

# BACTERIOLOGY OF PRECOOKED FROZEN FOODS<sup>1</sup>

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The precooked frozen food industry involves many problems of production, distribution and merchandising of these food products. All or a combination of these problems may alter the physical properties of these foods or change the flavor, odor and color of the product. Lastly, the biological and biochemical activity may determine the acceptability of frozen foods by the consumer. The activity of microorganisms in frozen foods should not be underestimated.

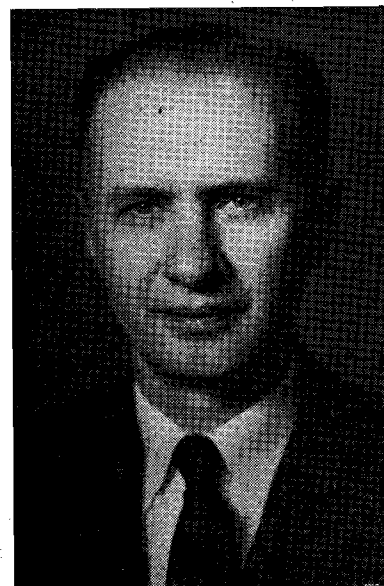
Microorganisms are widely distributed in nature so their presence in foods is not unusual. They respond to their environment such as temperature, oxygen, moisture and food supply. However, the nature of raw food products and the manner in which they are used, such as frozen fruits and vegetables served in raw salads, will influence the microbial content and may also be a source of infection if pathogenic organisms are present.

The greater the microbial contamination of the raw product the more numerous the organisms will be in the product to be processed. Obviously any method used to reduce the numbers of organisms in the product prior to processing will reflect in fewer microorganisms in the finished product. This in turn may be an important factor in determining the keeping quality of the foods.

Procter and Phillips (4) examined more than 125 different kinds of commercially prepared cooked foods and reported that the bacterial plate count ranged from 50,000 to 1,000,000 per gram. The direct microscopic count ranged from 500,000 to 40,000,000 per gram on similar samples.

Buchbinder *et al.* (1) studied the bacterial content on 40 samples of frozen foods at the retail outlets. They reported more than 1,000,000 bacteria per gram of viable organisms and over one-fourth of the samples showed the presence of enterotoxin type of *Staphylococcus*.

There is evidence to indicate that some microorganisms may remain viable in freezing storage for two years with no appreciable loss in viability or virulence of the organisms, that is, their ability to produce disease.



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The cooking process may destroy many organisms, but there are some kinds of bacteria that are capable of withstanding the heat treatment during processing. However, the temperature used will determine the numbers and kinds of bacteria that survive. Fortunately, the organisms that remain after the heat treatment used in the preparation of the precooked food may not be of any great significance in the frozen foods because the temperature is unfavorable for their metabolic activity. This, of course, will depend very largely on the way in which the food is handled prior to freezing. The food may be cooked, cooled before freezing and allowed to stand or handled in such a way that gross contamination may be involved. In this case cooking the food will not correct contamination. Clean sanitary conditions must prevail throughout the entire process if a good quality product is to be produced.

## DISTRIBUTION

Precooked frozen foods produced under good sanitary practices is not a guarantee that such products will reach the consumer in a high quality state.

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Channels of distribution can be an important factor in the ultimate quality of the food. Inadequate refrigeration in warehouses, retail delivery trucks and retail stores may create favorable conditions for the growth of microorganisms which are usually present in such foods.

### FREEZING

The freezing process should not be relied upon to effectively destroy all of the microorganisms present in the food product. Low temperature slows up the metabolic activities of the organisms without any immediate destruction of them. Moreover, there is very little multiplication of the organisms at low temperature. The inherent enzymes normally present in the food and enzymes produced by the microorganisms present in the product respond to temperature changes. Hence enzyme activity is appreciably affected by low temperature.

The lower the temperature the more effect freezing will have on the keeping quality of the food. A temperature around 0°F. or sub-zero storage of the frozen food will reduce the microbial count rapidly during the first 10 to 15 days and then the reduction will be much slower. Presumably through the process of genetics, the more resistant organisms survive the low temperature better than the less resistant types.

Low temperature should not be relied upon to replace poor sanitation. In such a situation the quality of the product may be unacceptable due to the excessive number of bacteria present. If the organisms present are toxigenic, toxins may have been formed during the initial stage of microbial growth in the food. The preformed toxin is not appreciably affected by the low temperature. Therefore, the reduction in viable bacteria by zero storage has limited value and fosters a false sense of security from the public health standpoint. Many investigators believe that pathogenic or disease producing bacteria as well as other microorganisms can survive several months at sub zero temperatures.

Recently Salch and Ordal (6) have shown that *Clostridium botulinum* in precooked frozen chicken a-la-king produced botulinus toxin when the food was defrosted and held at 86°F. for two days. They concluded that botulism is potentially dangerous when precooked foods are not properly handled from the public health standpoint. Similarly, *Salmonella* and *Staphylococcus* could be more dangerous when the food is held under comparable conditions.

Procter and Phillips (5) inoculated a food poisoning strain of *Staphylococcus* and *Salmonella enteritidis* separately into cooked foods of various kinds and then froze the samples and stored them at 0°F for

several months. Approximately 10 per cent of the pathogens used survived for more than six months in the foods.

Studies were conducted by Winter, Weiser, and Lewis (7) on the control of bacteria in chicken salad. Standard plate and *Salmonella* bacterial counts did not show any appreciable increase in shallow pans of chicken salad held alternately six hours in a kitchen at 80°F. and 18 hours in a refrigerator at 41°F. during a three day holding period. Both the standard plate and *Salmonella* bacterial counts increased rapidly during the first 36 hours when held continuously in a kitchen at 72° to 80°F. for three days.

