# PROCESSING TREATMENTS TO EXTEND THE STORAGE TIME OF FROZEN PINK SALMON

by

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# PROCESSING TREATMENTS TO EXTEND THE STORAGE TIME OF FROZEN PINK SALMON

## INTRODUCTION

### Pink Salmon

Of the five varieties of West Coast Salmon, the fish known as the pink salmon (Oncorhynchus gorbuscha) is outstanding for its delicate flavour and texture. Its flesh, while not as red as the sockeye (Oncorhynchus nerka), or cohoe (Oncorhynchus kisutch) varieties, is generally a pleasing pink. In population, pink salmon far outnumber the other four members of its species with the result that they constitute almost half of the entire United States canned salmon pack. Their abundance and a tendency toward consumer preference for the red varieties have priced the fish somewhat lower than sockeye and cohoe. If original colour, flavour and texture, together with abundance and price were the only criteria pink salmon would constitute a very large proportion of the frozen salmon pack.

This is not found to be the case. Nowhere are pink salmon frozen commercially on a large scale. During frozen storage there is found to be a rapid deterioration

of colour and flavour with the result that in a short time the quality of the flesh is below that required for consumer acceptance.

Freezing of Fish

Over the years men of the fishery industry have found that different species and varieties of fish vary in their adaptabilities to preservation by freezing. They have found that in general "fatty" fish which include herring (Culpea pallasii), mackerel (Scomber scombrus), pilchards (Sardinops caerulea) and salmon (generic name Oncorhynchus) can only be frozen and stored for a relatively short period of time while "non-fatty" fish such as cod (Gadus callarias), haddock (Melanogrammus aeglefinus) and whiting (Merluccius billinearis) may retain their quality for many months. They also have found that quality can be somewhat maintained by protecting the fish from exposure to air during the storage period. This knowledge has led them to believe that one of the main factors contributing to the spoilage of frozen fish is oxidation of the fats and oils.

## Project Aim

This project was designed to investigate several methods of protecting pink salmon against oxidative changes with a view towards developing a commercially acceptable pre-treatment.

It is felt that if a suitable pre-treatment and/or package could be devised for prolonged storage of frozen pink salmon, a large portion of the annual catch could be preserved by freezing to produce a relatively inexpensive and delicately flavoured product.

# REVIEW OF THE LITERATURE

## Frozen Pink Salmon Spoilage

Stansby and Harrison (7) reported that brined and unbrined frozen pink fillets were definitely not saleable after a four month's storage period. Stansby (6) suggested that the principal type of spoilage in frozen fish might be in the deterioration of the oil. Bauernfeind et al (1) stated that it has been generally known for a decade or two that frozen fish, particularly of the "fatty" type, undergo enzymatic oxidation and become rancid.

## Previously Reported Treatments

Some success has been reported in retarding spoilage by excluding air during storage and by the use of anti-oxidants in various pre-treatment methods.

### A. Vacuum and Gas Atmospheres

Bucher (4) reported that pink steaks frozen and stored under a vacuum of twenty five inches of mercury were little changed after nine months. Tarr

(10), in experiments with fish fillets (including pink salmon) that were frozen, then stored under atmospheres of nitrogen and carbon dioxide showed that the presence of small amounts of air in the carbon dioxide atmospheres resulted in considerably higher peroxide values than those that had been subjected to a vacuum and then to nitrogen or carbon dioxide atmospheres. He concluded that a container that was absolutely gas impervious would be necessary for any method of gas storage of frozen fish designed to prevent rancidity entirely and that even the presence of a very small amount of oxygen would probably lead to appreciable fat oxidation. The difficulty of selecting a frozen food container capable of holding a vacuum or one that was completely impervious to gases and that was acceptable for commercial use would at present be a formidable obstacle in extending the storage time of frozen fish by these methods of air exclusion.

B. Glaze

One method of protecting the fish from air that has been used on whole fish, has been to glaze the

fish with a thin film of ice or with an eutectic solution (2). Tarr (10) reported possibilities for this method in treating fish steaks. His experiments indicated an advantage in glazing with an ascorbic acid or sodium ascorbate solution of pH6. Bucher (4) stated that pink steaks that were ice glazed and vacuumized in cryovac latex bage were good after a twelve month's storage period. The fragile naturc of an ice or ascorbic acid glaze, and the rapid sublimation of ice from such coatings would limit their commercial value. The glaze - plus - cryovac method when used on small consumer packages would have the disadvantages of a brittle glaze together with a relatively costly pre-treatment.

C. Immersion

One further method of excluding air that Bucher (4) has found to be fairly successful has been to cover the fish with water in a glass jar, to seal the jar and to freeze and store in this condition.

D. Dips

Considerable success has been reported in

prolonging the storage life of "fatty" fish by dipping steaks or fillets in solutions containing anti-oxidants prior to freezing. Tarr (11), in working with salmon fillets reported considerable success with the use of ascorbic acid dips. Stoloff (8), in working with mackerel, reported success with the use of NDGA in oil, and with ascorbic and gallic acids when incorporated in dips made up of the anti-oxidants plus an Irish moss (Chondrus crispus) extract. The extract was included for its supposed synergistic effect, its ability to coat the fish in such a way as to maintain the concentration of the anti-oxidant in the dipping solution, and its protective nature when it gels.

Measurement of Quality

Stansby and Harrison (7) found that after a relatively short storage period both colour and flavour changes contributed to the poor quality of brined and unbrined frozen pink salmon fillets. They found that the flavour changed from that of fresh fish to a distinctly rancid flavour. The colour of exposed flesh developed yellow or dark off-colours while inner

surfaces were little changed from the original.

Organoleptic evaluations of colour and flavour changes in frozen salmon fillets and steaks have been supplemented by some objective measurements. Tarr (9) stated that as far as frozen fish is concerned, a test for the amount of fat peroxide present is generally conceded as being the most reliable single available chemical test for determining increase in rancidity. Dassow and Stansby (5) in studying the keeping qualities of frozen packaged pink salmon steaks measured colour changes by spectrophotometric analyses of colour photographs taken of cut and exposed surfaces of their samples.

# EXPERIMENTAL PROCEDURE

## Fillets

The salmon used in this project were Fraser River (mouth) gill-net pink salmon. They were filleted (skins on) by a company that prepared fish for fresh market and for freezing. Approximately four hundred pounds of bright, pink fillets were selected for the project and were packed in snow ice between sheets of parchment paper in order to assist in the retention of their original fresh quality while waiting for treatment. As they were needed the fillets were taken from the ice and parchment, were cut into approximately twelve ounze pieces and were treated according to the following list of code lots.

