REFRIGERATED DILL PICKLES—QUESTIONS AND ANSWERS[1]

by

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ABSTRACT

The discussion presented herein is a continuation of the "Question and Answer" technique first introduced by Mr. W. R. Moore, Jr., on the subject, "The Brining of Pickling Cucumbers . . . ," presented in the first issue of the journal, *Pickle Pak Science* (July, 1971). We have tried to continue this effective technique on the subject of refrigerated dill pickles — made for years in bulk (barrels), which are called "overnight dills" or "half-sours," and are now made and sold in glass containers in retail stores from refrigerated counters. We have tried to show the important differences between the bulk and the glass container items (usually 1 qt.). Here, emphasis is placed on the refrigerated glass container product with regard to its preparation, chemical properties of the brine, microbial spoilage potential, and handling and distribution to the refrigerated food storage and display cases in retail stores. Information is reported on the quality evaluation samples of 1 qt. jars of refrigerated dills collected from several areas in the USA.

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"For Those Who THINK PICKLES"

Moderator's Introductory Remarks

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This is a continuation of the discussion technique originally introduced in *Pickle Pak Science,* volume I, number 1, July, 1971, published by Pickle Packers International, Inc., entitled, "Factors Influencing the Brining of Pickling Cucumbers — Questions and Answers."

Information presented in that paper contained much previously unpublished and highly useful material gained through more than 38 years of experience by Dr. John L. Etchells[2] and coworkers at the cooperative U.S. Department of Agriculture's Food Fermentation Laboratory located in the Food Science Department, North Carolina State University, Raleigh, NC. The simplified question and answer technique was employed to give members of the pickle industry, suppliers and other interested persons a clearer understanding of some of the processes that have, over the years, been developed through trial and error.

We now review the manufacture of a "ready to eat," highly perishable pickle product sometimes referred to by the following terms; "fresh," "overnight," "half-sour," etc. This pickle apparently was introduced into the USA from recipes handed down by immigrants (particularly from eastern Europe) from generation to generation and made in bulk quantities. Only in recent years has its popularity soared outside of large metropolitan areas when packed and marketed (refrigerated) in glass containers. It has been estimated by others that this product (in glass) may reach an estimated 15 percent of total commercial pickle sales, although the authors consider this figure on the "high" side because we know of one bulk operator in particular that makes 35,000 barrels of overnight dills per season! This alone would amount to about 200,000 bu of cucumbers!

The importance of understanding methods to prevent potential spoilage in the manufacture of this highly perishable product must be obvious. Every person handling this type of pickle product should encourage widespread review of the processing procedures for the protection of the industry and the consumers that are served.

We have returned to visit with Dr. John L. Etchells and also his longtime coworker, Professor T. A. Bell, here in Raleigh, North Carolina. Dr. Etchells is now a Professor of Food Science and Microbiology and Mr. Bell is in charge of the Food Fermentation Laboratory (located at North Carolina State University) since Dr. Etchells retired from the USDA in 1974. Dr. Etchells and Mr. Bell have attracted worldwide recognition for their work in the field of microbiology and enzymology (pectinolytic), specializing in food fermentations. Their research accomplishments are a matter of record.

The type of pickle we are talking about in jars is a finished product. Making it requires relatively little equipment. However, when made in bulk, it is dependent on preservation techniques probably as old as man, yet much has changed since the product moved in quantity to jars! Although widely practiced, this type of pickling is still strictly an art. We believe that Dr. Etchells and Mr. Bell can make a valuable contribution by peeling away some of the mystery that surrounds this product and showing us that certain basic principles must be strictly adhered to in its manufacture so that it will not become a public health hazard.

As pointed out by Schucart (1942), when he reported his practical observations on the manufacture of bulk, overnight, kosher-style dill pickles over 30 years ago, "The chief characteristics of these pickles are the low salt and vinegar content, the strong spicing or seasoning (especially with respect to garlic) *and their perishability*" (italics are ours).

Etchells' and Bell's Introductory Remarks

In the pickle industry, the "overnight" or refrigerated dill pickle has generally been considered a specialty or ethnic item, and for many years, was prepared in bulk, usually by small packers located in or near large metropolitan areas of the country. In recent years, these pickles have also been prepared in quantity, directly in consumer-size, glass containers (usually 1 qt.) which are then *supposed* to be stored. distributed and retailed under refrigerated conditions (34 to 40°F). Details for preparation of this product in barrels have been described earlier by Schucart (1942) and by Etchells et al. (1968).

One important characteristic (mentioned earlier) emphasized by Schucart, over 30 years ago, for overnight dills made in bulk (barrels), was *"their perishability"* (italics are ours). He also mentioned the low salt and vinegar[3] content of the product and the strong spicing or seasoning, especially with respect to fresh garlic. We can say that, based on recent studies reported in detail herein on the quality of refrigerated dill pickles in glass jars collected from retail outlets in several metropolitan areas of the country, the same "perishability" characteristic, mentioned so long ago, for the product made in barrels, still exists when it is made in glass jars! Also reported is a *high degree of variability,* both as to the product's generic name (such as Half-Sours, Genuine Kosher Dills, Kosher New Dills, Sour Garlic Pickles, Half-Sour New Pickles, Fresh-Packed Half-Sour Kosher New Dills, and the like).[4] In the actual preparation of the product by individual companies, production and marketing practices vary, particularly as to: acidification; use of preservatives or other chemical additives; whole spices; spice emulsions; salt content; size and quality of green cucumbers; ratio of cucumbers to brine, on a percent/weight basis; and, the presence or absence of proper refrigeration facilities for the product during preparation, distribution and storage, and display at retail outlets; and finally, the spoilage potential.

The high degree of variability of this cucumber product by individual companies, as to preparation, prod-

[2]Retired from USDA, but is still employed on a part-time basis by the North Carolina Agricultural Experiment Station, Department of Food Science, North Carolina State University, Raleigh, 27607.

[3]Vinegar was not necessarily a standard ingredient.

[4]See Appendix F for additional names taken from labels.

uct name, distribution, and marketing leaves essentially only one important characteristic in common; namely, that the pickles are *supposed* to be sold from the refrigerated counters in retail stores. For this reason, and others developed later herein, we have decided to refer to these dill pickle products as: 1) Refrigerated Dill Pickles; 2) Refrigerated Dills; and, 3) Refrigerated Pickles, listed in the approximate frequency of usage in the article. This does not, on occasion, preclude slight modification of the above names, should certain information we have gathered so dictate.

Thus, Mr. Moderator, above are some of the items we hope to cover by your unique, yet effective, "Question and Answer" technique! We hope we can do justice to your most pertinent, timely and penetrating questions.

Further, we would like to emphasize that although for our experimental work presented in Appendix A, we used a rather close refrigeration temperature range of 38-40°F (*ca.* 4-5°C), whereas for the commercial operation, it has been suggested that this range be broadened to 34-40°F (*ca.* 1-5°C).

Description of Refrigerated Dill Pickle Products

MODERATOR: Thank you, gentlemen. We appreciate the fact that you are taking time from a busy schedule to give us your findings about this increasingly popular type of pickle. How would you describe this pickle, originally known as the "overnight dill" or, more recently, to the average consumer, as the "refrigerated dill pickle"?

ANSWER: Earlier, Mr. Moderator, we have described in general refrigerated, "overnight" dills, both in bulk and in glass containers, usually 1 qt. size. Because the product we are emphasizing is in containers for retail trade, we want to give you the various categories of this product. Herewith are short descriptions of four types of refrigerated dill pickles submitted by a most cooperative and successful packer of these pickles; the information has been reviewed by two other packers:

Kosher, Refrigerated Dills, Non-Acidified:

This is a green cucumber packed in a low-salt content brine (10-12° salometer equilibrated) and refrigerated immediately to try to prevent fermentation. The real connoisseurs of this type look for the green color which denotes little or no fermentation and acid development that destroys the green color. This is a quick turnover product and is only practical on a *very* restricted regional basis.

Half-Done, Refrigerated Dills:

This may also be a fresh, green cucumber type that is supposed to ferment slightly and then is refrigerated to retard the fermentation. This is a *gaseous,* messy type (in jars) that foams and spurts all over the packing case. It might completely ferment out as can be seen by the clear brine, with all the dead organisms settled to the bottom. Or, it might still be cloudy with a reduced but still active fermentation. Pressure on the cap (that doesn't leak) may reach above 15 lbs![5]

New, Vinegared, Refrigerated Dills:[6]

Recently, a new type of refrigerated dill is showing up in quantity in glass jars in the form of a low-salt (10-12° salometer equilibrated), vinegar-added, kosher dill. The finished acidity at equilibration normally runs between 4 and 6 grains vinegar (=0.4-0.6%) and contains benzoate of soda or another chemical preservative. It is very crisp, and if left at room temperature, a few jars may get by for a few weeks without fermenting. With refrigeration, however, the product seems to be quite stable and may keep its greenish-straw colored, fresh-pack appearance and texture for several weeks. Look for vinegar and a preservative in the ingredient list to identify this product. It is essentially a *non-heated, well-acidified, low-salt content, refrigerated, green cucumber, containing one or more preservatives with spices and flavorings.*

Genuine Kosher Dills:

This is a genuine dill containing about 4% (equilibrated) salt content that may or may not have been refrigerated in bulk storage. It is *repacked* into glass and displayed in the refrigerated counters. The brine will normally be fairly clear and the product cured. *Remarks by authors:* This item probably should not properly be placed in the refrigerated dill category. Actually, in the evaluation of samples of this product, it was rated "Not Acceptable" for kosher, refrigerated dills, but was placed as "Good" for a genuine dill.

Influence of Acidification and Brine pH on Spoilage

MODERATOR: At some point you discuss the role of pH and acidity in relation to retarding spoilage of the product. It is confusing to talk about a pH factor that is associated with a measurement of acidity. By that I mean we might correctly talk about a low acid reading and at the same time a high pH reading! These seem to be inverse readings; yet, while we can't be expected to know all about the technical or scientific basis for this relationship, an easy to understand table or graph with both acid and pH readings might help us to see what this is all about.