It is common practice in institutional kitchens to store diced chicken, without refrigeration for several hours, thus making environmental conditions favorable for microbial growth. The personal handling of the product by weighing and mixing prior to entering the unbaked pie can be an important factor in gross contamination.

Time and temperature are important factors in controlling the growth of microorganisms. It is not uncommon to have several million bacteria within a short time when conditions are favorable for microbial growth.

Therefore, improper storage of food at temperatures around 70° to 90°F. for a short time can result in gross contamination. All good sanitary practices will be cancelled out if other phases of the processing is conducive to maximum bacterial growth.

### COOKING

The cooking of raw food destroys many microorganisms that may be present in meats, poultry, vegetables and other products. A high bacterial contamination in the raw product may result in poor quality of the finished product because microbial activity may have caused excessive decomposition. Another important consideration is recontamination when the cooked foods are further processed prior to final freezing. A good example is chicken pies, when the meat of the chicken is cooked and then allowed to cool before the meat is removed from the carcass, usually by hand. Hence the human element may be an important factor in contamination. The dicing of the picked meat mechanically adds more organisms because these machines are difficult to clean and sanitize.

### MICROBIAL STANDARDS

Many undesirable organisms under favorable environment may induce spoilage and some bacteria may be significant from the public health standpoint. Ob-

viously the more sanitary practices emphasized the fewer undesirable organisms will be present in the food. There are microbiological standards for some foods in order to safeguard the public. Therefore, similar standards should apply to foods not regulated at the present time. The Quartermaster Food and Container Institute suggest a standard of not more than 100,000 viable bacteria per gram of precooked frozen food and a coliform count of less than 10 per gram.

Several investigators have recognized the need for standardized methods for the examination of frozen foods. Test organisms such as *Escherichia coli*, *Salmonella typhosa* and *Streptococcus faecalis* have been studied and only the latter culture was able to survive when all were inoculated into pasteurized orange concentrate and frozen.

The presence of fecal streptococci on vegetable samples in appreciable numbers seem to be sufficient evidence that this organism could be used as a test culture in checking the sanitary quality of various frozen products. The inference implies that the fecal streptococci are present in uncooled frozen foods. It may be possible that other intestinal types of bacteria may be present as well.

#### SUMMARY

The quality of the raw product, processing, added ingredients, storage and temperature are factors that will determine the shelf life of all precooked frozen foods. Usually the storage life of precooked frozen foods is much shorter than comparable frozen foods uncooked. The latter suffers a loss of the freshly cooked aroma and flavor of many seasoned products during freezing storage. The rancidity of fats may contribute to the loss of the product.

The composition of precooked foods will determine how long they may be stored. Stewed and sweetened fruits, seasoned beef stew, fruit cake and cookies may be stored for twelve months without any appreciable deterioration in flavor. Cooked vegetables, fried chicken or fish, barbecued pork and many bakery products cooked in deep fat, and left overs are stable for only a few weeks in freezing storage.

A bacteriological summary was made on frozen foods by E. P. Larkin *et al.* (2) at the University of Massachusetts. They stressed the fact that frozen foods, as possible health hazards, have been relatively free from suspicion. However, frozen fruits and vegetables served in raw salads could be a source of infection.

Ostrolenk and Hunter (3) found fecal streptococci

in all vegetable samples examined and these organisms were present in significant numbers to be a public health hazard. Streptococci were found in citrus concentrates, although in much less numbers than in vegetables. This is a significant observation since frozen juices are not heated while frozen vegetables are usually cooked before they are eaten.

#### CONCLUSIONS

The production, processing, storage and distribution of precooked frozen foods must have a low microbial content if the quality of the product is to be maintained.

The ingredients used in precooked frozen foods are perishable and usually will support microbial growth especially, if the temperatures are above freezing, or growth can increase very rapidly if the temperature approaches 68-70°F.

If the temperature is favorable for increased growth the metabolic activity will produce off-flavors, off-odors, off-colors and may be an ultimate cause of certain types of infection.

Obviously a few careless producers or distributors can do much harm in creating a false security on the part of the consuming public in the whole precooked frozen food industry.

A need for reasonable high standards should be maintained. The dissemination of basic principles of microbiology should be encouraged, thus instilling a sense of respect, loyalty and devotion to the maintenance of high quality from the raw product to the finished product and ultimately into the hands of the consumer. Lastly the consumer will be the final judge in accepting or rejecting precooked frozen foods.

#### REFERENCES

1. Buchbinder, L., Loughlin, V. W., and Gangler, W. M. A Survey of Frozen Precooked Foods with Special Reference to Chicken-a-la-king. *J. Milk and Food Technol.* 12: 209. 1949.
2. Larkin, E. P., Litsky, W., and Fuller, J. E. Fecal Streptococci in Frozen Foods. *Applied Microbiol.* 3: 98-101. 1955.
3. Ostrolenk, M., and Hunter, A. C. Distribution of Enteric Streptococci. *J. Bact.* 51: 735-741. 1946.
4. Proctor, B. E. and Phillips, A. W., Microbiological Aspect of Frozen Precooked Foods. *Refriger. Engin.*, 53: 30. 1947.
5. Proctor, E. E., and Phillips, A. W. Frozen Precooked Foods. *Am. J. Pub. Health.* 38: 44. 1948.
6. Salch, M. A., and Ordal, Z. J. Studies on the Growth and Toxin Production of *Clostridium botulinum* in Precooked Frozen Food. *Food Research.* 20: 332. 1955.
7. Winter, A. R., Weiser, H. H., and Lewis, Marther. The Control of Bacteria in Chicken Salad. II. Salmonella. *Applied Microbiol.* 6: 278-281. 1953.