## Code Lots

(A) 1 to 24 Pieces frozen in Canco container, dry

(B) 1 to 24 Pieces plus water frozen in Canco

(C) 1 to 24 Pieces plus 0.5% NDGA solution frozen in Canco

| | | |
|---|---|---|
| (D) | 1 to 24 | Pieces plus 0.2% ascorbic acid solution frozen in Canco |
| (E) | 1 to 24 | Pieces plus 3.0% NaCl solution frozen in Canco |
| (F) | 1 to 24 | Pieces frozen in wooden form, placed in Canco, water added, sealed and stored in zero room |
| (G) | 1 to 24 | Pieces frozen in wax carton (consumer size), dry with wax paper overwrap |
| (H) | 1 to 24 | Pieces frozen in wax carton, dry, wax overwrap and four packages exhausted and sealed in cryovac bags |
| (J) | 1 to 24 | Pieces frozen in wax carton with wax paper overwrap after a 15-20 second dip in solution of 0.5% Krim Ko Gel plus 0.3% ascorbic acid. Solution temperature 40-45 degrees F |
| (K) | 1 to 24 | As for J except packages were exhausted and sealed in groups of four in cryovac |
| (L) | 1 to 24 | Pieces frozen in wax carton with wax paper overwrap after a 15-20 second dip in 0.5% Krim Ko Gel. Temperature of solution 40-45 degrees F |
| (M) | 1 to 24 | As for L except that packages were exhausted and sealed in groups of four in cryovac |
| (N) | 1 to 24 | As for J except solution contained in addition to ascorbic acid and Krim Ko Gel, Tweens 81 in concentration of 0.001% |
| (O) | 1 to 24 | As for K except solution contained in addition to ascorbic acid and Krim Ko Gel, Tweens 81 in concentration of 0.001% |

(P) 1 to 24 Pieces frozen in wax carton with wax paper overwrap after a dip of 15-20 seconds in a 0.5% Krim Ko Gel and 0.5% NDGA solution. Temperature of solution 40-45 degrees F

(R) 1 to 24 As for P except that packages were exhausted and sealed in groups of four in cryovac

NDGA - Nordihydroguaiaretic acid made from a preparation containing 10% Nordigydroguaiaretic acid {4,4'-(2,3-dimethyltetramethylene)-dipyrocatchoc} in sorbitan esters of fatty acids of cottonseed oil which also contained 1% citric acid as a synergist. Percentages refer to concentrations of nordihydroguaiaretic acid.

Ascorbic - crystaline l-ascorbic acid.

Krim Ko Gel - an Irish moss extract.

Tweens 81 - Polyoxyalkylene derivative of sorbitan monooleate used as a wetting agent.

Canco containers were selected for codes A through F because of their present commercial acceptability as frozen foods containers and because of their ability to hold a liquid medium. Wax carton containers with a wax paper overwrap were selected for the other codes because of their widespread use in the frozen foods industry.

Freezing

All packages except code F, were placed on wire freezing screens in an air blast freezer at approximately -10 degrees F for twelve hours. They were removed from the freezer, were sealed in fibreboard cartons, and were stored at 0 degrees F.

Fillet pieces for code F were packed in a 3/8 inch plywood form with a plywood top held in place by angle iron and "C" clamps. The form was sectioned with strips of plywood so that each section formed a block of fish that, when frozen, would fit into a Canco container and leave a 1/16 inch clearance between the block and each inner surface of the container. The pieces were frozen in the form in the air blast (-10 degrees F). After twelve hours the form was taken from the freezer, the pieces were quickly removed from the form; placed in Canco containers; cold water added to cover; the containers sealed; and placed in 0 degrees F storage for twelve hours. The containers were next sealed in fibreboard cartons and stored at 0 degrees F.

The fish were caught, prepared and frozen within thirty six hours. All packages were transported in dry ice to Oregon State College where they were stored at 0 degrees F before periodic determinations of the quality of their contents.

Examination

It was found that samples H, K and M which had been packed in cryovac had lost their vacuum and therefore were not tested.

Five of the remaining codes were examined each week over a period of fourteen weeks starting after fifteen weeks of storage. This meant that each code was examined at least four times. A portion of each package examined was subjected to analysis for peroxides (3), and evaluation by a taste test panel (3). After the twenty third week colour difference between external and internal portions of flesh were rated visually by the authour in such a way that he was not aware of the code.

Codes B, C, D, E, F, J, L, N and P were selected for testing on a rotation basis. Samples from four of these treated codes were tested in one run, samples from the next four codes in the next run and so on continuing with code B after code P. Eight samples were tested during each run. Four of the samples were chosen in pairs from two of the treated code lots, two of the samples were from two other treated code lots and two of the samples were from the control code lots A or G. The night before samples were to be tested they were placed in a fibreboard carton and left in a warm room overnight to thaw.