ANSWER: You are correct. We have not, as yet, discussed the important role of acidity and pH in relation to the spoilage of the product, and also from the standpoint of preventing the product from becoming a public health hazard! We have, however, prepared three pH charts (APPENDIX B, Figures 1-3) that should give the reader an understandable relationship as to pH *vs* acidity; also, refer to APPENDIX G, Tables 1-4. For more detailed and technical information, the reader is referred to "The Canned Food Reference Manual," American Can Company, 3rd ed., 1947.

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[5]The "half-done" or "half-sour" kosher dill pickles may be made as indicated above, together with all the problems associated with the process in jars. However, at this point, the authors wish to emphasize that these products have also been made by repacking from bulk (bbls) of traditional "Overnight Dills." The repacking is done when the barrelled product has fermented sufficiently to reach the point that the retail name indicates. Thus, in this case, the retail, refrigerated product could properly be called a "refrigerated, 'overnight' dill pickle." It will be up to State and Federal agencies to decide on the proper name for this variety of refrigerated dill pickle.

[6]It is products of this type that we believe have been responsible for the remarkable increase in total commercial sales of pickles referred to earlier by Moderator Moore in his opening remarks. We believe that it is the crispness-crunchiness quality that the consumer is looking for!

As you have so clearly pointed out, a high pH reading can mean a low acidity reading because as you indicated the two readings are "inverse." I believe you will understand this situation when a *careful* study of the three pH charts are made. One *must learn* that a high pH value reflects a low acidity and vice versa.

The Role of Salt Concentration in Making the Product

MODERATOR: In your paper on brining of cucumbers for the manufacture of process pickles, you played up the importance of salt. How important is salt in the making of refrigerated dill pickles?

ANSWER: The salt content of the refrigerated dill is, as you know, rather low, about 2-2.5%/wt. This amount would have very little effect on the organisms we discussed in the "Brining papers" you mentioned. Essentially, for the refrigerated dills, the salt content is primarily for organoleptic purposes (taste); this concentration might inhibit some undesirable microbes and yet the lactic acid bacteria can develop most vigorously as well as the coliform types. Thus, in brief, the salt content of refrigerated dill pickles has very little effect on preservation of the product as the tabulated information to follow will demonstrate (APPENDIX D). However, if the product is made properly as given herein, and refrigerated promptly, little or no growth even by lactic acid bacteria will result for several months — even *without* a chemical preservative.

Effective Refrigeration of Dills

MODERATOR: Although you have previously indicated that the outside air temperature, the product temperature, and the brine tank temperature are important in the brining of pickling cucumbers, we wish you would explain the role of temperature in storage of refrigerated dill pickles prior to their consumption.

ANSWER: We must emphasize that in the production of brine-stock pickles and of refrigerated dill pickles, the role of temperature is wholly different. For brine-stock, we want a desired fermentation temperature for nongas-forming lactic acid bacteria (80-85°F) to utilize the cucumber sugars with a minimum production of gas. In contrast, for refrigerated, acidified dill pickles, we want to keep the microbes inhibited with a minimum of growth until the product is marketed and sold. This has to and can be done by preparing, storing, distributing, and displaying the product under proper refrigerated conditions (34-40°F). The reason for refrigeration is to inhibit or retard growth of microorganisms, particularly those considered to be undesirable and able to create a potential public health hazard. The latter is done by maintaining a pH range of 4.5-4.6 or lower.

We have no objections to the use of acceptable chemical preservatives for containers that are going to be opened and closed many times before being emptied.

In short, refrigerated dills should be kept *continuously* at refrigerated temperatures (34-40°F) from start to finish.

Acidification Used in Making This Type of Pickle

MODERATOR: Please explain the role of acidification and how it occurs, whether naturally or by the addition of artificial acids in the preparation of refrigerated dills.

ANSWER: The role of acidification and the proper amount of acid needed to obtain the proper pH is vital for a reasonable preservation period of the product. This is given in detail in the APPENDIX A, which also describes how to get the proper pH range that may be required by State and Federal agencies. We also emphasize that different sized cucumbers, as well as mixed sizes, because of their different buffering action, will require different acidification treatments to obtain the correct equilibrated pH range. This is also described in APPENDIX A. We are not really interested in the "naturally" produced acid, which usually indicates lack of proper refrigeration. Such a condition also promotes the growth of gas-forming lactics and yeasts which can cause bloater damage to the product, pressure on the cap, and a high degree of brine turbidity (cloudiness), together with "off" flavor.

The Importance of a Uniform Solids to Liquid Ratio

MODERATOR: Frequently, I have been told that the addition of any acid, or the fermentation of the naturally-occurring sugars of the cucumber into acid is a "sure-safe" preservation system. Are there conditions such as the solids to liquid ratio of the product in which, even with addition of acid, the environment in the container of refrigerated dill pickles could change, possibly to an unsafe condition?

ANSWER: Mr. Moderator, this question seems on the repetitious side. However, we will restrict ourselves to the part dealing with the solids to liquid ratio. Actually, this is very important — a too tight pack, particularly of small stock, does not give the proper pH because of so much buffering action; conversely, a too loose pack will give too high an acidity and too low a pH (meaning toward 1). Thus, you can see that highly irregular pack-outs can cause considerable trouble with refrigerated dill pickles. It is vital to pack to a volume ratio close to 60:40% with respect to solids and liquid. Procedures to determine the desirable pH for a given pack-out ratio are given in detail in APPENDIX A. Certain equipment is required to make the necessary determinations. We will discuss this under the section on "Controls."

The pH Range of Refrigerated Dills

MODERATOR: Please discuss the pH range of refrigerated dill pickles and whether or not there is a preservation prediction curve or spoilage threshold with which to be concerned.

ANSWER: The maximum equilibrated pH range for refrigerated dills, as far as we are concerned, is 4.5-4.6; the specific Federal regulations list a value of 4.6 or below. We feel that the variations in pH meters and operators are such that a single value is too rigorous for the practical day-to-day operation of a conscientious plant following the FDA GMP[7] requirements for "low acid foods." The objective of pH control is to preclude the growth of microorganisms that can cause a public health hazard. The pH values given above will accomplish this objective.

[7]Means: "Good Manufacturing Practices." Also, see Title 21, Food and Drugs, Part 128b, "Thermally Processed Low-Acid Foods Packaged in Hermetically Sealed Containers," *Federal Register*, vol. 38, no. 16 (January 24, 1973), pp. 2398-2410.

The Use of Chemical Preservatives

MODERATOR: Even though we understand a perfectly acceptable, although highly perishable, refrigerated, fresh cucumber pickle can be made without an artificial preservative, can you review the use of these substances and the interaction of other factors such as temperature, solids to liquid ratio, pH, etc.?

ANSWER: We have tabulated the number of samples that declared one or more preservatives or additives on their labels. (APPENDIX E, Table 1). However, as you can see from our procedure for preparation of refrigerated dill pickles (APPENDIX A, Tables 1 and 2) we were able to keep this product in 1 gal. jars for about 103 days *without* a preservative! Actually, we made two runs in this manner and the results were essentially the same.

However, we have no objection to the use of an acceptable preservative in containers that may be opened repeatedly, such as those for institutional use, and for use where the pickles may be removed by hand instead of by a clean, sanitized fork or the like. We know that institutional customers are not fully aware of the nature of the product they have, and may not keep it under proper refrigeration. Of course, proper refrigeration cannot always be blamed on the processor — but he should inform all his wholesale and retail buyers and brokers how his product should be cared for. We know at least two processors who see that these requirements are met.

We have noted labels declaring one or more preservatives added — but no acid! This would prevent the preservative from being effective. It requires pH 5 or below (toward 1) for preservatives like sodium benzoate or sorbic acid to be effective. Yet we find preservatives added to non-acidified products (APPENDIX E, Table 1)! We have emphasized the importance of acidification and will not repeat it here. The solids to liquid ratio is vital when the product is acidified in order to get the proper acidification and resultant pH (4.5-4.6). *This cannot be over emphasized.* The matter of temperature has also been discussed and its influence on acid and pH equilibration is given in APPENDIX A.

The Keeping Quality of This Type of Pickle

MODERATOR: From what you have already told us, it is obvious that we are dealing with a highly perishable product requiring strict attention to detail. Can you please make some observations about the keeping quality of this product?

ANSWER: Yes, Mr. Moderator, you are certainly right. Earlier we quoted from Schucart (1942) about the "perishability" of the product (bulk). Also, our evaluation of samples from several areas in the USA show the same perishability problem. It is imperative that the product be so acidified to equilibrate at pH 4.5-4.6 by use of acetic acid or a suitable strength vinegar at the outset. The detailed procedure will be found in APPENDIX A. Next, the product *must* be kept refrigerated, 34-40°F, throughout its preparation, distribution, storage, and then put out for sale in refrigerated counters in retail stores.[8]

For more specific chemical and physical information on the keeping quality of the product prepared under the best of conditions, we again refer you to APPENDIX A, Table 1 and 2. We think that any responsible processor who wishes to produce a good product with the best interests of the consumer in mind can do so. Also, he must clearly and emphatically inform his brokers, distributors or warehouse operators, or any large supermarkets (with whom he may deal direct) that they are dealing with a perishable item and it should be treated as such!

I trust, Mr. Moderator, we have sufficiently emphasized the question of perishability that you so aptly raised!

Product Spicing and Flavoring

MODERATOR: Apparently, in the absence of heat, a different set of conditions exist relative to spicing and flavoring. It would be helpful if you would review flavoring of what essentially is a "cold-pack" or refrigerated dill pickle.

ANSWER: As mentioned earlier, the refrigerated dill pickle packed in glass containers is a highly variable item as to preparation; and, the spicing and flavoring is no exception. Some processors use whole spices and fresh garlic; some use garlic oil and dill emulsions; others use only essential oils with just a few dehydrated garlic flakes, mostly for appearance. There is no standard procedure. The sanitized whole spices are much more helpful in extending the product's refrigerated shelf life (about 2 weeks or more) than the nonsanitized, whole material.

