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# MINCE & FILLET PINK SALMON BLOCKS

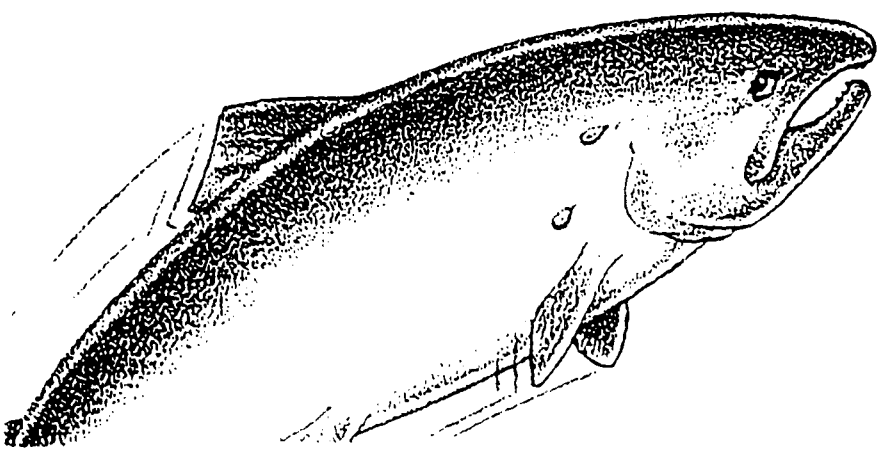
## A TECHNICAL STUDY

**JUNE 1988**

GETTING THE

# JUMP

ON SALMON



# INTRODUCTION

## Executive Summary

Blocks prepared from skinless, boneless pink salmon fillets and mince were evaluated as potential product forms. The project objectives included:

1. obtaining usable yield and recovery figures for block production.

2. determining shelf life of the product forms produced using fresh and frozen (reprocessed) dressed pink salmon during a year long storage trial.

3. evaluating different packaging methods and antioxidant mixtures on the shelf life and product quality of pink salmon blocks during a fourteen month storage trial.

Yields: Recoveries of skinless, boneless pink salmon fillets ranged between 32% to 34% from round fish and 46% to 49% from dressed fish. Recoveries from frozen, dressed salmon were slightly lower, ranging between 43% to 45%. The yield of usable trim ranged between 12% to 15% from round fish and 17% to 21% from dressed fish. Mince recovery from the trimmings averaged 90%.

Shelf Life and Reprocessing Studies: Blocks containing 100% and 75% fillets were preferred over blocks with 75% and 100% mince. The high fillet blocks had better texture and flavor throughout the twelve month storage period.

Blocks prepared from fresh pink salmon fillets and mince had slightly better flavor, more moistness and tenderness than blocks made from reprocessed (frozen) fish. However, reprocessed salmon produced acceptable blocks during the twelve month storage trial. After twelve months frozen storage little difference existed between blocks from fresh and reprocessed salmon.

Thaw drip increased during the storage trial and was greatest at twelve months. Product produced from reprocessed fish had significantly higher thaw drip than fresh product. By twelve months, reprocessed block thaw drip exceeded 10%. High mince blocks (75% and 100% mince) had higher thaw drip.

Rancidity developed slowly in all product forms. The 100% mince blocks had noticeable rancidity after six months frozen storage. Blocks from reprocessed salmon had lower initial rancidity than fresh blocks, but quickly increased during subsequent storage.

All product forms were acceptable after twelve months storage with the high mince blocks deteriorating faster than the high fillet blocks. Estimated shelf life for these products ranges between six and twelve months.

Packaging Study: Vacuum packaged blocks were preferred by the taste panels over plastic wrapped product. These blocks had better flavor and more moistness as a result of the vapor/gas barrier of the vacuum bags. Noticeable differences existed at one and seven months frozen storage, although both packaging styles produced acceptable product. After fourteen months, the differences between vacuum and plastic wrapped blocks were small.

Deep skinned product was preferred over shallow skinned product. The removal of the fat layer gave the deep skinned product better flavor. Both skinning methods produced acceptable product up to seven months frozen storage. At fourteen months frozen storage, shallow skinned product was much darker and less desirable. .

The ideal packaging strategy from this experiment was a vacuum packaged, deep skinned block. These blocks held up better under frozen storage. Shallow skinned, plastic wrapped blocks suffered noticeable deterioration after seven months frozen storage.

