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EFFECTS OF TEMPERATURE UPON THE STORAGE LIFE OF FRESH SHUCKED PACIFIC OYSTERS (OSTREA GIGAS)[1/]

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ABSTRACT

SHUCKED PACIFIC OYSTERS WERE STORED IN FRICTION-LIDDED JARS AT FOUR DIFFERENT TEMPERATURES. PERIODICALLY, SAMPLES WERE EXAMINED FOR CHANGES IN pH AND TOTAL BACTERIAL COUNT. A SEPARATE EXPERIMENT WAS PERFORMED TO DETERMINE THE BACTERIOLOGICAL SIGNIFICANCE OF THE INITIAL COOLING RATE OF JARRED OYSTERS. THE RESULTS INDICATED THAT RAPID COOLING AND LOWER TEMPERATURES (IN THE NEIGHBORHOOD OF 32° F.) WILL PROLONG THE STORAGE LIFE WHILE SLOW COOLING AND HIGHER STORAGE TEMPERATURES WILL BE CONDUCIVE TO RAPID SPOILAGE.

INTRODUCTION

Two important factors in considering the storage of fresh shucked oysters are the speed of cooling after shucking and the temperature of storage. Without consideration of these factors, it is possible that oysters can become an undesirable and even dangerous food product.

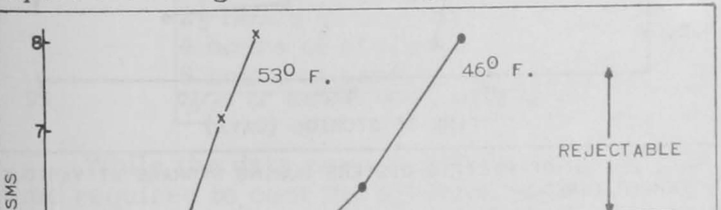

FIG. 1 - TOTAL BACTERIAL COUNTS OF PACIFIC OYSTERS DURING STORAGE AT VARIOUS TEMPERATURES.

Because of the nature of the animal, its habitat in shallow coastal waters, and handling in preparation for market, a variety of micro-organisms is often present in the edible portions. Under proper conditions, these organisms can multiply rapidly and thereby cause spoilage. In addition, while most of these forms of microbial life are not harmful to the consumer, on occasions there are, at least, small numbers of bacteria which are fecal in origin. It is entirely possible that this latter group might include typhoid, paratyphoid, and other forms of human disease organisms.

The best initial means of avoiding bacterial spoilage and the associated dangers is the minimizing of contamination of clean growing areas and careful sanitation during processing. Proper refrigeration is a necessary adjunct (as it is for all foods which are sold fresh) for keeping bacterial growth at a minimum level until the product has reached the consumer.

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Much literature has been accumulated on the various tests for the measurement of bacterial populations in oysters (Tanner 1944). Among the techniques generally used

Table 1 - Current Bacterial Indices and Control Limits for Shucked Oysters

Class	M.P.N. for Coliform Organism (org./100 ml.)	Total or Standard Plate Count (org./ml.)
1. Acceptable	Less than 16,000	Less than 50,000
2. Conditional (pending further investigation)	16,000-160,000	50,000-1,000,000
3. Rejectable	Over 160,000	Over 1,000,000

are the determinations of the "Most Probable Number" (MPN) of coliform organisms and the Standard Plate Count for "total" number of organisms (Anonymous 1954). The MPN determination is for organisms of fecal origin and when applied to a product is used solely for the estimation of the sanitary quality. The "total" count, on the other hand, yields information as to the sanitary quality and/or the storage conditions and storage life of the product. The current United States Public Health Service recommendations (anonymous 1954) are that shucked oysters be classified according to the levels described in table 1.