We have found very high populations of bacteria on certain spices used in fresh-pack pickles (Etchells and Ohmer, 1941). The fresh-pack process (heat and acid) destroys most of these microorganisms, except the spore forms, that are unable to grow in the acidified brine (pH 3.8-4.0). However, no such protective mechanism such as heat is used for the refrigerated dill. Thus, the acidification to the desired pH affords the major protection against organisms of public health significance. Effective refrigeration is also a most helpful inhibitor to microbial growth, particularly in a properly acidified brine.

Some processors add no whole spices, just a little chopped garlic or onion, which may be dehydrated, plus a dill emulsion in the cover brine, often plus a preservative such as potassium sorbate or sodium benzoate. In one case, we found both declared!

Today, as mentioned earlier, there is probably no one product that we could call the *typical* "refrigerated dill pickle" *per se*. It has become a variety of products made in a variety of ways. There is no such thing, packed in glass, that represents the typical, old-time, overnight dill that is produced in bulk in the large metropolitan areas such as New York City and Los Angeles, CA (Schucart, 1942; Etchells et al., 1968).

Suggested Processing Controls for Greater Uniformity of Quality

MODERATOR: In a business that obviously is basically an "art," it would seem desirable to introduce more controls. On the basis of your experience, what do you recommend?

ANSWER: Yes, Mr. Moderator, you have again really struck a re-

[8]It is *most* important that the refrigerated counters where the pickles are displayed be so constructed that the product is maintained within the range of 34-40°F. Often the temperature recorder comes from deep within the refrigerated unit — not where the pickles are located! We have checked jars that have ranged from close to room temperature to those where the contents were *frozen!*

sponsive cord with respect to controls for processors of refrigerated dill pickles. It is imperative that they obtain sufficient and proper equipment that will give them reliable values as to brine acidity, pH and salt. Also, for different sizes of stock and mixed sizes, they will have to have a blender of adequate size (1 gal.) to obtain the pH of blended samples prior to manufacture, so as to be able to acidify their product to meet any proposed State and Federal pH regulations.

The following equipment is needed: a reliable pH meter; a blender (1 qt.-1 gal.); silver nitrate solution and indicator for making salt determinations; standard sodium hydroxide for acid determinations; a USDA fruit pressure tester for determining firmness. Other useful items would be materials for determining brine-sugars and brine turbidity. All these items can be obtained from any reputable, scientific supply house, with possibly one exception; the source for the USDA fruit pressure tester can be obtained by writing the authors, or Pickle Packers International, Inc., St. Charles, Illinois 60174, USA.

Further, it is necessary that the product be prepared, distributed and stored (retail) at 34-40°F. This has been emphasized before in this article.

Influence of the Use of Different Sized Cucumbers

MODERATOR: Observations of commercial offerings of refrigerated dill pickles suggested that little attention is paid to sizing the stock. Small sizes, crooks, nubs, and large cucumbers can be found all mixed together in the same jar. Does this mixing affect the product in any way?

ANSWER: Mr. Moderator, earlier I believe we have touched on the problem of different sizes of stock as well as mixed sizes. As indicated earlier, the processor must blend his typical pack (solids to liquid ratio) and determine the proper acidification to get the required pH for the final, equilibrated product. It is important that the pack — be it small sizes, mixed sizes, nubs, crooks, or large sizes — be blended to obtain the equilibrated pH so that the processor can adjust the acidity of his cover-brine to obtain the proper pH required by State and Federal agencies.

The processor can obtain full information on the subject by studying the material given in APPENDIX A. Here he will find the procedure for making acceptable, refrigerated dill pickles as well as the length of time this product can reasonably be kept under refrigeration *without* a preservative.

One must realize that this product is, as has been said before, "perishable," and should be so considered as such. To do otherwise is to invite the danger of a public health hazard. We have tried to insist that processors should acidify their product to a specific pH range to preclude growth of organisms that are of public health significance in this publication and in an earlier "Advisory Statement" on this subject published by Pickle Packers International, Inc., St. Charles, Illinois 60174.

The Factor of Crispness in Refrigerated Dills

MODERATOR: Cool, crisp, crunchy pickles are sought by the consuming public. What factors change a refrigerated pickle from a crisp product to an essentially soft and flabby product?

ANSWER: Your statement that the cool, crisp, crunchy pickles are sought after by the consuming public is really a statement that implies that the consumer is trying to get the raw cucumber texture. The closest to this, of course, is the refrigerated dill. Our processors of fresh-pack pickles have, in the interests of production, reduced crispness to the point where the sales of unheated refrigerated dill pickles have increased to an unbelievable level.

As indicated earlier, Mr. Moderator, crispness centers around the word *heat;* (1) to much *heat* in blanching and poor control; (2) inefficient *heat* control during pasteurization; (3) inadequate cooling of the *heated* product; and, (4) casing hot pickles and putting them in the warehouse to continue to *heat* and deteriorate as to flavor and texture. All this adds up to *heat* in the interest of more and more production!

This past August (1975) in Holland one of the writers (JLE) saw fresh-pack cooled to 70°F or near that figure! You say, well their air temperatures are much lower than ours! Not so, they had the hottest season (92-97°F while JLE was there) in 50 years. Also, they do not blanch as we do and therefore put out a real crisp pickle. Apparently we have sacrificed quality (crispness) of fresh-pack in the interest of production.

But, to answer your original question, the deterioration of the refrigerated dill is simply one of the "perishability" as indicated several times herein, together with its original description. One can hardly expect a pickle with only 2-2.5% salt, with or without vinegar (usually without), and with very poor refrigeration facilities to have a very long keeping quality! We have seen samples with the maximum, 5+ microbial growth[9] taken from supermarkets as well as jars with 15 lbs pressure on the cap. So, to answer your question in brief, conscientious attention to the vital requirements for production and handling of this product from start to finish is necessary to insure an acceptable product (see APPENDIX A).

Influence of Container Size

MODERATOR: Does the size of the container play a role in the quality of the finished refrigerated pickle, with respect to acidification, pH and other considerations?

ANSWER: The container size is, of course, very important in the final quality of refrigerated dill pickles. Actually, container size, cucumber size, cucumber-to-brine pack-out ratio, and certain factors all interact with other factors such as refrigeration and acidification. Thus, it is difficult to separate them and assign a given importance to each.

When we consider container size, for refrigerated dills, we must also consider cucumber size and, more important, the pack-out ratio of cucumbers to brine per container. With the usual 1 qt. size jar, about 58% of the volume is occupied with small cucumbers; for larger stock, the percentage will be less. Thus, for this product, without blanching or some sort of brine shrinking for ease of packing as we know it (for fresh-pack pickles and loss of crispness), it is hard to get the desired pack-out ratios, particularly with an automatic packer. This then brings on the problem of correct acidification to obtain the desired pH ranges.

[9] = Brine turbidity (cloudy or milky): 0 = clear; 1 + = slightly turbid; to 5 + = very turbid.

Whatever the container size, the same problem exists with different cucumber sizes. This is why we have suggested (APPENDIX A) the need for blending the jar contents prior to manufacturing to determine the proper acidification to achieve the required pH range, for a given production run!

As a matter of interest, by determining the pack-out ratios (on a volume basis) of 73 quarts of dills, representing six manufacturers, we learned the following: (1) the overall solids pack-out for 73 quart lots was 56%; (2) of the total number of samples, only 6 contained 60% pickles; and, (3) of the same 73 samples, the lowest average pack-out of pickles for the 6 manufacturers was 51%.

This should give the processor some food for thought when he changes container size and/or cucumber size.

Summary and Discussion

In the preparation of the bulk overnight dill pickles (refrigerated), the barrelled product may be stored for a few days at room temperature and *then* refrigerated at 34 to 40°F (ca. 1 to 5°C). Under such conditions (nonacidified) and at equilibrated brine strengths of 10 to 12° salometer (1° salometer = 0.264% salt by weight), microbial growth (chiefly coliforms, gas-forming and nongas-forming lactics, and fermentative yeasts) and enzymatic activity (pectinolytic and cellulolytic), together with the curing process continue at a slow rate. But, in a few months, the stored pickles may have lost much of their desired characteristic flavor, texture and color, and also may be bloated because of a gaseous fermentation by one or more of the principal gas-forming microbial groups present, mentioned above (Etchells et al., 1968), as compared to standard pickle items (APPENDIX G).

Whether these pickles are made in bulk or in the retail jar, the fact remains that the very nature of the product makes it difficult to maintain good quality pickles for any reasonable length of time. The barrelled product probably reaches the GMP-FDA recommended brine pH of 4.6 or lower (toward 1), before refrigeration or shortly thereafter, and then slowly continues acid development, often with deterioration as to quality by undesirable microbial growth and/or softening enzyme activity.

The above recommended condition for brine-product-pH cannot be assured for the product made in the refrigerated retail jar because there is no accepted, uniform process used by the packers as a whole, wherein the product is acidified at the outset (so as to equilibrate at pH 4.5 to 4.6), or where, to our knowledge, a definite gas-forming acid fermentation is obtained even though the jars may be deliberately incubated, hopefully for development of a nongaseous, natural lactic acid fermentation *prior* to refrigeration, presumably to produce "half-sours" or "half-done" refrigerated dills. Whether this incubation of the jars is intentional to make a partially acidified product or results from lack of adequate refrigeration is a debatable point according to certain processors. In our experience, a controlled, natural fermentation would not be the case, as the definition of this pickle so indicates (see question no. 1, item 2) as to the gaseous nature of the product! Earlier the authors have offered refrigerated dill pickle processors an "Information Statement" through Mr. W. R. Moore, Jr., of PPI, suggesting how to get their product in the acceptable pH range. Several packers with the necessary equipment and talent have been able to utilize this information successfully, not only for their own benefit, but for the consumers' protection as well. This important information on pH adjustment has been presented in detail (APPENDIX A).