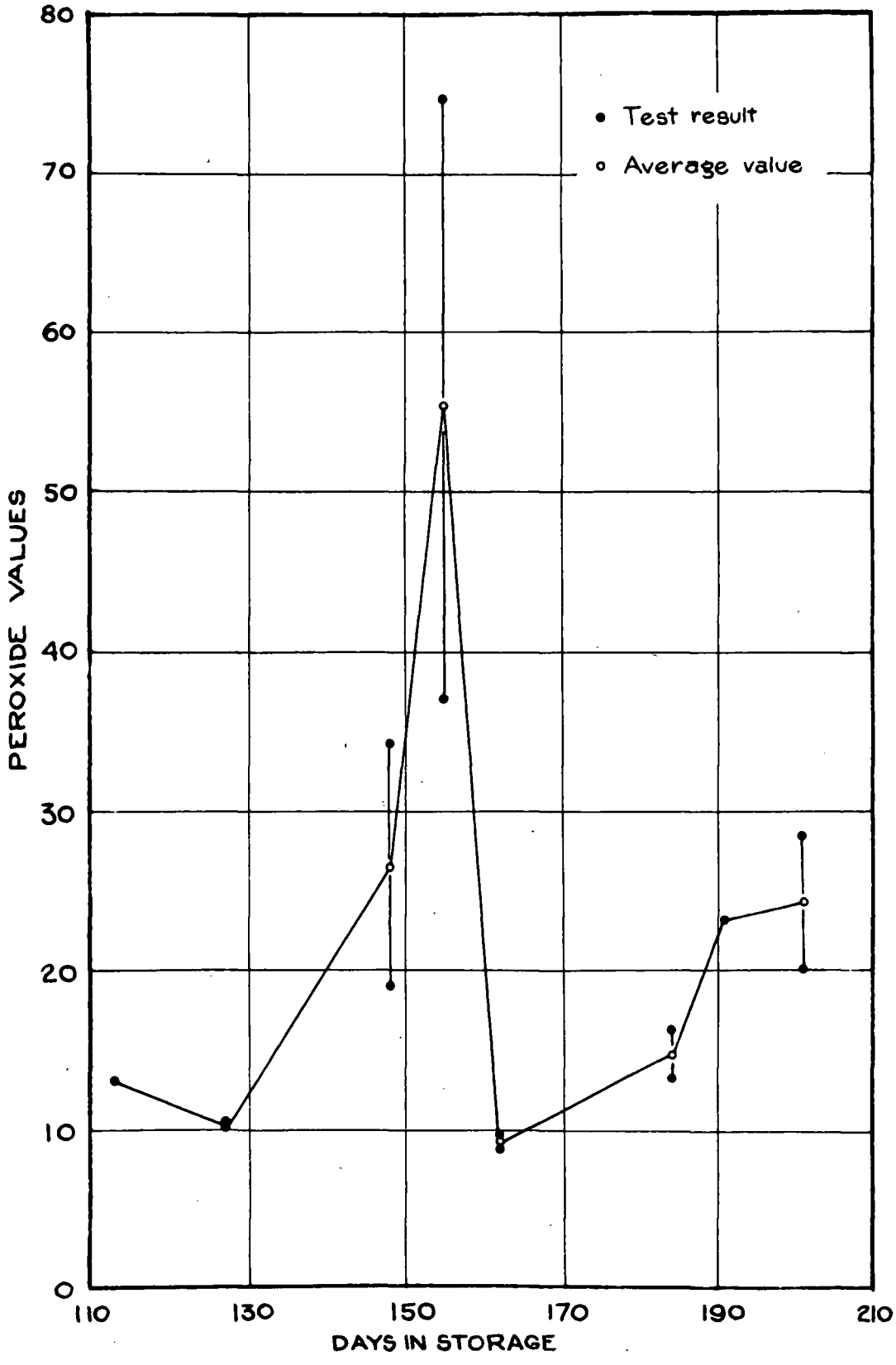
# RESULTS

## Peroxide Values

During each run portions of the eight samples were tested for peroxides. Tarr's method for peroxide determinations (12) was used for the first seven weeks of the tests (to 155 days storage). An inspection of Graph I in which peroxide values for control code A are plotted on a base of storage time will show the wide fluctuation in values typical for samples up to 155 days of storage. It will be seen from the graph that one sample of code A was tested on the 113th day of storage and two on each of the 127th, 148th and 155th days. Values for duplicate samples on the 127th day were very close but duplicates differed by as much as 57% on the 148th day and 70% on the 155th day.

For the remaining runs all samples were evaluated by a modified Tarr's method (3). The modification included a procedure in which extraction of oil was carried out in a waring blendor and titrations against aliquots were based on a standard weight of oil extract

# GRAPH I
# PEROXIDE VALUES CODE A



rather than against a standard volume of extracts. An inspection of the graph will show that more consistent results for duplicate samples were obtained with the new method. This graph is typical of the variation within a given codo.

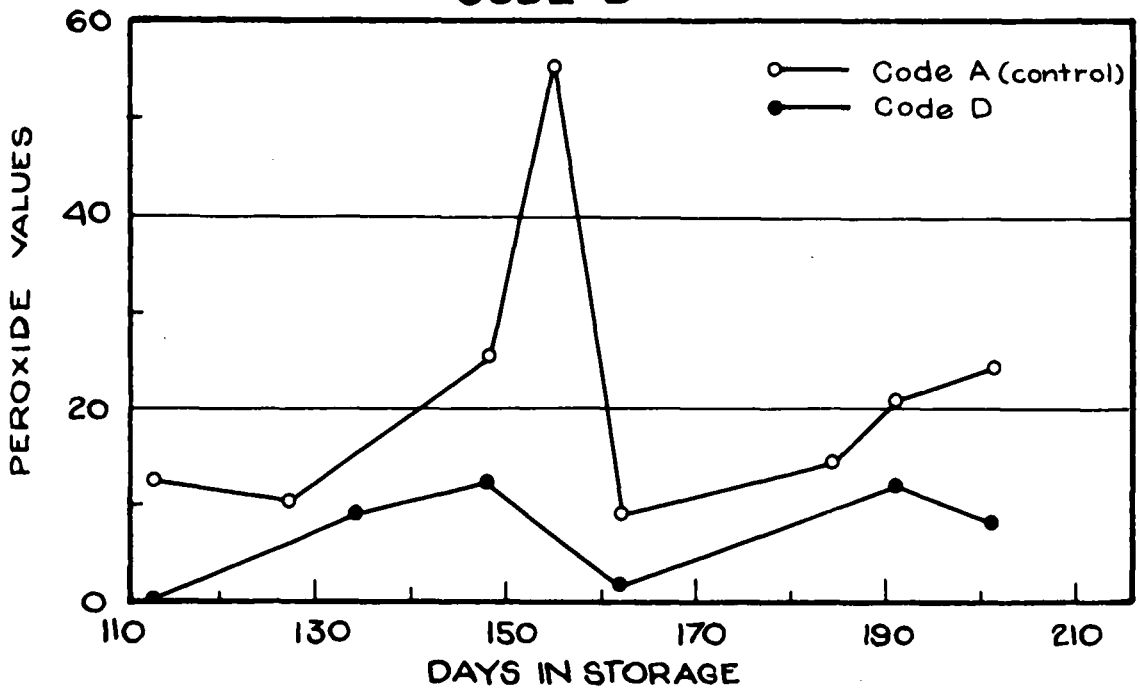
When results of the modified method were compared it was found that the treatments could be grouped in two general classifications:

1. Those treatments that produced lower peroxide values than the control samples, and

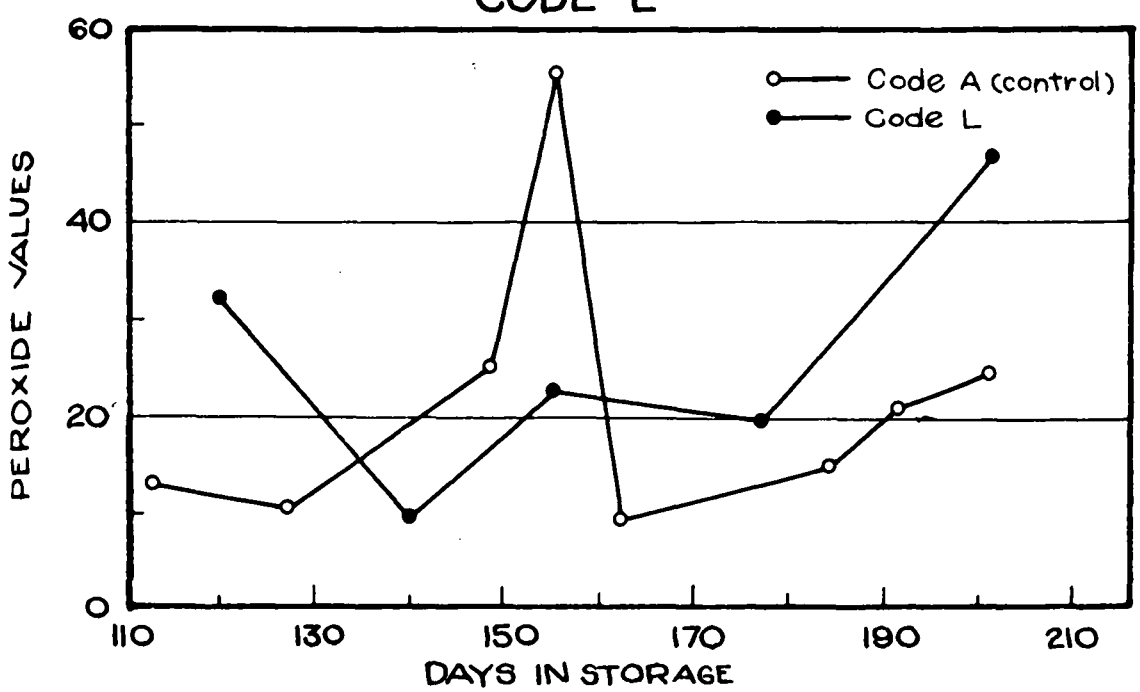
2. Those that apparently did not produce lower values than the control samples.

A presentation of graphs to show each of the comparisons of treated samples and control samples would be tedious and of little value. It is felt that representative graphs for the two classifications together with a list of the treatments grouped in their classification should be sufficient. Graph 2 is representative of charts obtained for the first classification (peroxide values apparently lower than control). It shows values

## GRAPH 2
## PEROXIDE VALUES CODE A AND CODE D




## GRAPH 3
## PEROXIDE VALUES CODE A AND CODE L



for both the treated sample and the control sample when plotted on the same time basis. Graph 3 is similarily representative of the second classification (peroxide values apparently not lower than control).

When peroxide values of the modified method were compared within the two general classifications it was found that a further subdivision could be made into samples that showed considerably lower, lower and slightly lower values for the first classification and no different and higher values for the second classification. The samples are classified and subdivided in Table 1.

Table 1

Classification Of Codes When Peroxide Values Are Compared With Peroxide Values Of Control Code A

I Peroxide Values Lower Than Control

(a) Considerably lower
Code F - Canco container, block frozen, water added

(b) Lower
Code E - Canco container, frozen in water
Code C - Canco container, frozen in solution of NDGA
Code D - Canco container, frozen in solution of ascorbic acid
Code B - Canco container, frozen in solution of NaCl
Code H - Wax carton container, dip in solution of Krim Ko Gel, ascorbic acid and Tweens 81

(c) Slightly lower
Code J - Wax carton container, dip in solution of Krim Ko Gel, and ascorbic acid

II Peroxide Values Not Lower Than Control

(a) No difference
Code G - Wax carton container, no treatment
Code F - Wax carton container, dip in Krim Ko Gel and NDGA

(b) Higher
Code L - Wax carton container, dip in Krim Ko Gel

Taste Tests

On the day of each run two taste panels were formed, one at approximately 10:30 a. m. and the other at approximately 3:30 p. m. The taste panels were made up of an average of eleven judges who were staff members or students in Food technology at Oregon State College. Because samples of known quality were not readily available and because time for testing was limited, no effort was made to select judges according to their ability to taste salmon. The inability of enough judges to schedule their time for such a series of tests prevented the same judges from tasting every week. Over the period of the tests fifteen judges tasted ten or more times; six tasted between five and nine times; and forty tasted less than five times.

Each sample portion to be tasted was immersed in a 5% NaCl brine solution for two minutes, was rolled in unsalted cracker crumbs and was placed in a pyrex pie plate. Four samples to be tested, each in separate plates, were baked for twenty minutes at 550 degrees F in a household gas oven. When baking was completed any

burnt edges were trimmed from the samples and the skin was removed. Preliminary investigation had shown that members of a taste panel had found it easier to evaluate the taste of mascerated samples than individual whole portions so each of the four samples were thoroughly mascerated.

A portion of each sample was given the individuals on the panel. The portions were served on numbered plates so that the judges were not aware of the code identities. Each judge evaluated four samples, two of which were from the same code lots but from different packages and two of which were from different lots. One portion given the judges in each of the morning and afternoon panels was a control code A or G.

The judges were asked to evaluate the taste of their sample portions according to the following schedule of scores:

Score

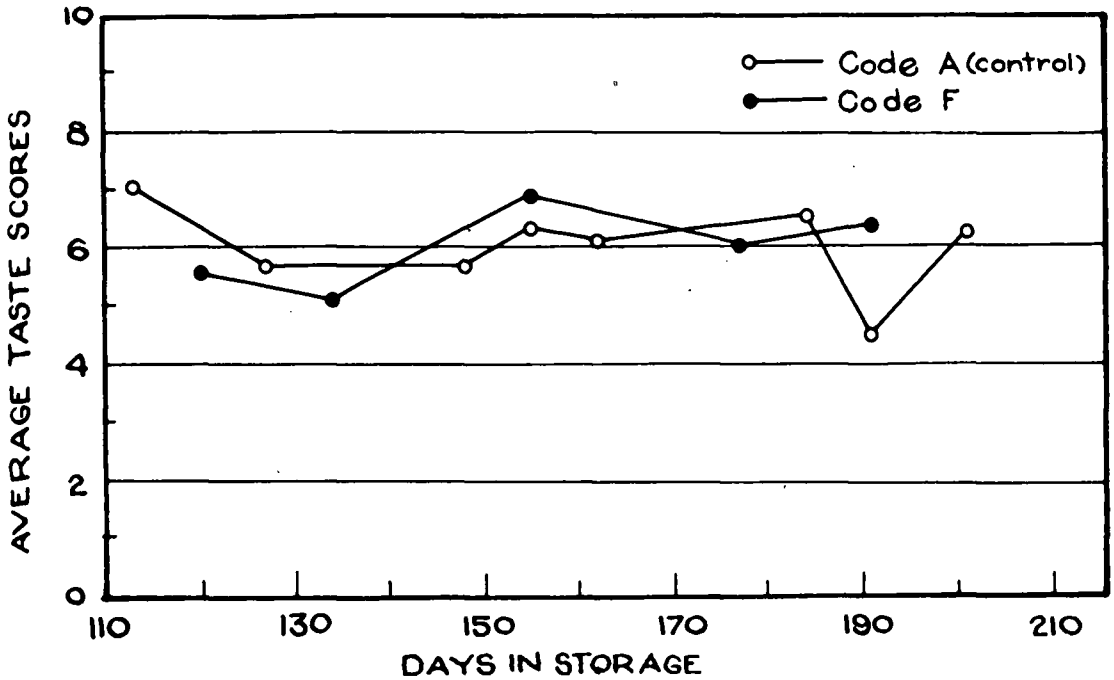
| | |
|---|---|
| 10 - ideal | 4 - fair |
| 9 - excellent | 3 - poorly fair |
| 8 - very good | 2 - poor |
| 7 - good | 1 - very poor |
| 6 - fairly good | 0 - repulsive |
| 5 - acceptable | |

After each run the scores recorded by all the judges for each treatment were totaled, averaged and reported as average taste scores.