Antioxidant Study: All levels of antioxidants were effective in retarding the development of rancidity during the fourteen month storage trial. During the first seven months, rancidity values increased only slightly. After fourteen months, rancid flavors were noted in some samples.

Blocks from deep skinned fillets developed less rancidity than shallow skinned product. The removal of the fat line was critical to controlling fat oxidation.

Use of an ascorbic acid/citric acid mix was not acceptable. Its addition to the products resulted in very high thaw drip and an unpleasant acid flavor.

Blocks with sodium erythrobate levels at 0.50% combined with deep skinning gave the best shelf life stability.

## Introduction and Purpose

Pink salmon (Oncorhynchus gorbuscha) is the most abundant salmon species harvested in Alaska, accounting for over 45% of total landings. The fisheries in Southeast Alaska, Prince William Sound and Kodiak rely on pink salmon for the bulk of their production. In recent years, record pink catches have been landed in these areas with resulting lower ex-vessel prices and returns to processors. One of the reasons for reduced value is the lack of product forms for new markets.

Traditionally, pink salmon have been canned. But, with changing consumer attitudes, canned product no longer commands the market share it once enjoyed. Consumption trends are shifting from canned foods toward frozen, convenience-type foods. This trend has reduced demand and prices for canned pink salmon and, in some years, left seafood processors with large carry-over inventories to sell.

This dilemma has led to the development of new product forms that will increase the value of pink salmon for both processors and fishermen. Some products such as fillets, steaks and whole frozen fish are already well established in markets, providing processors with products of added value. However, with larger pink salmon forecasts, more and varied products will be needed to fully utilize the resource and provide increased returns to processors and fishermen. Product forms must be developed that can take advantage of potential high volume markets. These are forms that can be used by secondary processors and major food companies in creating new convenience foods.

Concerned with declining consumer interest in canned pink salmon, the State of Alaska through the Office of Commercial Fisheries Development (OCFD) developed frozen fillet and minced pink salmon blocks in 1985. The success of this study prompted the state to continue the project and produce pink salmon "logs" in the 1986/7 salmon seasons and distribute them to major food companies for product development.

As an adjunct to the State of Alaska project, the University of Alaska Fishery Industrial Technology Center and Alaska Fisheries Development Foundation cooperatively provided technical support to the state project by generating information on the acceptability, shelf life and functional attributes of alternate pink salmon products.

## Approach

Preparation of Product Forms: Five product forms were evaluated for shelf life, reprocessing potential and functional characteristics. They included:

- dressed fish (used as control)
- fillets (IQF)
- 100% fillet "log/block"
- 100% mince "log/block"
- combination fillet/mince "log/block"
  - 75% fillet/25% mince
  - 50% fillet/50% mince

Product forms were produced with fish obtained from a local processor. The fish were of uniform quality taken from a salmon seiner that had delivered to the processor's dock.

All product forms were frozen to -20°F in the plate freezer at National Marine Fisheries Service Gibson Cove pilot plant assuring minimal quality loss. Frozen product was stored at -5°F during the shelf life trials. Products were packaged in plastic bags and stored in plastic lined cardboard boxes for shelf life trials. Salmon used as controls were vacuum packaged and stored at -30°F.

Shelf Life Evaluation: Shelf life studies were conducted for all product forms. Blocks were held at -5°F for 1, 3, 6 and 12 months storage. At the end of each storage period, samples were analyzed by sensory, physical, microbiological and chemical methods. Analyses consisted of:

1. Sensory evaluation of steamed samples by a trained taste panel. A 7 point anchored scale was used to evaluate flavor, texture, odor, chewiness, moistness and overall desirability.

2. Measurement of rancidity using Lemon's modified TBA test.

3. Thaw drip of all samples using standard methods.

4. pH.

5. Visual examination of products before sensory evaluation.

6. Proximate analyses of selected samples measuring protein, fat, moisture and ash content.

7. Color measurement of selected samples to determine any changes in flesh or mince.

8. Yield data to determine potential economic benefits and added recoveries from methodology.

9. Microbial analyses that included testing for aerobic plate count, fecal coliform, E. Coli, Salmonella and Staphylococcus aureus. All chemical and microbiological tests used standard methodology.