Spoilage of nonacidified, poorly refrigerated products is caused chiefly by the gas-forming microbial groups mentioned earlier. Gas production may be sufficient to reach 15-lbs pressure on the cap! For acidified products, gaseous spoilage by yeasts and gas-forming lactic acid bacteria are usually the principal microbial groups involved, during periods of inadequate refrigeration. For properly acidified products (pH 4.5-4.6 or below), growth by the coliforms and species of Clostridia (i.e., *Cl. botulinum)* is considered to be precluded.

One of our samplings of a total of 50, 1 qt. jars of refrigerated dill pickles from refrigerated counters or cases of large retail stores located in five geographical areas of the country, indicated that every third jar was judged "Not Acceptable for Commercial Use." Twenty-five percent more were placed in the "Barely Acceptable" to "Poor" categories! A follow-up study on 23 more jars in a large northern metropolitan production area (for the second time) gave better results as to jars of pickles placed as "Not Acceptable" (½ of the number of the first study), but "Barely Acceptable" to "Poor" ratings were given nearly 40% of the jars! Those jars of pickles placed as "Fair," "Good," and "Excellent" amounted to 17, 13 and 17%, respectively.

The first examination cited above that was conducted in a "large metropolitan area," was done in April when the greenstock has to be shipped in from Florida, Texas, or possibly Mexico! The second examination was made in August from cucumbers probably obtained from nearby growing areas.

ACKNOWLEDGMENTS

The authors wish to express their sincere gratitude to the following pickling companies[10] and their technical staffs for their dedicated help and direct assistance which made this publication possible:

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M. A. Gedney Company, Chaska, Minnesota
Spike Miller Company,[11] Pompano Beach, Florida
Mount Olive Pickle Company, Mount Olive, North Carolina
Oxford Pickle Company, South Deerfield, Massachusetts
Perfect Packed Products, Inc., Henderson, North Carolina
Vlasic Food Products, Imlay City, Michigan
Wellworth Pickle Company, Paterson, New Jersey

[10]Companies listed alphabetically.
[11]Brokerage company.

We also wish to thank other members of the U.S. Food Fermentation Laboratory (USDA-ARS) for their assistance in the chemical analyses and examination of the product.

Finally, we express our sincere gratitude to the President and Directors of Pickle Packers International, Inc., (St. Charles, Illinois) for their support in preparation of this article, and for emphasizing its importance to the industry, and also for supplying helpful information.

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APPENDICES SECTION (General Descriptive Titles)

CONTENTS

APPENDIX A:

PREPARATION OF ACIDIFIED, REFRIGERATED DILLS, PACKED IN 1 GALLON GLASS JARS AND STORED AT 38-40°F (ca. 4 to 5°C); INCLUDING BRINE ACID AND pH EQUILIBRATION TIMES. [1, 2]

SUMMARY:

Acidified, refrigerated dills were made in 1-gallon containers under laboratory conditions using conventional methods, except no chemical preservatives were used and, the cucumbers, cover-brine, acetic acid, and other ingredients were first cooled to 38-40°F (ca. 4 to 5°C); storage of the gallon jars of pickles was at the same temperature. It was apparent that the brine acid reached equilibrium several days before brine pH. Further, the natural green cucumber color desired by certain consumer areas for this product could be maintained for about three to four weeks at a brine pH that would meet the requirements for "Good Manufacturing Practices" (GMP), (FDA) as well as *our* desired pH range at equilibration, namely, 4.5 to 4.6. Also, the use of smaller cucumbers, required more acidification to overcome the buffering action of such stock. It would appear that 30-40 ml of 10% acetic acid (100 grain vinegar) would be required to obtain the desired equilibration pH (4.5-4.6) of the brined cucumbers in the sizes that have been given herein. It is obvious that other combinations of sizes will require specific tests on blended material (cucumbers, brine and acid) to determine the proper acidification procedure to be used to obtain the desired equilibrated brine-product pH.

PROCEDURE:[3]

1. **Cucumbers:** Mostly no. 2's, large, 1⅜ to 1½ inches in diameter; all lots stored in 50°F (10°C) refrigerator overnight.
2. **Source:** Grown in Mexico and shipped from Texas by air freight, in wooden crates, wire bound, and so constructed to provide for adequate ventilation during transit.
3. **Condition of stock:** Good condition; clean, some desiccation noted at stem end; some broken, but little or no disease or rot noted.
4. **Pre-brining treatment:** For above titled experiment, the carefully graded stock to be used was mixed, soaked 5-10 min. in tap water, and, after packing in 5 jars (1 gal), was washed by vigorous shaking in several changes of warm water, then chilled to 40°F (ca. 5°C) with ice and water and stored overnight at 40°F. Pack-out was about 60% cucumbers and 40% brine by weight (= about 5 lbs of cucumbers; weight of brine was calculated as that of water).
5. **Brine used:** The 40°F (ca. 5°C) cold water was poured off and replaced with a cold 18 to 22° sal. cover brine; about 1,200 ml/gal. per jar.

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[1]Prepared by John L. Etchells, North Carolina Agricultural Experiment Station, Department of Food Science, North Carolina State University, Raleigh, and Roger L. Thompson, Agricultural Research Service, U.S. Department of Agriculture, Raleigh, North Carolina 27607, USA.

[2]Published in part by: Pickle Packers International, Inc. (Oct., 1974), P.O. Box 31, St. Charles, Illinois 60174, USA.

[3]Second run, Table 2, is included, using different acidification levels and field-run sized green stock, including a considerable percentage of small cucumbers (1-1⅛ inches diam.).

6. **Preservations added:** None.
7. **Acidification:** 25 ml of 10% acetic acid added at time of brining; exceptions, nos. 4 and 5, both of which received only half the required acid at the outset; no. 4 received the balance of acetic acid (13 ml) 24 hours after brining; no. 5, 48 hours after brining; see Table 1.
8. **Spicing:** 10 ml of dill concentrate emulsion added at brining, plus 3 tablespoons of whole spices (sanitized in 70% alcohol) and 3 tablespoons of garlic flakes. Jars were capped with White Cap, 6-lug closures (fitted with serum stoppers for sampling) and then shaken well to distribute the ingredients.
9. **Sampling:** Sampled at 16 intervals for 103 days for pH and acidity. Also, color pictures taken initially and at intervals during storage. Observations were made as to color change of pickles: 0 reading = fresh green cucumber color; 4 = yellowish-straw color of fresh-pack dills.

RESULTS:

Refrigerated dills were prepared in the conventional manner, except no chemical preservatives were used and all ingredients were cooled to 38-40°F (cucumbers, brine, etc.) and the spices were sanitized. Storage was at 38-40°F throughout the experiment. The pickles were packed in 1 gal. jars (about 5 lbs) using mostly no. 2 size stock (1⅜ to 1½ inches in diam.).

About 1,200 ml of 18-20° sal. brine per jar, was acidified to obtain the desired, equilibrated brine pH of 4.6. For acidification, acetic acid was added at the rate of 25 ml of 10% glacial acetic acid. The added acid appeared to equilibrate in 24-48 hours (to about 0.18-0.20%, calculated as lactic); however, the equilibration of the brine pH took considerably longer, one to two weeks, if all the acid was added at the outset (see tabular material given in Table 1).

If only half of the acetic acid was added at the beginning, and the balance one to two days later, the equilibration was delayed for a period about equal to the time between the first and second addition of acid.

The desired "Raw Green Color" appearance was retained fairly well for about three to four weeks with storage at 38-40°F. Then, the color slowly changed to "yellowish-straw" or "fresh-pack" color.

After two months' storage (38-40°F); the brine was essentially clear and the acidity had changed very little, about 0.05-0.08%; and, after 103 days' storage, about 0.11-0.15% brine acid had been formed. By this time, the jars had been removed from the 38-40°F storage 16 times for brine sampling and examination as to appearance.

Two jars were opened at 103 days and were about 70% cured, but received high ratings as to overall quality (texture, flavor, etc.) for commercial use.

The results for the second run were, in general, comparable to those just described, except that when smaller cucumbers were packed, then the amount of acid needed to obtain the desired, equilibrated pH had to be increased. This was because of the greater buffering capacity of smaller-sized green stock. Thus, 25-30 ml of 10% acetic acid (100 grain vinegar) per gallon of brined material was sufficient to reach the desired pH of 4.5 to 4.6 with large no. 2's (1⅜-1½ inches diam.). However, 35-40 ml would probably be needed when smaller sizes are used (per gallon of brined material).

It would be imperative for the processor to make careful tests on the pH and brine acidity of blended lots using different cucumber sizes and combinations (and pack-out ratios) for the packed product, including different acidification levels, in order to obtain vital information necessary for packing a product that would consistently meet any Federal and State pH requirements so as to avoid any possibility of the product being considered a public health hazard, resulting from microbial growth of a pathogenic nature (i.e., *Cl. botulinum).*

It should be emphasized that the pH of the blended cucumber-brine-slurry (filtered through several layers of cheesecloth) from freshly made, refrigerated dills usually will be slightly higher (toward 7; about 0.10-0.15 pH units) than brine from the same product that is allowed to fully equilibrate in the jar under refrigerated conditions. This stems from the fact that all the buffering capacity of the blended raw cucumber is active in resisting the anticipated pH change. Apparently, the nonblended product, even after complete equilibration, does not have the buffering capacity in the brine as does the blended, freshly made pickles.

APPENDIX A: Table 1 (first run)

BRINE ACID AND pH EQUILIBRATION OF ACIDIFIED, REFRIGERATED DILLS IN 1 GALLON GLASS JARS, STORED AT 38-40°F (ca. 4-5°C).

