use of small maximum-indicating thermometers placed inside marked jars or cans of the pickle. It should be emphasized that care must be taken to guard against overheating, since this will result in a marked loss in crispness or firmness of the product as well as possible development of cooked or "off" flavors. In this connection it is also well to point out that prompt cooling must follow the pasteurization holding period in order to prevent continued "cooking" of the product.

### Experimental Results

**P**REVIOUS work<sup>2, 3</sup> has demonstrated that principally yeasts and acid-forming bacteria are the types of organisms involved in the spoilage of sliced fresh cucumber pickle. Continued work along this line has shown that essentially the same organisms are involved in the spoilage of fresh dills. In connection with the manufacture of these two unfermented products, it is of particular interest to point out the numbers and types of organisms that are borne by the cucumbers as they come into the plant as well as the effectiveness of the usual commercial washing procedure in the removal of these organisms. The figures shown in Table 1 represent average estimates of the total

Table 1. Incidence of microorganisms on cucumbers at time of delivery at the plant.

Sample	Types of microorganisms			
	Total count <sup>1</sup>	Aerobacter <sup>2</sup>	Acid-formers <sup>2</sup>	Yeasts <sup>4</sup>
	per cc.	per cc.	per cc.	per cc.
Before washing	9,800,000	3,500,000	1,900,000	1,100
After washing	44,000	21,000	15,000	100

<sup>1</sup> Using plain agar.

<sup>2</sup> Estimates by use of brilliant green agar (Difco) and Levine's eosin methylene blue agar (Difco).

<sup>3</sup> Using nutritive caseinate agar (Difco).

<sup>4</sup> Using acidified dextrose agar.

and different types of microorganisms carried by the cucumbers prior to washing and after washing with the ordinary rotary vegetable washer. The cucumbers were first soaked for a short time in water in order to loosen the adhering particles of soil before being given the rotary washing treatment. It will be noted that the *Aerobacter*, acid-forming bacteria, and yeasts comprise a goodly portion of the total number of microorganisms borne by the cucumbers and adhering particles of soil; the balance of the total count is composed chiefly of heat-resistant spore-forming types. Furthermore, it is evident that some microorganisms of each type mentioned are still present on the cucumbers after being given a thorough cleaning in the rotary washer. Of the three types (*Aerobacter* acid-forming bacteria, and yeasts) carried over during the preparation of fresh pickle, the yeasts and acid-forming bacteria usually survive the application of hot liquor; therefore, if

adequate, controlled pasteurization is not carried out, spoilage will result through fermentation by these organisms. The *Aerobacter* are not concerned in spoilage of unpasteurized pickle since they are killed by the acid content of the liquor.

Two typical illustrations of the fermentation of unpasteurized fresh dills are shown in Table 2. It will be observed that in the case of lot A the active fermentation was brought about exclusively by the acid-forming bacteria, while in the case of lot B the early fermentation was due to yeasts with the acid-forming bacteria participating later. The *Aerobacter* were absent from both fermentations due to the acid content of the liquor.

Table 2. Growth of microorganisms in unpasteurized lots of fresh dill pickle.\*

Lot	Age in days	Microorganisms per cc. of liquor		
		Acid-forming bacteria	Yeasts	<i>Aerobacter</i>
A	Initial	1,000	10	0
	1	320,000,000	0	0
	2	410,000,000	0	0
	4	81,000,000	0	0
B	Initial	...	...	..
	4	0	16,200,000	0
	5	0	18,200,000	0
	7	0	20,000,000	0
	8	30,000,000	18,000,000	0
	9	93,000,000	4,000,000	0

\* Acid content, 6 to 8 grains acetic acid.

Table 3. Incidence of microorganisms in various classes of pickle products before and after pasteurization (165° F. for 15 min.).

	Total number of microorganisms per cc. of liquor					
	Unfermented		Partially fermented		Fully fermented	
	Sliced fresh cucumber pickle*	Fresh dills*	Overnight dills**	Genuine dills**	Genuine dills** (1938)	Genuine dills** (1939)
Unpasteurized	9,400	1,300	20,000,000	26,800,000	14,000	10,500
Pasteurized	1,700	276	330	10	20	20

\* 25-oz. jars.

\*\* One-gal. cans.

The incidence of microorganisms in representative types of the three general classes of pickle products requiring pasteurization is shown in Table 3. The figures show the relative numbers of microorganisms in the various products before and after pasteurization. In general, the figures for the pasteurized lots show that a marked reduction in numbers of organisms (chiefly acid-forming bacteria and yeasts) was brought about by pasteurization. The surviving organisms in all cases were of the heat-resistant spore-forming types. The presence of these is of no concern since it has been demonstrated<sup>2, 3</sup> that there is little or no change in their numbers during storage of pasteurized pickle. Observations on the keeping quality of the pasteurized products listed in the unfermented and fully fermented classes (Table 3) have demonstrated that most of the original crispness or firmness is retained for storage periods of from 8 months (for sliced fresh cucumber pickle and fresh dills) to 16 months (for fully fermented genuine dills). Up to this time, in our studies of products in the partially fermented class the storage

period has not been as long as 16 months; however, the indications are that the final results as to keeping quality will be similar to those obtained with fully fermented dills.

## Summary and Conclusions

A DISCUSSION dealing with various aspects of pasteurization for the preservation of pickle products has been presented. Attention has been called to the fact that pasteurization has proven valuable not only in the processing of unfermented and partially fermented products but also in preservation of genuine dills.

Pickle products requiring pasteurization during their manufacture have been placed in three general classes, namely, (1) unfermented, (2) partially fermented and (3) fully fermented. Typical examples of products in each of these classes, covering an acid content range of from about 4.0 to 17.0 grains acetic acid have been investigated with respect to the use of the same pasteurization procedure in all cases, namely, 165° F. for 15 min. The results indicate that the organisms responsible for fermenting or otherwise deteriorating the products were killed; also, that most of the original crispness or firmness of the products was retained over a reasonable storage period.

It has been demonstrated that a uniform pasteurization procedure, such as 165° F. for 15 min. followed by prompt cooling, can be adopted by packers for the manufacture of high-quality pasteurized pickle products of all types.

The adoption of uniform pasteurization procedures is recommended.

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