Reprocessing Study: Dressed salmon were held at -5°F for 3, 6 and 12 months frozen storage. At the end of each storage period, fish were thawed and processed into the four product forms. These forms were packaged as described above, re-frozen and held for storage trials for 3, 6 and 9 months. At the end of the storage period, the reprocessed product forms were evaluated by the sensory, physical and chemical analyses described above.

Packaging Study: Combination fillet/mince (75%/25%) blocks were produced for a packaging study. Fillets were "deep" skinned, removing the fat line, and "shallow" skinned to determine the importance of skinning method in block production. Blocks were packaged in vacuum bags or plastic liners and boxed in cardboard cartons. Product was held at $-5^{o}F$ for 1, 7 and 14 months frozen storage. At the end of each storage period product were evaluated as described above for chemical, sensory and physical attributes.

Antioxidant Study: Combination fillet/mince (75%/25%) blocks were produced for an antioxidant study. Fillets were "deep" skinned, removing the fat line, and "shallow" skinned to determine the importance of skinning methods in block production. Antioxidants were added as a dry mix to the blocks in the following concentrations:

0.25 % sodium erythorbate
0.50 % sodium erythorbate
1.00 % sodium erythorbate
0.45 % ascorbic acid + 0.05% citric acid
no antioxidant

Blocks were held at $-5^{o}F$ for storage trials and evaluated after 0, 7 and 14 months frozen storage for lipid oxidation products. Sensory evaluation was also conducted on these samples to determine development of detectable rancidity.

Project Management: Project management was performed by the faculty of the Fishery Industrial Technology Center (FITC), University of Alaska. The center director, Dr. Jong Lee, had responsibility of budgetary matters. The project was under the direct supervision of Dr. Elisa Elliot and Mr. Charles Crapo, FITC faculty members.

# FINAL REPORT

NOAA COOPERATIVE AGREEMENT # 86-ABH-00044
SUBCONTRACTOR (FITC, UAF) ACCOUNT # 39520-255230

| | | |
|---|---|---|
| PROJECT BUDGET: | FEDERAL | $34,880.00 |
| | MATCHING FUNDS | $16,560.00 |
| | TOTAL | $51,440.00 |

PROJECT TITLE: PINK SALMON DEVELOPMENT (Alternate Pink Salmon Product Forms) A component of the AFDF FULL UTILIZATION OF AMERICAN SURIMI AND OTHER UNDERUTILIZED SPECIES.

GRANTEE: Alaska Fisheries Development Foundation, Inc.

SUBCONTRACTOR: Fishery Industrial Technology Center (A unit of the School of Fisheries and Ocean Sciences of the University of Alaska - Fairbanks)

SUBCONTRACT PERIOD: From October 1986 to June 1988

# PART I

## Sample Preparation and Yields

The pink salmon used for this experiment (2000 lbs.) were purchased from a local processor, iced and transported to the NMFS facility at Gibson Cove. All fish were dressed and 275 were immediately frozen, glazed, individually wrapped in a two mil polyethylene sleeve and packed in a master carton lined with a two mil polyethylene liner. The salmon were plate frozen at -40°F for 6-12 hours or air-blast frozen for 16 hours at -5°F. The recovery data of dressed salmon are presented in Table 1.

Table 1. Recovery data for dressed pink salmon

| | Weight in pounds |
|---|---|
| Whole Salmon (30 fish) | 106.0 |
| Average Weight | 3.53 |
| Dressed Salmon | 76.5 |
| % Recovery | 72.17% |

The remaining dressed salmon were belly-iced and held in insulated totes overnight at 32°F. On day two, the fish were removed from the ice, rinsed and filleted. The results are presented in Table 2. The dressed pink salmon were "planked" to remove the backbone. The fins and collar were then removed. Fillets were skinned using a Baader 50. Figure 1 illustrates the cuts used to prepare the boneless fillet. The top portion of the fillet resulting from the cut used to remove the pin-bones was included with the major portion of the fillet in preparing the fillet blocks. The recovery data of boneless fillets and trimmings are presented in Table 3.