Storage time after brining	Gallon jar number	Examination of the brine		Pickle color rating[3]
		pH	Acidity as acetic[5]	
Days	No.		%	
1	1	4.05	0.11	0
	2	3.95	.13	0
	3	4.05	.12	0
	4[1]	4.25	.09	0
	5	4.55	.08	0
2	1	4.30	0.11	0
	2	4.15	.12	0
	3	4.27	.12	0
	4	4.05	.12	0
	5[2]	4.75	.06	0
3	1	4.42	0.10	0
	2	4.30	.11	0
	3	4.35	.11	0
	4	4.25	.12	0
	5	4.35	.12	0
5	1	4.30	0.12	
	2	4.30	.12	
	3	4.38	.12	
	4	4.25	.12	
	5	4.42	.12	
7	1	4.50	0.12	0
	2	4.43	.12	0
	3	4.47	.12	1
	4	4.40	.12	1-2
	5	4.50	.12	2
11	1	4.45	0.14	
	2	4.45	.13	
	3	4.48	.14	
	4	4.42	.15	
	5	4.53	.15	
14[4]	1	4.65	0.14	0
	2	4.63	.15	0
	3	4.65	.15	1
	4	4.58	.15	1-2
	5	4.70	.17	2
21	1	4.50	0.15	1
	2	4.50	.16	1
	3	4.53	.15	1-2
	4	4.48	.14	1-2
	5	4.45	.16	2

Storage time after brining	Gallon jar number	Examination of the brine		Pickle color rating[3]
		pH	Acidity as acetic[5]	
Days	No.		%	
28	1	4.53	0.15	
	2	4.50	.16	
	3	4.55	.15	
	4	4.50	.16	
	5	4.58	.17	
34	1	4.50	0.15	
	2	4.50	.16	
	3	4.50	.15	
	4	4.50	.15	
	5	4.58	.17	
44	1			3
	2			3
	3	(No chemical data)		3
	4			3
	5			2+
48	1	4.45	0.16	3
	2	4.50	.15	3
	3	4.55	.14	3
	4	4.50	.15	3
	5	4.57	.16	2-3
57	1			4
	2			4
	3	(No chemical data)		4—
	4			4—
	5			3+
61	1	4.44	0.16	3+
	2	4.38	.17	3-4
	3	4.40	.16	3-4
	4	4.40	.17	3-4
	5	4.43	.17	3-4
72	1			4
	2			4
	3	(No chemical data)		4
	4			4
	5			4
103	1	4.30	0.20	4
	2	-		-
	3	4.35	0.20	4
	4	-		-
	5	-		-

[1]Final 1/2 (13 ml) of 10% acetic acid added 1 day after brining, after sampling.
[2]Final 1/2 (13 ml) of 10% acetic acid added 2 days after brining, after sampling.
[3]0 Reading = fresh green cucumber color; 4 = yellowish-straw color of fresh-pack dills.
[4]Brine pH's about 0.15-0.2 high (toward 7) based on acidity and pH data for 11 and 21 days.
[5]To convert to lactic acid, multiply by 3 and divide by 2.

APPENDIX A: Table 2 (second run)

BRINE ACID AND pH EQUILIBRATION OF ACIDIFIED, REFRIGERATED DILLS IN 1 GALLON GLASS JARS, STORED AT 38-40°F (ca. 4-5°C).
(Started June 21, 1974)

Storage time after brining	Gallon jar no.[1] & equivalent amount of 100 grain vinegar		Examination of the brine as to:				Pickle color rating[2]
			pH	Acidity calculated as		Salt (NaCl) conc.	
				Lactic	Acetic		
Days	No.	ml		%	%	%	
3	1	20	4.20	0.15	0.10	2.25	0
	2	30	4.58	.13	.09	2.35	0
	3	30	4.33	.28	.18	2.20	0
	4	40	4.18	.20	.13	2.30	0
	5	40	4.22	.20	.13	2.30	0
Weeks							
1	1		4.75	0.12	0.18	1.95	0
	2		4.51	.16	.10	2.05	0
	3		4.46	.28	.18	2.05	0
	4		4.40	.20	.13	2.00	0
	5		4.39	.20	.13	2.00	0
2	1		4.83	0.14	0.09	1.80	0
	2		4.56	.20	.13	1.80	0
	3		4.59	.19	.12	1.80	0
	4		4.48	.24	.16	1.80	0
	5		4.45	.24	.16	1.80	0
3	1		4.93	0.11	0.07	1.70	±
	2		4.82	.14	.09	1.75	±
	3		4.76	.18	.12	1.75	±
	4		4.62	.22	.14	1.80	1-2
	5		4.59	.23	.15	1.70	1-2
4	1		4.97	0.16	0.10	1.70	1-2
	2		4.68	.19	.12	1.75	1-2
	3		4.72	.19	.12	1.70	1-2
	4		4.57	.25	.16	1.75	2-3
	5		4.56	.22	.14	1.75	2-3
5	1		4.91	0.16	0.10	1.65	1-2
	2		4.65	.19	.12	1.75	1-2
	3		4.69	.19	.12	1.70	1-2
	4		4.56	.26	.14	1.70	2-3
	5		4.55	.24	.16	1.75	2-3
Weeks							
6	1		4.90	0.16	0.10	1.60	1-2
	2		4.64	.19	.12	1.70	2
	3		4.68	.19	.12	1.70	2
	4		4.55	.25	.16	1.70	2-3
	5		4.55	.25	.16	1.70	2-3
8	1	20	4.86	0.18	0.12	1.60	2
	2	30	4.63	.20	.13	1.70	2
	3	30	4.68	.20	.13	1.70	2
	4	40	4.55	.24	.16	1.70	3
	5	40	4.54	.20	.13	1.70	3
10	1		4.74	0.18	0.12	1.60	2
	2		4.54	.21	.14	1.70	3-4
	3		4.51	.22	.14	1.70	3-4
	4		4.50	.27	.18	1.70	4
	5		4.35	.25	.16	1.70	4
11	1		4.32	0.20	0.13		2
	2		4.54	.23	.15		3
	3		4.53	.23	.15	. . .	3
	4		4.44	.28	.19		3
	5		4.44	.27	.18		4
12	1		4.71	0.22	0.15		3-4
	2		4.52	.23	.15		4
	3		4.55	.24	.16	. . .	4
	4		4.44	.28	.19		4
	5		4.43	.27	.18		4
19	1		4.54	0.26	0.18	1.70	4
	2		4.09	.45	.30	1.80	4
	3		4.19	.48	.32	1.70	4
	4		4.45	.32	.21	1.70	4
	5		4.42	.30	.20	1.70	4

[1]Acidification treatment, using 10% acetic acid: jar no. 1, received 20 ml; jar nos. 2 & 3, 30 ml; and jar nos. 4 & 5, 40 ml. All jars were refrigerated promptly after preparation.

[2]Pickle color ratings: 0 reading means fresh green cucumber color; 4 means yellowish-straw color similar to fresh-pack dills. Note: There was little or no evidence of microbial turbidity after 8 weeks.

APPENDIX B:

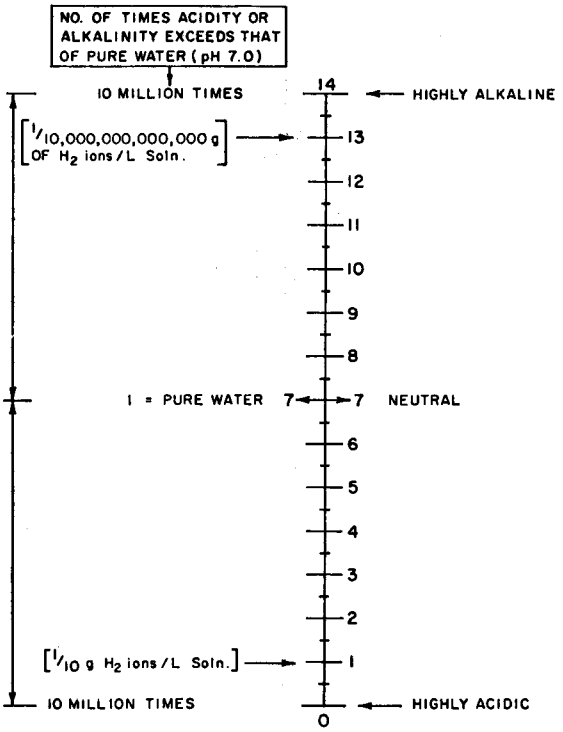

Fig. 1. The pH chart. (Based on grams of Hydrogen ions/liter of soln.; from J. L. St. Johns, Food Inds. 13 (12): 66 (1941).)

APPENDIX B:

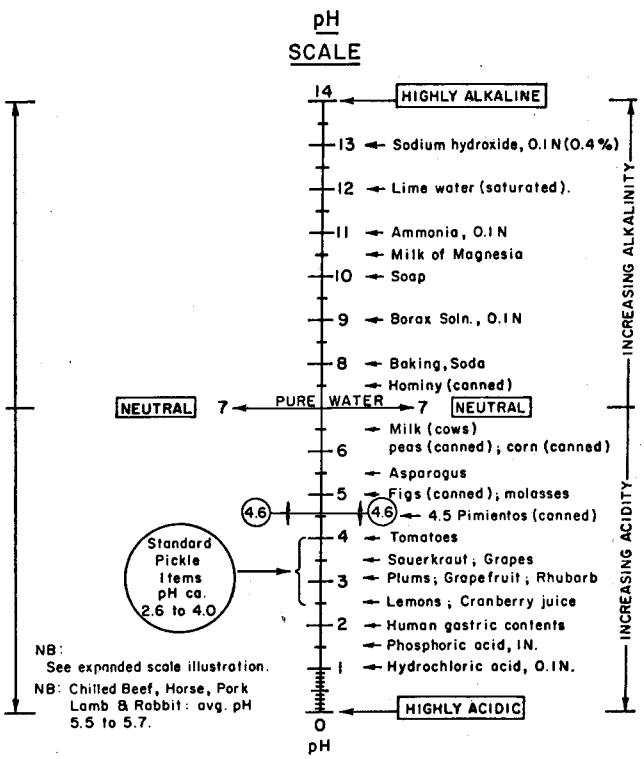

Fig. 2. pH values of certain common items, including pickles. (Based in part on J. L. St. Johns, Food Inds. 13 (12): 66 (1941) and, "The Canned Food Reference Manual," American Can Co., 3rd ed., 1947.)