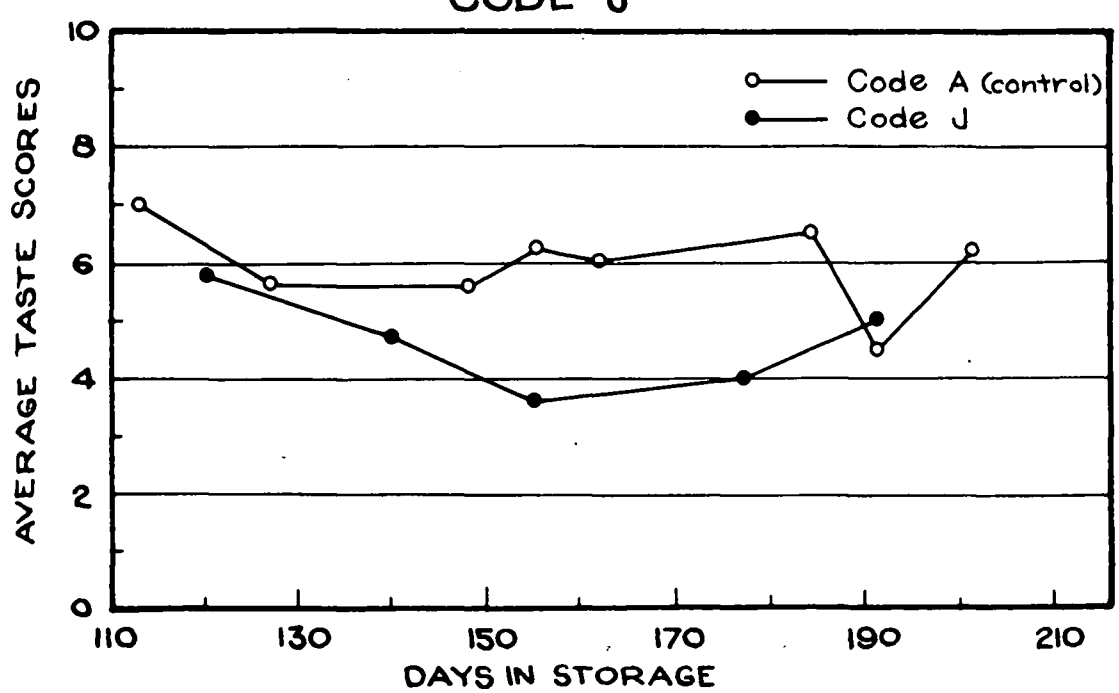
As with peroxide results it was thought to be advisable to present representative charts and summary tables rather than charts for each code lot.

Graph 4 is representative of charts obtained when average scores of A were compared with those of all codes except J. Codes A and J are compared in Graph 5. It can be seen from Graph 4 that the panel was evidently not able to detect any difference between the control samples and codes other than J. Taste test averages for these samples fell between five and seven which would place them in the acceptable to good range with the averages tending to centre around a rating of fairly good. An inspection of Graph 5 will show that the averages for J fell between three and six which would place them in the fairly good to poorly fair range with results scattered but tending to be lower than those for the control code A. Values below five indicate that the samples were not acceptable.

## GRAPH 4
## TASTE SCORES CODE A AND CODE F




## GRAPH 5
## TASTE SCORES CODE A AND CODE J



In Table 2, the codes are classified by taste scores in the two groups:

1. Not different from control
2. Worse than control

The decision of placing a code in one group or the other could not be made very precisely because of the irregularities in the taste scores as mentioned above. Thus most of the codes were substantialy the same as the controls at the end of the 200 days storage. At least they are not proven to be different.

Table 2

Classification Of Codes When Average Taste Scores Are Compared With Average Taste Scores Of Control Code A

I Not different from control

Code B - Canco container, frozen in water
Code C - Canco container, frozen in solution of NDGA
Code D - Canco container, frozen in solution of ascorbic acid
Code E - Canco container, frozen in solution of NaCl
Code F - Canco container, block frozen, water added
Code L - Wax carton container, dip in solution of Krim Ko Gel
Code N - Wax carton container, dip in solution of Krim Ko Gel, ascorbic acid and Tweens 81
Code P - Wax carton container, dip in solution of Krim Ko Gel and NDGA