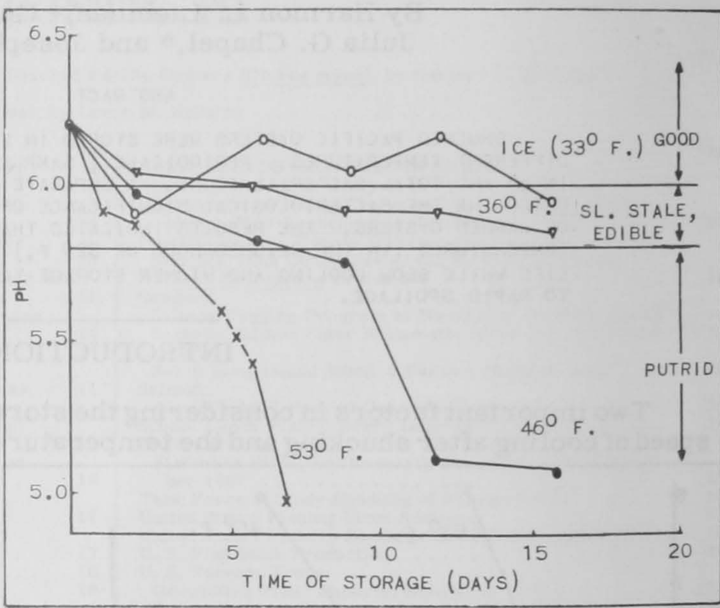

FIG. 2 - pH OF PACIFIC OYSTERS DURING STORAGE AT VARIOUS TEMPERATURES.

A measure which often has been used as a rapid indication of spoilage of oysters is the acidity or, as it is alternatively known, the hydrogen ion concentration or pH. The acid in oysters arises from the breakdown of the muscle sugar, glycogen, into lactic acid. This breakdown can be caused by autolytic activity of the oyster itself and by micro-organisms, as a result of their growth and metabolism. Regardless of the causative agent, many investigators (Piskur 1947; Pottinger 1948; Anderson, Betzold, and Carr 1949; Bordaweker 1950; Gardner and Watts 1956) have found that there is an increase in the amount of acid (indicated by the decline in pH value) associated with organoleptic changes of flavor, odor, and appearance. While there are differences due to variety, season, and area, the relationships indicate generally that, when both liquor and meats have a pH of 6.0 or above, oysters are acceptable organoleptically. A pH range of 5.8 to 6.0 has been correlated with borderline acceptability, and pH's of 5.7 or lower have been associated with unacceptable quality.

This paper is concerned with the effects of good and poor refrigeration practice in relation to bacterial growth and spoilage during cooling and subsequent storage. "Total" bacterial counts and pH measurements have been employed to determine the progress of spoilage of shucked oysters which were stored at various temperatures.

EXPERIMENTAL PROCEDURE

Samples of Pacific oysters (Ostrea gigas) were obtained from the Samish Bay area of Puget Sound. Prior to shucking, these oysters had been held for two days in the shell.

Immediately after shucking, the oysters were packed into half-pint friction-lidded glass jars which then were packed in ice. The shucking and packing operations were done in a commercial plant. The samples were delivered to the School of Fisheries, University of Washington, the same day as packed. At the School's processing laboratory, the jars were placed in storage in ice, at 34°-38° F., at 39°-45° F., and at 46°-54° F. (The center temperature of the jars averaged, over a 16-day storage period, 33° F., 36° F., 46° F., and 53° F., respectively.) Control samples were taken immediately upon receipt, and the initial pH and bacterial counts were determined.

Over the next 16 days, samples were removed from storage at specific intervals, the pH of each sample was measured, and the bacterial counts were determined.

The day following delivery of the samples, a portion of the jars from the group held in ice were removed from storage. These jars were warmed to a center temperature of 75° F. in 35 minutes, and then placed in cooling baths. One group was cooled in such a manner that the center temperature reached 50° F. at the end of 2½ hours. A second group was cooled to a center temperature of 50° F. in four hours, and a third group was cooled to a center temperature of 50° F. in six hours. At the end of each of these intervals the pH and total bacterial count of each sample was determined.

RESULTS AND DISCUSSION

The results of the experimental work for the cooling experiment are shown in table 2.

Table 2 - Bacterial Counts on Oysters and pH Changes in Samples Cooled from 75° F. to 50° F. Over Varying Time Intervals

Class	Total Plate Count Organisms/Gram	pH 1/
Control.	-	5.9
2½ hours of cooling	2,500	6.0
4 hours of cooling.	4,500	6.0
6 hours of cooling.	6,000	5.8

1/ pH OF GROUND MEATS AND LIQUOR.

While the data are not conclusive, there is an indication that the longer the time required to cool the oysters, the higher the bacterial counts and the lower the pH. This can be interpreted to mean that the longer the time necessary to cool the product to the required 50° F. level, the poorer will be the condition of the product at the start of storage.

From a public health point of view, these results are of importance. If micro-organisms present in oysters double in number every two to three hours during cooling from 75° F. to 50° F. and if any of these micro-organisms are of fecal origin, then a delay in cooling or slow cooling may result in sufficient numbers of pathogenic organisms to cause the oysters to become dangerous to the consumer.

The results of the 16-day storage study are presented in figures 1 and 2.