Table 2. Recovery of fillets from dressed pink salmon

| | Weight in pounds |
|---|---|
| Dressed Salmon (10 fish) | 23.0 |
| Fillets[1] with skin | 18.0 |
| Fillets[1] | 14.2 |
| Skin | 4.5 |
| Backbone, fins and collar | 3.9 |

[1]Baader model 50 machine used to skin the fillets.

Table 3. Recovery data of boneless fillet and trimmings from dressed pink salmon

| | Weight in pounds |
|---|---|
| Fillet[1] | 14.2 |
| % recovery-dressed wt. | 61.74% |
| % recovery-whole wt. | 44.56% |
| Boneless Fillets[2] | 10.6 |
| % recovery-dressed wt. | 46.09% |
| % recovery-whole wt. | 33.26% |
| Fillet Trimmings (pin and rib bones) | 3.9 |
| % recovery-dressed wt. | 16.96% |
| % recovery-whole wt. | 12.24% |

[1] % recovery-dressed wt. = 14.2/23.0 x 100
[2] % recovery-dressed wt. = 10.6/23.0 x 100

The boneless fillets and trimmings were held at 32°F overnight. On day three the trimmings were minced using a Baader 694 mincer/deboner with a 5mm drum. Approximately, 90% of the trimmings was recovered as minced flesh. From the results of a small-scale run, 33.26% of the weight of whole pink salmon was recovered as boneless fillets and 11.01% (12.24% x .90) as minced flesh (Table 3). This resulted in a ratio of fillet (75.12%) to minced flesh (24.88%) of 3:1. On a larger scale, the ratio of boneless fillet (68.6%) to minced flesh (31.4%) was 2.2:1. The ratio of fillet (skinless, boneless) to trimmings (pin and rib bone fractions) is presented in Table 4.

Table 4. Recovery data of boneless fillets and trimmings from pink salmon

| | Weight in pounds | |
|---|---|---|
| | Small Scale | Large Scale |
| Dressed Salmon | 23.0 | - |
| Fillet | 14.2 | - |
| Boneless fillet | 10.6 | 95.25 |
| (% of fillet) | 73.10% | 66.26% |
| Trimmings (pin and rib bones) | 3.9 | 48.5 |
| (% of fillet) | 26.90% | 33.74% |

A second batch of pink salmon were processed at All Alaskan Seafoods, Inc. in Kodiak. On a small scale, ten pink salmon were followed through the various processing steps to determine recovery data. The results are presented in

Table 5. Skin-on fillets were iced and taken to Gibson Cove for "deep-skinning" using the Baader 50. After skinning, removal of pin and rib bones, blocks of fillets (cut into thirds to facilitate packing the blocks) with 25% added minced salmon flesh (from pin and rib bone trimmings) were frozen at -40°F in a Dole plate freezer. The various treatments being evaluated were blocks packaged with or without vacuum and containing (1) no additives, (2) citric acid (0.05%) plus ascorbic acid (0.45%), and (3) sodium erythorbate (at 0.25%, 0.5%, and 1.0%).

Table 5. Recovery data of boneless fillets (deep-skinned) and trimmings from pink salmon using mechanical filleting and skinning machines.

| | Weight in pounds |
|---|---|
| Whole Fish (10) | 37.25 |
| Viscera removed (manually) | 31.25 |
| Head and Collar removed (Baader 421) | 23.75 |
| Fillets with skin (Baader 50) | 21.25 |
| Fillets (skinless, boneless) | 12.50 |
| (% Recovery-Whole weight) | 33.56% |
| Trimmings | 5.50 |
| (% Recovery-Whole weight) | 14.76% |

A third batch of of dressed pink salmon were processed at All Alaskan Seafoods, Inc. to prepare blocks of "shallow-skinned" fillets plus 25% minced salmon flesh. The results are presented in Table 6. The various treatments were the same as for the "deep-skinned" salmon blocks prepared on August 5th.

Table 6. Recovery data of boneless fillets (shallow-skinned) and trimmings from pink salmon using mechanical filleting and skinning machines

| | Weight in pounds |
|---|---|
| Dressed Salmon | 499.00 |
| Fillets (skinless, boneless) | 236.50 |
| (% recovery-dressed weight) | 47.39% |
| Trimmings | 115.75 |
| (% recovery-dressed weight) | 23.20% |

The recovery data of fillets (skinless, boneless) and trimmings from the different processing parameters are presented in Table 7. For all three experiments, it appeared that the ratio of fillets (skinless, boneless) to trimmings (pin and rib bones) was roughly 2:1 (Table 8).