APPENDIX B:

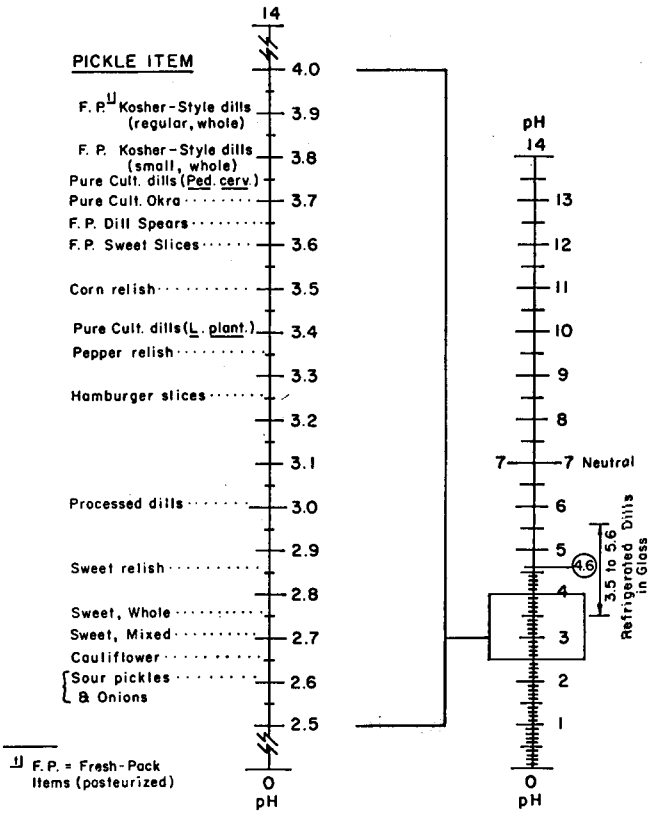

Fig. 3. Expanded pH scale for pickle products. (Based on information compiled by cooperating personnel of the U.S. Food Fermentation Laboratory and the Department of Food Science, N. C. State University, Raleigh, 27607.)

APPENDIX C:

EVALUATION OF REFRIGERATED DILL PICKLES FROM RETAIL CONTAINERS (1 QT. GLASS) COLLECTED PRIMARILY IN THE METROPOLITAN NEW YORK CITY AREA[1]

Summarized Results

During the three-day period from March 31-April 2, 1972, a total of 25 samples, consisting of 24, 1 qt. jars and a single 1½ qt. jar of whole, "Refrigerated Dill Pickles" (= overnight, half-sour dills, or new pickles, etc.) were collected in the metropolitan area of New York City. These samples, representing products prepared by seven manufacturers, were obtained from refrigerated cases in nine large retail stores located in two counties of New Jersey (Bergen and Passaic).

The pickles, stored at 40°F (ca. 5°C), were evaluated on the premises of a cooperating New Jersey pickle plant as to "Overall Acceptability" by a panel of five experienced judges. These ratings, based mostly on product flavor, odor, texture, and appearance, were supplemented with a number of chemical and physical tests such as: acidity, pH, and salt content of the pickle brine; together with bloater content, % cure, and firmness measurements on whole pickles. The latter chemical and physical tests are summarized herein (APPENDIX D).

[1]Prepared by John L. Etchells.

Of the first 25 samples judged (see Table 1, area IA), over half (56%) were placed as "Not Acceptable." Only one-fifth (20%) of the pickle samples were rated as "Good." Of the remaining samples, three (12%) were judged "Fair;" and one each (4%) was placed as "Excellent," "Poor," and "Barely Acceptable." The reasons most frequently given by the judges for their ratings of "Not Acceptable" were: (1) the product was actively fermenting, resulting in an unpleasant odor and flavor; (2) the pickles were soft, apparently resulting from an undesirable fermentation, faulty closure, or packing moldy stock; and, (3) the green-stock used was already undergoing decomposition and spoilage at the time it was packed.[2]

It was also noted that, of the 14 samples rated "Not Acceptable," 10 had undergone vigorous fermentation with a visual brine turbidity value of 3+ or greater; also, this condition was usually accompanied by gas pressure on the cap, ranging from a low of 0.5 lb to a high of 8 lbs (measured at 40°F). The five lots of pickles receiving the highest numerical ratings, namely, 9, 8.2, 8, 8, and 7.4 (based on a score of 1 = Not Acceptable to 10 = Excellent), all had brine turbidity values of 2+ or less (two had "0" turbidity).

A follow-up study on 23 jars collected in the same metropolitan production area about three-four months later (APPENDIX C, Tables 1 (IB) and 2) gave better results as to fewer number of jars of pickles placed as "Not Acceptable" (half of the number of the first set of samples), but the "Barely Acceptable" to "Poor" ratings represented nearly 40% of the jars. The percentage of jars of pickles placed as "Fair," "Good" and "Excellent" amounted to 17, 13 and 17%, respectively.

It is apparent that the quality of Refrigerated Dill Pickles in glass jars being offered the consumer in the geographical area(s) sampled leaves much to be desired.[3]

[2]Reasons given by the judges for ratings for pickle samples from other geographical areas (including a second run on the area I) were essentially the same as given above.

[3]Results of examination of some 73 Refrigerated Dill Pickle samples, including the first 25 of those discussed above, from five geographical areas of the USA, are shown in Table 1, Sources I, II, III, IV, and V.

APPENDIX C: Table 1

SUMMARY OF RESULTS OF THE EVALUATION OF 73 SAMPLES OF REFRIGERATED DILL PICKLES FROM SEVERAL GEOGRAPHICAL AREAS OF THE COUNTRY[1]

Area	Source of samples	Number of samples	Number and percentage of samples placed in each rating category											
			Not Acceptable		Barely Acceptable		Poor		Fair		Good		Excellent	
	Code		no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
I-A	NYA[2]	25	14	56	1	4	1	4	3	12	5	20	1	4
B	NYB[3]	23	3	13	3	13	6	26	4	17	3	13	4	17
II	CM	10	0	0	4	40	2	20	2	20	2	20	0	0
III	DM	8	1	12.5	2	25	2	25	2	25	1	12.5	0	0
IV	RDU	5	2	40	0	0	0	0	3	60	0	0	0	0
V	SDM	2	0	0	0	0	1	50	0	0	1	50	0	0
	Total	73	20	27%	10	14%	12	16%	14	19%	12	16%	5	7%

[1]Samples were, with one exception, in 1 qt. glass jars stored in refrigerated counters or cases of large retail stores. Period covered by samplings was from April 1, 1972 to August 19, 1972.
[2]Metropolitan area of the coded city. Sampling made April 1, 1972, unless otherwise stated.
[3]Sampling made August 19, 1972.

APPENDIX C: Table 2

SUMMARY OF RESULTS OF THE EVALUATION OF 23 ADDITIONAL SAMPLES OF REFRIGERATED DILL PICKLES IN THE NEW YORK CITY AREA (AUGUST 19, 1972).

Manufacturer in NYB area	Number of samples	Number and percentage of samples placed in each rating category											
		Not Acceptable		Barely Acceptable		Poor		Fair		Good		Excellent	
I		no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
A	8	2	25	1	12.5	1	12.5	3	37.5	1	12.5	0	0
B	6	0	0	0	0	0	0	1	17	1	17	4	66
C	6	1	16	2	34	3	50	0	0	0	0	0	0
D	2	0	0	0	0	1	50	0	0	1	50	0	0
E	1	0	0	0	0	1	100	0	0	0	0	0	0
Total	23	3	13%	3	13%	6	26%	4	17%	3	13%	4	17%

APPENDIX D: Sample Area I-NYA Table 1

Summarized Information on Certain Physical Characteristics of Jar Contents, the Jar Closure, Product Price, and Pickle Quality of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples[1]	Values shown represent the range: Volume of brine	Number of pickles	Size of pickles (diameter)	Pct. of jar occupied by pickles	Vacuum or pressure on container closure		Product price	Quality rating[2] of product as to acceptability	
						Vac.	Pres.			
I:	No.	Ounces	No.	Inches	%	Inches	Pounds	Cents	Score	Adjective
NYA-A	6	14 to 15	7 to 18	5/8 to 1½	53-56	0-0	0-0.5	79-79	1-6	NA-F
B	6	11 to 14½	7 to 14	3/8 to 2⅛	51-65	½ to 2½	3-8	59-65	1-8	NA-G
C	3	10½ to 15	7 to 9	¾ to 1⅞	53-67	0-0	1-5	55-69	1-7	NA-G
D	5	13 to 15	7 to 10	½ to 1⅝	52-59	½ to 10	½ to 5	59-59	1-9	NA-E
E	3	12½ to 13	13-14	1 to 1¼	59-61	0-0	0-6	69-69	1-2	NA-BA
F	1	12½	7	¾ to 1⅜	61	1	0	59	1-1	NA-NA
G	1	13	8	⅞ to 2	59	0	4	65	1-1	NA-NA
Average for sample area	25	13	10	1⅛	58	1	3	66	1	Not Acceptable

[1]All jars 32 oz. capacity.
[2]Quality ratings: Excellent (E) = 9-10; Good (G) = 7-8; Fair (F) = 5-6; Poor (P) = 3-4; Barely Acceptable (BA) = 2; and, Not Acceptable (NA) = 1.