Figure 1 presents the bacterial counts of the samples stored at the various temperatures. It can be seen that the oysters stored at 53° F. would have been classed as "rejectable" using the United States Public Health Service standards at the end of 4 days of storage. At 46° F., the samples would have been classed as "rejectable" at the end of 8 days. Those stored at 36° F. would have been classified as "acceptable" after 12 days of storage and "conditional" from 13 days on. The samples stored on ice would have been classified as "acceptable" through 15 days of storage and as "conditional" on the sixteenth day.

From this illustration, it is evident that lower temperatures of storage--approaching that of ice--are conducive to maintaining low level bacterial counts in fresh shucked oysters.

Figure 2 illustrates the changes in pH of the samples stored at different temperatures. The organoleptic boundaries are those suggested by Bordawekar (1950), who demonstrated the existence of a very close correlation between pH and organoleptic scores. The figure shows that oysters held at 53° F. passed into the "putrid" range after but three days of storage. Oysters held at 46° F. came into this range after seven days, while those at 36° F. and on ice were still edible at 16 days of storage. It can also be seen that the jars stored in ice were in the "good" range approximately five days longer than those held at 36° F., which entered into the "slightly stale" region after seven days.

While slight discrepancies between the results of the bacterial determinations and the pH-organoleptic results are noted, the correlation is so close that there is no doubt that an intimate relationship between bacterial growth and glycogen decomposition was in existence.

These slight discrepancies in the absolute storage times are not of major significance. If oysters of better or poorer initial quality, or oysters obtained from a different area or during a different season, or of a different variety had been used as the test animal, the absolute results would probably have differed from those reported above. However, the relation between quality, storage time, and temperature of storage would not change greatly, if at all.

SUMMARY

To summarize the results of the experiment: the samples held at 53° F. were unacceptable after 3 to 5 days; those held at 46° F. were unacceptable after 7 or 8 days; while those stored at 36° F. and on ice were still acceptable after 13 to 16 days of storage.

It is apparent that temperature is an important factor with respect to the rate of spoilage of fresh shucked oysters. Rapid cooling and lower temperatures (in the neighborhood of 32° F.) will prolong the storage life, while slow cooling and higher storage temperatures will be conducive to rapid spoilage and a short shelf life.

LITERATURE CITED

ANDERSON, R. B.; BETZOLD, C. W.; AND CARR, W. J.
1949. pH DATA ON PACIFIC OYSTERS. COMMERCIAL FISHERIES REVIEW, VOL. 11, NO. 11 (NOVEMBER), P. 1.

ANONYMOUS
1954. RECOMMENDED PROCEDURES FOR BACTERIA COUNTS OF SHUCKED OYSTERS. SHELLFISH BRANCH, MILK, FOOD AND SHELLFISH SANITATION PROGRAM, DIVISION OF SANITARY ENGINEERING SERVICES, U. S. PUBLIC HEALTH SERVICE (JULY 1954).

1956. PUBLIC HEALTH REPORTS. SHELLFISH SANITATION WORKSHOP. U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, VOL. 71, NO. 10, P. 1054.

BORDAWEKAR, B. R.
1950. A STUDY OF THE RELATIONSHIP OF pH TO THE QUALITY OF PACIFIC OYSTERS (OSTREA GIGAS) AS DETERMINED BY ORGANOLEPTIC TEST. M. S. THESIS, SCHOOL OF FISHERIES, UNIVERSITY OF WASHINGTON, UNPUBLISHED.

GARDNER, E. A., AND WATTS, B. M.
1956. CORRELATION OF pH AND QUALITY OF SHUCKED SOUTHERN OYSTERS. COMMERCIAL FISHERIES REVIEW, VOL. 18, NO. 11 (NOVEMBER), P. 8.

PISKUR, FRANK A.
1947. PRELIMINARY STUDY OF CORRELATION OF pH AND QUALITY OF SHUCKED PACIFIC OYSTERS. COMMERCIAL FISHERIES REVIEW, VOL. 9, NO. 6 (JUNE), P. 22.

POTTINGER, S. R.
1948. SOME DATA ON pH AND FRESHNESS OF SHUCKED EASTERN OYSTERS. COMMERCIAL FISHERIES REVIEW, VOL. 10, NO. 9 (SEPTEMBER), P. 1.

TANNER, F. W.
1944. MICROBIOLOGY OF FOODS. GARRARD PRESS, CHAMPAIGN, ILL., 2ND ED., PP. 810-832.