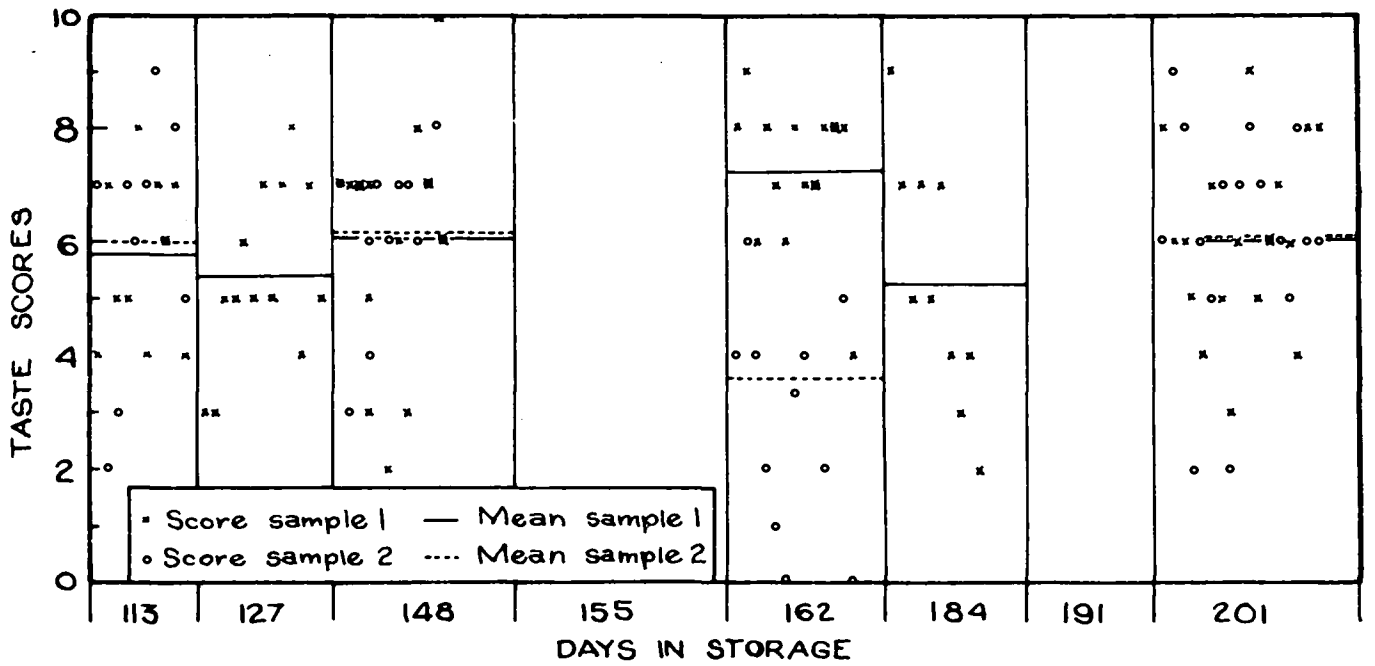
II Worse than control

Code J - Wax carton container, dip in solution of Krim Ko Gel and ascorbic acid

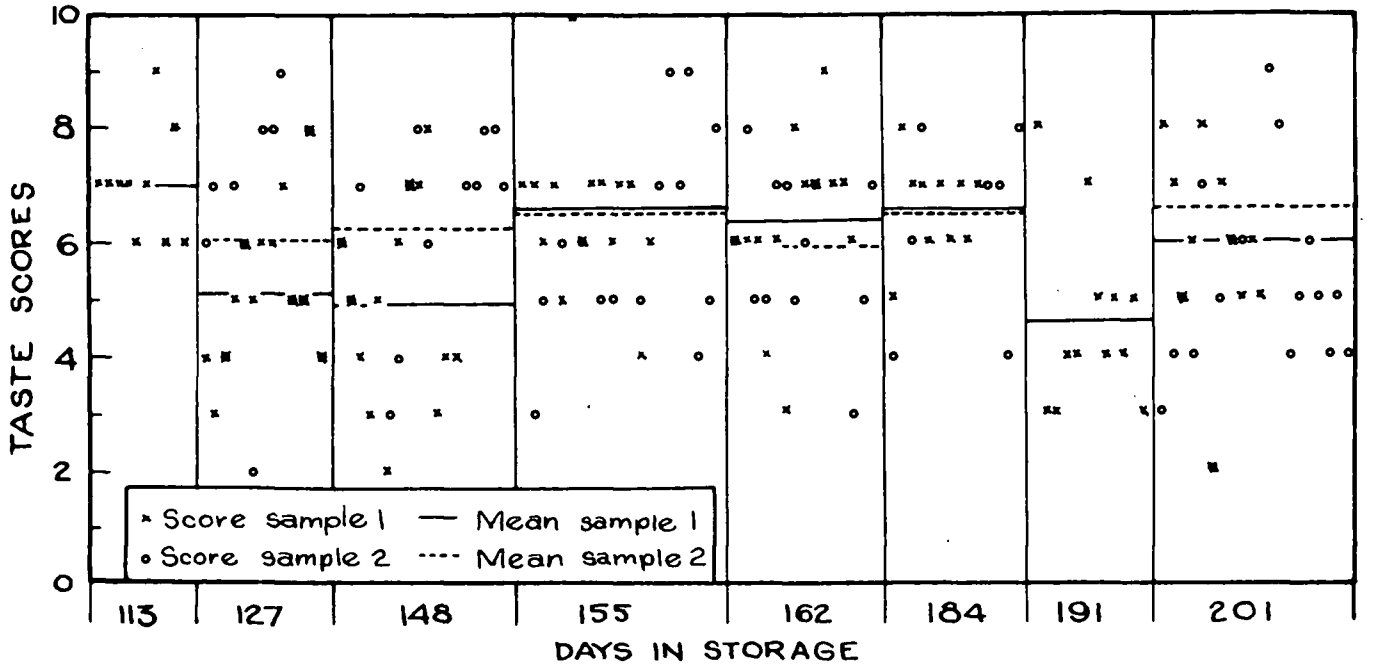
Although average scores fell within fairly narrow ranges, individual scores were widely scattered. Graphs 6 and 7 are representative of plots obtained when individual scores were charted over the period of the tests. An inspection of Graph 6 (148 days storage) will show that one judge gave a score of as much as ten and another as little as two for portions of the same sample. This difficulty might have been overcome if the judges had been selected according to their abilities to taste salmon. It is of course not known how frequent this situation would occur with the consuming public.

It was found that average scores of samples from the same code lot and tested on the same day were not necessarily similar. An inspection of Graph 6 will show a difference in average scores between samples on the 162nd day of 3.7(3.5 to 7.2) and Graph 7 will show a difference on the 148th day of 1.4(4.9 to 6.3). From these results it would appear that there was, in some cases, a difference between samples that was greater than could be attributed to treatment alone. If care had been taken to select one portion of fish or perhaps one fish for each treatment this difficulty may have