APPENDIX D: Sample Area I-NYA Table 2

Summarized Information on Brine Analysis and Examination of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples	Values shown represent the range: Brine analysis as to: Acidity as		pH	Salt content (NaCl)	Visual turbidity[1]	Examination of pickles as to: Degree of cure	Pickle firmness[2]	Bloaters found[3]
		Lactic	Acetic						
I:	No.	%	%		%	0-5+	%	Pounds	%
NYA-A	6	0.165-.276	0.11-.184	4.63-5.21	2.3-3.6	1-4+	0-60	8-18	0-0
B	6	0.108-1.02	0.072-.678	3.67-5.29	1.8-3.4	0-4+	5-80	8-19	0-67
C	3	0.078-.765	0.052-.51	3.65-5.34	2.2-3.1	2-5+	5-100	10-20	33-44
D	5	0.135-.525	0.09-.35	3.93-4.83	2.3-2.8	1-4+	0-30	10-19	0-10
E	3	0.52-.87	0.38-.58	3.63-4.08	4.0-4.2	2-3+	70-90	15-16	0-15
F	1	0.39	0.26	4.35	2.4	2+	30	13	0
G	1	0.375	0.25	4.11	2.2	3+	30	12	0
Average for sample area	25	0.397	0.266	4.41	2.8	2+	30	15	7

[1]Turbidity: 0 = Clear; 1+ = Slightly turbid (= cloudy or milky); 5+ = Very turbid.
[2]Firmness ratings by USDA Fruit Pressure Tester: 18 lbs and above = Very firm pickles; 14-17 lbs = Firm; 11-13 lbs = Inferior; 5-10 lbs = Soft; 4 lbs and below = Mushy; ten pickles tested for firmness; if less in jar, actual number used.
[3]Bloater values include both Balloon and Lens types; all pickles in jar were cut.

APPENDIX D: Sample Area II-CM
Table 3

Summarized Information on Certain Physical Characteristics of Jar Contents, the Jar Closure, Product Price, and Pickle Quality of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples[1]	Values shown represent the range:								
		Volume of brine	Number of pickles	Size of pickles (diameter)	Pct. of jar occupied by pickles	Vacuum or pressure on container closure		Product price	Quality rating[2] of product as to acceptability	
						Vac.	Pres.			
II:	No.	Ounces	No.	Inches	%	Inches	Pounds	Cents	Score	Adjective
CM-A	7	11-13	7-9	½ to 1¼	46-58	0-0	5-14	65-73	2-7	BA-G
B	3	10½ to 12	6-7	1 to 1½	50-56	0-0	10-15	73-73	2-5	BA-F
Average for sample area	10	11.2	7	1-1/16	52	0	11	70	4	Poor

[1]All jars 24 oz. capacity.
[2]Quality ratings: Excellent (E) = 9-10; Good (G) = 7-8; Fair (F) = 5-6; Poor (P) = 3-4; Barely Acceptable (BA) = 2; and, Not Acceptable (NA) = 1.

APPENDIX D: Sample Area II-CM
Table 4

Summarized Information on Brine Analysis and Examination of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples	Values shown represent the range:							
		Brine analysis as to:					Examination of pickles as to:		
		Acidity as		pH	Salt content (NaCl)	Visual turbidity[1]	Degree of cure	Pickle firmness[2]	Bloaters found[3]
		Lactic	Acetic						
II:	No.	%	%		%	0-5+	%	Pounds	%
CM-A	7	0.38-0.63	0.25-0.42	3.45-4.00	3.10-4.10	1-3+	5-50	18-20	0-85.7
B	3	0.36-0.72	0.24-0.48	3.45-3.85	3.00-3.40	2-2+	10-15	19-20	28.6-33.3
Average for sample area	10	0.52	0.34	3.70	3.46	2+	18	19	24.3

[1]Turbidity: 0=Clear; 1+=Slightly turbid (= cloudy or milky); 5+=Very turbid.
[2]Firmness ratings: see footnote 2, Table 2.
[3]Bloater values: see footnote 3, Table 2.

APPENDIX D: Sample Area III-DM
Table 5

Summarized Information on Certain Physical Characteristics of Jar Contents, the Jar Closure, Product Price, and Pickle Quality of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples[1]	Values shown represent the range: Volume of brine	Number of pickles	Size of pickles (diameter)	Pct. of jar occupied by pickles	Vacuum or pressure on container closure		Product price	Quality rating[2] of product as to acceptability	
						Vac.	Pres.			
III:	No.	Ounces	No.	Inches	%	Inches	Pounds	Cents	Score	Adjective
DM-A	2	13⅛	7-7	1¼ to 1¾	58-58	0-0	0 to ½	64	1-2	NA-BA
B	2	11½ to 13½	9-16	⅞ to 1⅜	58	0-0	0-0	77-77	6-7	F-G
C	2	13½ to 15¼	14-16	¾ to 1⅜	52-58	0	0-8	74	2-4	BA-P
D	2	11⅔ to 14½	7-13	1⅛ to 1½	55-64	0-0	1-1	59-59	3-6	P-F
Average for sample area	8	13⅜	11	1¼	58	0	1.4	68	4	Poor

[1]All jars 32 oz. capacity.

[2]Quality ratings: Excellent (E) = 9-10; Good (G) = 7-8; Fair (F) = 5-6; Poor (P) = 3-4; Barely Acceptable (BA) = 2; and, Not Acceptable (NA) = 1.

APPENDIX D: Sample Area III-DM
Table 6

Summarized Information on Brine Analysis and Examination of Refrigerated Dill Pickes—Values Shown are the Range.

Area and mfr. codes	Number of samples	Values shown represent the range: Brine analysis as to: Acidity as Lactic	Acidity as Acetic	pH	Salt content (NaCl)	Visual turbidity[1]	Examination of pickles as to: Degree of cure	Pickle firmness[2]	Bloaters found[3]
III:	No.	%	%		%	0-5+	%	Pounds	%
DM-A	2	0.42-0.42	0.29-0.29	4.23-4.28	2.45-2.68	1-1+	25-30	—	0-0
B	2	0.33-0.35	0.22-0.23	4.58-4.63	2.26-2.60	1-1+	5-10	—	0-0
C	2	0.42-0.46	0.28-0.31	3.88-4.01	2.28-2.46	4-4+	10-20	—	0-40
D	2	0.66-0.79	0.44-0.53	3.78-4.03	2.28-2.90	4-4+	85-90	—	10-14.3
Average for sample area	8	0.48	0.32	4.18	2.49	3+	41		8

[1]Turbidity: 0=Clear; 1+=Slightly turbid (= cloudy or milky); 5+=Very turbid.

[2]Firmness ratings: see footnote 2, Table 2.

[3]Bloater values: see footnote 3, Table 2.

APPENDIX D: Sample Area IV-RDU

Table 7

Summarized Information on Certain Physical Characteristics of Jar Contents, the Jar Closure, Product Price, and Pickle Quality of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples[1]	Values shown represent the range:								
		Volume of brine	Number of pickles	Size of pickles (diameter)	Pct. of jar occupied by pickles	Vacuum or pressure on container closure		Product price	Quality rating[2] of product as to acceptability	
						Vac.	Pres.			
IV:	No.	Ounces	No.	Inches	%	Inches	Pounds	Cents	Score	Adjective
RDU-A	3	14-16	8-17	7/8 to 1 3/4	51-56	1-1	—	89-89	5-6	F-F
B	2	11-13	8	3/4 to 1 3/4	54-66	—	.5	99-99	1-1	NA-NA
Average for sample area	5	14	7	1 1/4	56	1	.5	93	3	Poor

[1]All jars 32 oz. capacity.
[2]Quality ratings: Excellent (E) = 9-10; Good (G) = 7-8; Fair (F) = 5-6; Poor (P) = 3-4; Barely Acceptable (BA) = 2; and, Not Acceptable (NA) = 1.

APPENDIX D: Sample Area IV-RDU

Table 8

Summarized Information on Brine Analysis and Examination of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples	Values shown represent the range:							
		Brine analysis as to:					Examination of pickles as to:		
		Acidity as		pH	Salt content (NaCl)	Visual turbidity[1]	Degree of cure	Pickle firmness[2]	Bloaters found[3]
		Lactic	Acetic						
VI:	No.	%	%		%	0-5+	%	Pounds	%
RDU-A	3	0.55-0.60	0.37-0.40	3.90-4.05	2.85-3.07	0-.17+	0-40	15-17.8	0-0
B	2	0.70	0.47	3.55	2.41	3.10-4+	100	4-8.8	0-42.2
Average for sample area	5	0.61	0.41	3.87	2.83	1.47+	36	12.4	8.4

[1]Turbidity: 0=Clear; 1 + =Slightly turbid (= cloudy or milky); 5 + =Very turbid.
[2]Firmness ratings: see footnote 2, Table 2.
[3]Bloater values: see footnote 3, Table 2.

APPENDIX D: Sample Area V-SDM

Table 9

Summarized Information on Certain Physical Characteristics of Jar Contents, the Jar Closure, Product Price, and Pickle Quality of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples[1]	Values shown represent the range:								
		Volume of brine	Number of pickles	Size of pickles (diameter)	Pct. of jar occupied by pickles	Vacuum or pressure on container closure		Product price	Quality rating[2] of product as to acceptability	
						Vac.	Pres.			
V:	No.	Ounces	No.	Inches	%	Inches	Pounds	Cents	Score	Adjective
SDM-A	2	12-14	10-11	5/8-1 3/8	56-56	9-0	0-½	69	3-8	P-G
Average for sample area	2	13	10½	1-1/16	56	4.5	¼	69	6	Fair

[1]All jars 32 oz. capacity.

[2]Quality ratings: Excellent (E) = 9-10; Good (G) = 7-8; Fair (F) = 5-6; Poor (P) = 3-4; Barely Acceptable (BA) = 2; and, Not Acceptable (NA) = 1.

APPENDIX D: Sample Area V-SDM

Table 10

Summarized Information on Brine Analysis and Examination of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples	Values shown represent the range:							
		Brine analysis as to:					Examination of pickles as to:		
		Acidity as		pH	Salt content (NaCl)	Visual turbidity[1]	Degree of cure	Pickle firmness[2]	Bloaters found[3]
		Lactic	Acetic						
V:	No.	%	%		%	0-5+	%	Pounds	%
SDM-A	2	0.135-0.594	0.396-0.90	3.6-5.3	2.0-2.8	0-5.0	0-0	19-19	10-36
Average for sample area	2	0.365	0.648	4.5	2.4	2.5+	0	19	23

[1]Turbidity: 0 = Clear; 1+ = Slightly turbid (= cloudy or milky); 5+ = Very turbid.

[2]Firmness ratings: see footnote 2, Table 2.

[3]Bloater values: see footnote 3, Table 2.

APPENDIX D: Sample Area VI-NYB

Table 11

Summarized Information on Certain Physical Characteristics of Jar Contents, the Jar Closure, Product Price, and Pickle Quality of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples[1]	Values shown represent the range: Volume of brine	Number of pickles	Size of pickles (diameter)	Pct. of jar occupied by pickles	Vacuum or pressure on container closure		Product price	Quality rating[2] of product as to acceptability	
						Vac.	Pres.			
VI: NYB-A	No. 8	Ounces 13½ to 16	No. 7-12	Inches ¾ to 1½	% 50-58	Inches ½	Pounds 2-6.5	Cents 63-69	Score 1-8	Adjective BA-G
B	6	14-15	8-10	¾ to 1¾	53-56	3-11	2	49-59	6-10	F-E
C	6	12¾ to 16	6-8	1 to 1¾	50-60	0-0	0-4	79-79	1-4	NA-P
D	2	13½ to 15½	8-10	1¼ to 1¾	52-58	0-0	0-4	48-48	3-7	P-G
E	1	14	7	1¼ to 1½	56	8	0	65	4	P
Average for sample area	23	15	9	1-5/16	54	3	2	65	5	Fair

[1]All jars 32 oz. capacity.

[2]Quality ratings: Excellent (E) = 9-10; Good (G) = 7-8; Fair (F) = 5-6; Poor (P) = 3-4; Barely Acceptable (BA) = 2; and, Not Acceptable (NA) = 1.

APPENDIX D: Sample Area VI-NYB

Table 12

Summarized Information on Brine Analysis and Examination of Refrigerated Dill Pickles—Values Shown are the Range.

Area and mfr. codes	Number of samples	Values shown represent the range: Brine analysis as to: Acidity as Lactic	Acidity as Acetic	pH	Salt content (NaCl)	Visual turbidity[1]	Examination of pickles as to: Degree of cure	Pickle firmness[2]	Bloaters found[3]
VI: NYB-A	No. 8	% 0.21-70	% 0.20-.47	3.47-4.48	% 2.3-3.6	0-5+ 1-3+	% 40-80	Pounds 5-17	% 0-22
B	6	0.15-.40	0.10-.27	3.96-4.97	2.5-3.0	0-3+	60-80	14-17	0-0
C	6	0.32-76	0.21-51	3.89-4.55	3.3-4.0	0-4+	40-80	15-18	0-33
D	2	0.16-.45	0.11-.30	3.87-5.14	2.3-2.7	0-2+	60-75	13-15	0-15
E	1	0.36	0.24	4.21	2.8	0+	75	17	0
Average for sample area	23	0.39	0.26	4.30	2.9	2+	64	15	6

[1]Turbidity: 0 = Clear; 1+ = Slightly turbid (= cloudy or milky); 5+ = Very turbid.

[2]Firmness ratings: see footnote 2, Table 2.

[3]Bloater values: see footnote 3, Table 2.

APPENDIX E
Table 1

Summary of Extent of Additives Declared on Labels of 73 Samples of Refrigerated Dill Pickles Examined

Area of mfrs., no. of mfrs. & sample code identity			No. of sample labels examined	No. of sample labels declaring the following additives:			
				Sodium Benzoate	Sorbic Acid[1]	Distilled Vinegar	Other
area	no.	code		no.	no.	no.	no.
I	7	NYA	25	10	3	0	1[2]
II	2	CM	10	0	0	0	10[3]
III	4	DM	8	2	2	2	0
IV	2	RDU	5	0	0	3	0
V	1	SDM	2	2	2	0	0
VI	5	NYB	23	5	2	11	2[4]
		Total	73				

[1]Refers also to "Sorbaice" and "Potassium Sorbate."
[2]Refers to "acetic acid" added.
[3]Refers to "alum" added.
[4]Refers to "artificial" color added.
Note: For additional information on additives for individual manufacturers, see attached notes (APPENDIX E, cont.).

APPENDIX E (cont.)
Additive Notes

Area I — **25 samples,** 7 mfrs.: 1 mfr. with vinegar and benzoate of soda, 5 of 6 samples; 1 mfr. with no sorbic acid and no vinegar, 6 samples; 1 mfr. with sorbic acid and no vinegar, 3 samples; 1 mfr. with vinegar only, 5 samples, plus 1 with benzoate of soda plus vinegar; 1 mfr. with acetic acid, 4 samples; 1 mfr. with sodium benzoate, 3 samples; 1 mfr. with no additives listed, 1 sample.

Area II — **10 samples,** 2 mfrs.: both with alum, 10 samples; no other additives declared.

Area III — **8 samples,** 4 mfrs.: 1 mfr. with sodium benzoate, 2 samples; 1 mfr. with potassium sorbate, 2 samples; 2 mfrs. with no additives declared, 4 samples.

Area IV — **5 samples,** 2 mfrs.: 1 mfr. with distilled vinegar only, 3 samples; 1 mfr. with no additives declared, 2 samples.

Area V — **2 samples,** 1 mfr.: both samples with 2 preservatives, sodium benzoate (0.1%) and potassium sorbate. This would be above legal amounts of preservatives acceptable.

Area VI — **23 samples,** 5 mfrs.: 1 mfr., nothing declared, 8 samples; 1 mfr., distilled vinegar declared, 6 samples; 1 mfr., sodium benzoate and vinegar declared, 4 of 5 samples, plus artificial color for 2 samples; 1 mfr., sorbic acid declared for both samples; 1 mfr., 1 sample, with both sodium benzoate and vinegar declared.

APPENDIX F:

Some of the Names of Refrigerated Dill Pickles Taken From Labels

1. Half Sour, Fresh Kosher New Dills
2. New Half Sours
3. Kosher New Dills
4. Sour Garlic Pickles
5. Fresh-Packed, Half Sour Pickles
6. Kosher New Pickles
7. Half Sour, New Pickles
8. Home-Style, New Pickles
9. Overnight, Kosher Dill Pickles
10. Barrel Cured Kosher Dills—Fresh
11. Home Style, Kosher New Pickles
12. BBL Cured Homemade Pickles

APPENDIX G: Table 1

pH OF FRESH, PICKLING CUCUMBERS OF DIFFERENT SIZES (MODEL VARIETY)[1]

Cucumber size as to diameter	Weight	pH of blended cucumber tissue
Inches	**Grams**	
3/8 to 5/8	5 to 10	6.1
to 7/8	10 to 25	5.9
to 1 1/8	25 to 50	5.8
to 1 3/8	50 to 75	5.7
to 1 1/2	75 to 100	5.8
to 1 3/4	100 to 150	5.7
to 1 7/8	150 to 200	5.8
to 2	200 to 300	5.2
> 2[2]	> 300	4.4 to 5.0

[1]From: Bell, T. A., *Botanical Gazette* 113 (2): 216-221. 1951.
[2]Ripe or near ripe cucumbers may be pH 3.8 or even lower, particularly near the seed area.

APPENDIX G: Table 2

ACIDITY AND pH OF CERTAIN PICKLE PRODUCTS[1] FROM PPI[2] QUALITY EVALUATIONS OF ITEMS SUBMITTED BY MEMBERS.

Type of pickle	Samples tested	Acidity as acetic acid	Brine pH
	Number	Range in %	Range
Processed dills	27	0.50-0.90	3.0-3.4
Fresh-pack dills	21	0.42-0.86	3.4-4.2
Processed, hamburger slices	12	0.59-1.19	3.0-3.6
Fresh-pack sweet slices	19	0.80-1.43	3.4-3.8

[1]Results shown represent analysis of a large number of packers submitting one or two samples for examination at regular PPI Meetings.
[2]Pickle Packers International, Inc. (St. Charles, IL).

APPENDIX G: Table 3

pH VALUES OF CERTAIN PICKLE PRODUCTS FROM A COOPERATING COMPANY (A)

Pickle Item	No. of samples	Brine pH
		Range
Processed Pickles		
Sweet, whole	10	2.60-3.00
Sweet, mixed	9	2.60-2.90
Sour	9	2.50-2.90
Dills	22	2.75-3.25
Fresh-pack pickles		
Kosher-style dills	15	3.50-3.80
Kosher-style, baby dills	26	3.70-4.00
Dill strips (spears)	10	3.60-3.80
Sweet chips (slices)	15	3.40-3.75
Sweet strips (spears)	10	3.35-3.80

APPENDIX G: Table 4

pH VALUES OF CERTAIN PICKLE PRODUCTS FROM A COOPERATING COMPANY (B)

Pickle Item	Processed pickles (pH)		Fresh-pack pickles (pH)	
	Brine	Pickle	Brine	Pickle
	Range	Range	Range	Range
Dills, whole	2.50-2.90	2.60-2.85	3.00-3.50	3.00-3.60
Dills, slices	2.75-2.85	2.70-2.85	3.30-3.40	3.30-3.40
Sweet, whole	2.70-3.00	2.65-3.10	—	—
Sweet, sliced	2.45-2.95	2.40-2.90	3.10-3.50	3.20-3.50
Mustard pickle	2.75[1]	—	—	—
Sweet relish	2.80-2.90[1]	—	—	—
Corn relish	3.55[1]	—	—	—
Pepper relish	3.35[1]	—	—	—
Cauliflower	2.65	3.00	—	—
Onions	2.60	2.70	—	—

[1]Refers to whole product, liquid and solids blended.
NOTE: Number of samples tested was not given.