# GRAPH 6
# INDIVIDUAL SCORES
# CODE B



# GRAPH 7
## INDIVIDUAL SCORES
## CODE A

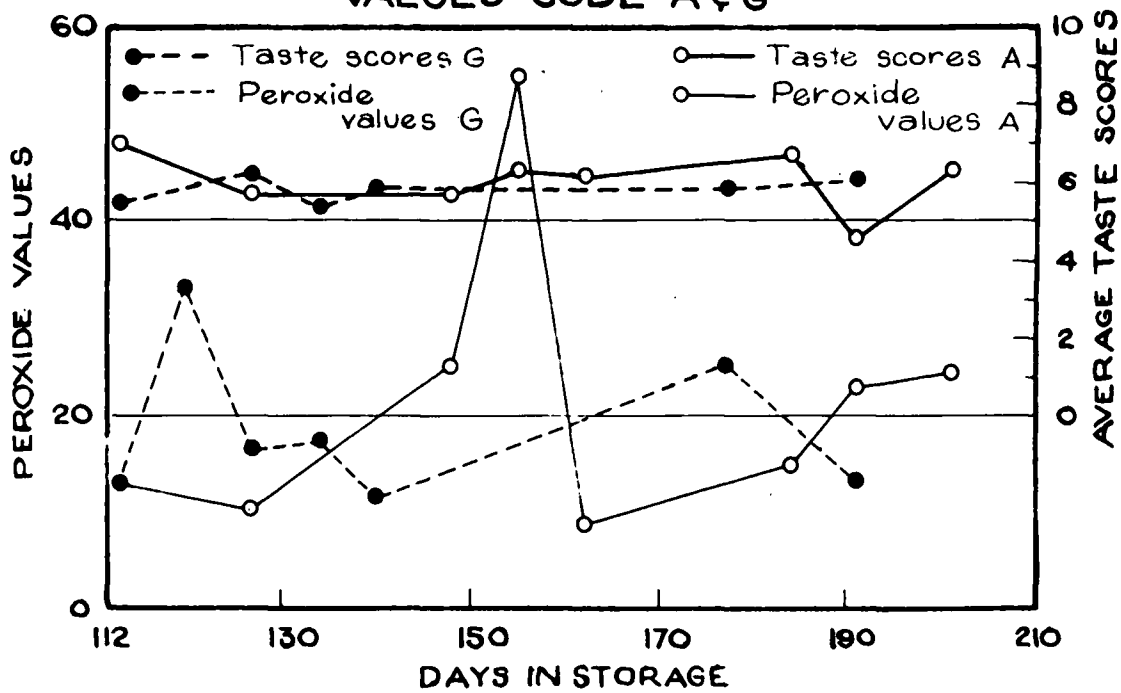


been overcome.

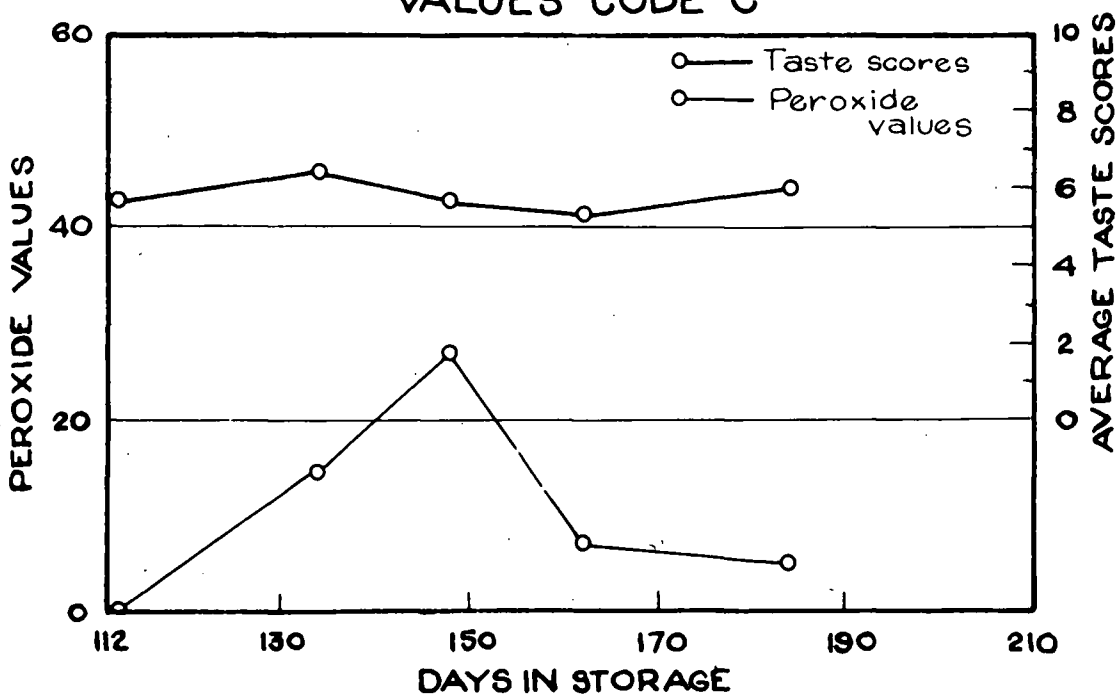
Correlation of Peroxide Values and Taste Tests

Graphs 8 and 9 are representative of charts obtained when average taste scores and peroxide values were plotted on the same time base. One would expect that as storage time increased, the peroxide values would increase and average taste scores would decrease. An inspection of these graphs will show that there were apparently no such trends nor was there any such correlation between the two sets of values. Even when the modified method for peroxide determinations was used (160 to 201 days of storage) some graphs showed a gradual increase in peroxides (control code A in Graph 8) while others showed a decline (code G in Graph 8 and code D in Graph 9). Taste tests also fluctuated throughout the test. In the limited time between evolution of the improved peroxide method and the termination of the tests, this lack of correlation prevented the use of peroxide values as measurements of acceptability. It is felt, however that the peroxide results will show good consistencies if somewhat longer storage times are used.

## GRAPH 8
## TASTE SCORES AND PEROXIDE VALUES CODE A & G




## GRAPH 9
## TASTE SCORES AND PEROXIDE VALUES CODE C



Visual Colour

Visual colour scores were given each sample tested from the 168nd day of storage. A one inch portion was cut from one end of the sample and the colour of the external flesh was compared to that of the internal flesh. The assumption was made that the internal flesh colour approximated that of the original (6).

Scoring was based on a scale of 0 to 10 with descriptions similar to taste test scores in mind. 0 was considered an extreme change with the description repulsive in colour and 10 was given for no change with the description ideal. Intermediate values were given the gradations of change between these limits.

The scores and average scores are presented in Table 8.

Table 3

Visual Evaluation Of Colour

| Code | Storage Time In Days | | | | | | | | | | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 162 | | 177 | | 184 | | 191 | | 201 | | |
| | Sample | | Sample | | Sample | | Sample | | Sample | | |
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | |
| A | 6 | 5 | | | 6 | 3 | 3 | | 2 | 5 | 4.3 |
| B | 8 | 8 | | | 9 | | | | 9 | 7 | 8.0 |
| C | 9 | 5 | | | 7 | 7 | | | | | 7.0 |
| D | 5 | | | | | | 10 | | 10 | | 8.3 |
| E | | | 10 | | | | 9 | 9 | | | 9.3 |
| F | | | 9 | 8 | | | 6 | | | | 7.7 |
| G | | | 1 | 3 | | | 6 | | | | 3.3 |
| J | | | 6 | 2 | | | 3 | 4 | | | 3.8 |
| L | | | 4 | | | | | | 4 | 2 | 3.3 |
| N | | | | | 5 | 5 | | | 5 | | 5.0 |
| P | 10 | | | | 5 | | | | 5 | 10 | 7.5 |

10 - no change; 0 - extreme, repulsive change

Although variations in scores within code lots are as much as five points it is felt that an approximation of the colour ratings can be given by the average scores.

The codes are re-arranged in the Table 4 by average scores with the highest average (presumably least change) at the top and lowest (greatest change) at the bottom.

Table 4

Rank By Colour Evaluation

| Average Score | Code | Identity |
|---|---|---|
| 9.3 | E | Canco container, frozen in solution of NaCl |
| 8.3 | D | Canco container, frozen in solution of ascorbic acid |
| 8.0 | B | Canco container, frozen in water |
| 7.7 | F | Canco container, block frozen, water added |
| 7.5 | P | Wax carton container, dip in Krim Ko Gel and NDGA |
| 7.0 | C | Canco container, frozen in solution of NDGA |
| 5.0 | N | Wax carton container, dip in solution of Krim Ko Gel, ascorbic acid and Tweens 81 |
| 4.3 | A | Canco container, no treatment |
| 3.8 | J | Wax carton container, dip in solution of Krim Ko Gel and ascorbic acid |
| 3.3 | G | Wax carton container, no treatment |
| 3.3 | L | Wax carton container, dip in solution of Krim Ko Gel |

It can be seen that the control codes A and G are in the lower portion of the list while some treated samples are considerably higher in the scale.

The codes are classified into two groups in Table 5, namely those codes whose colour is apparently,

1. better colour than control code A
2. not better than control code A.

Table 5

Classification Of Codes When Average Visual Colour Scores Are Compared With Average Visual Colour Scores Of Control Code A

1. Better colour than control

Code B - Canco container, frozen in water
Code C - Canco container, frozen in solution of NDGA
Code D - Canco container, frozen in solution of ascorbic acid
Code E - Canco container, frozen in solution of NaCl
Code F - Canco container, block frozen, water added
Code N - Wax carton container, dip in solution of Krim Ko Gel, ascorbic acid and Tweens 81
Code P - Wax carton container, dip in solution of Krim Ko Gel and NDGA

2. Not better colour than control

Code G - Wax carton container, no treatment
Code J - Wax carton container, dip in solution of Krim Ko Gel and ascorbic acid
Code L - Wax carton container, dip in solution of Krim Ko Gel

The small difference, 0.7(5.0 to 4.3) between average visual colour scores of codes N and A would make it seem questionable whether N should be classified as having a better colour than control code A. Since the differences in average scores between A to J, A to G and A to L were so slight, 0.5, 1.0 and 1.0 respectively, the classification; not better than control code A, is probably better than a classification such as; worse than control code A.

Net Results

The codes are re-grouped in Table 6 by their positions in the classifications of quality based on taste, peroxide and visual colour results.

Table 6

Grouping Of Codes By Classifications Based On Taste, Peroxide And Visual Colour Results

I Better than control by average peroxide values and average visual scores; not different by average taste scores

Code B - Canco container, frozen in water
Code C - Canco container, frozen in solution of NDGA
Code D - Canco container, frozen in solution of ascorbic acid
Code E - Canco container, frozen in solution of NaCl
Code F - Canco container, block frozen, water added
Code N - Wax carton container, dip in solution of Krim Ko Gel, ascorbic acid and Tweens 81

II Better than control by average peroxide values; not better by average visual scores; worse by average taste scores

Code J - Wax carton container, dip in solution of Krim Ko Gel and ascorbic acid

III Not better than control by average peroxide values; better by average visual scores; not different by average taste scores

Code P - Wax carton container, dip in solution of Krim Ko Gel and NDGA

IV Not better than control by average peroxide values; not better by average visual scores and not different by average taste scores

Code G - Wax carton container, no treatment
Code L - Wax carton container, dip in solution of Krim Ko Gel

It can be seen from this table that:

1. When evaluated by both peroxide values and visual colour ratings, all codes packed in solutions in Canco containers showed better quality than control.

2. Code N (dip in solution of Krim Ko Gel, ascorbic acid and Tweens 81) is the only pretreated code lot packed in wax cartons that is rated better than control by both peroxide and visual colour results. It was questionable whether code N should be grouped in the classification of "better than control by visual evaluation". (See Results, Visual colour, page 37).

3. Code N (dip in solution of Krim Ko Gel, ascorbic acid and Tweens 81) and code J (dip in solution of Krim Ko Gel and ascorbic acid) are in different groups. An inspection of the group headings would indicate that when used with Krim Ko Gel and ascorbic acid, Tweens 81 assists in the retention of quality.

4. Code J (dip in solution of Krim Ko Gel and ascorbic acid) and code P (dip in solution of Krim Ko Gel and NDGA) are each in groups in which some improvement in retention of quality was noted over the

control code. This would indicate that some benefit can be derived from the use of a suitable anti-oxidant in a pre-treatment dip with Krim Ko Gel.

5. Code G (wax carton container, no treatment) and code L (dip in solution of Krim Ko Gel) are each in the group in which no differences in quality were noted between these codes and the control code A. This observation would indicate that there is no difference in quality between untreated samples packed in the two containers tried, and that Krim Ko Gel alone used in a pre-treatment dip does not assist in the retention of quality.

# SUMMARY AND CONCLUSIONS

Approximately four hundred pounds of bright pink salmon fillets were selected for a project in which two packaging materials, five immersion treatments and ten pre-treatments were used in an effort to prolong the storage life of frozen pink salmon fillets. The fillets were evaluated by peroxide determinations, taste test scores and visual evaluation of colour changes after a six month's storage period.

There was considerable variability in the taste test results and between samples of a given code. Peroxide determinations, taste test results and visual colour results each permitted the classification of code lots into two general groups, the first being somewhat better than controls and the second being not clearly superior to the controls.

Based on the results of this investigation it may be concluded that:

1. Immersion freezing assisted in the retention of quality of stored pink salmon fillets.

2. Freezing in a compact block followed by the

addition of water to completely fill the package assisted in the retention of quality during storage.

3. Pre-treatment dips in solutions of Krim Ko Gel and suitable anti-oxidants assisted some in the retention of quality of frozen pink salmon fillets.

4. Untreated pink salmon fillets frozen in Canco containers and in wax cartons with wax paper overwraps showed no difference in their retention of quality during storage.

5. A pre-treatment dip of pink salmon fillets in a solution of Krim Ko Gel alone showed no better retention of quality than control samples.

6. When used in dips of Krim Ko Gel and ascorbic acid, the addition of the wetting agent, Tweens 81, resulted in slightly better colour retention and considerably better flavour acceptability.

7. Only samples that were frozen in solutions or frozen in block followed by the addition of water to completely fill the package had acceptable colours and flavours up to a six month's storage period.

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