Table 7. Recovery of fillets (skinless, boneless) and trimmings from manual and mechanical test runs

| | % Recovery (Whole Weight Basis) | | |
|---|---|---|---|
| | Manual (Deep-skinned) | Mechanical (Deep-skinned) | Mechanical (Shallow-skinned) |
| Fillets (skinless, boneless) | 33.26% | 33.56% | 34.12%[1] |
| Trimmings | 12.24 | 14.76 | 16.70[1] |

[1]Estimated using a recovery of 72% dressed weight from whole pink salmon.

Table 8. Recovery data of fillets (skinless, boneless) and trimmings (pin and rib bones) from skin-off pink salmon fillets

| | % Recovery of skin-off fillets | | |
|---|---|---|---|
| | Manual (Deep-skinned) | Mechanical (Deep-skinned) | Mechanical (Shallow-skinned) |
| Fillets (boneless) | 66.26% | 69.03% | 67.14% |
| Trimmings (pin-and rib bones) | 33.74 | 30.97 | 32.86 |

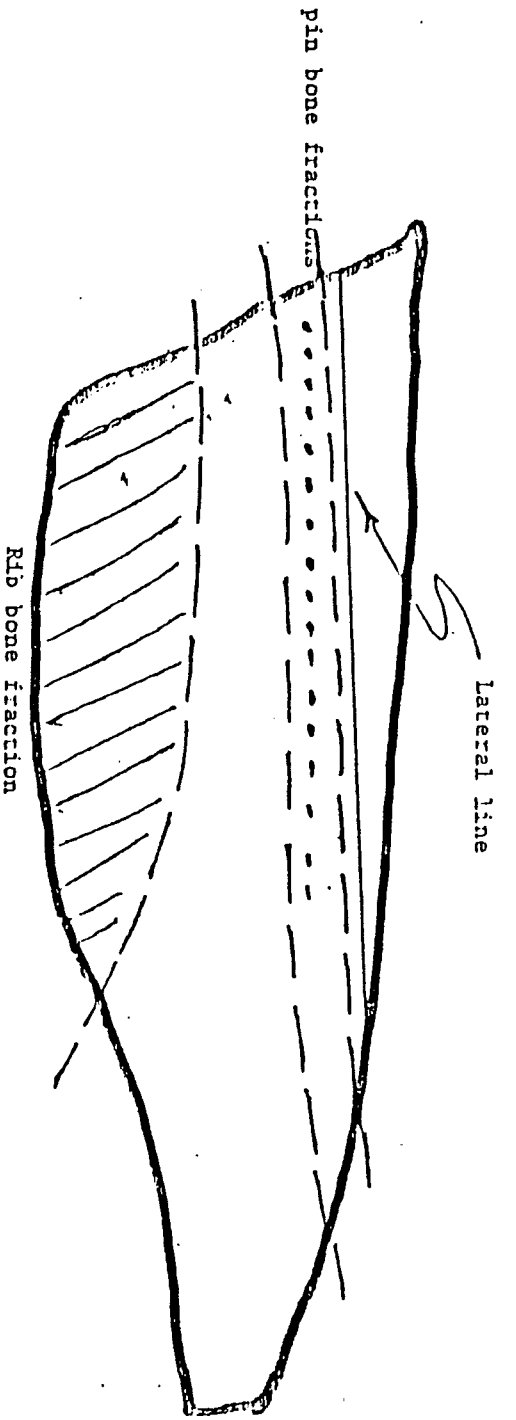



Fig. 1. Cuts used to prepare pink salmon fillets (skinless, boneless) and trimmings (pin-and rib-bones).

# PART II

Evaluation of One Month Fresh Frozen Pink Salmon Products

Fillet, mince and combination fillet/mince pink salmon blocks produced for the shelf life study were analyzed after approximately one month of frozen storage at $0^{o}F$. The data obtained would serve as the baseline for subsequent analyses.

Sensory Analysis: Mean taste panel scores for all product forms are presented in Table 1. The panelists used a seven point scoring scale for all attributes except texture which was reduced to a five point scale. A copy of the score sheet is shown as Appendix A. As part of the experimental design, values for the control samples were anchored. The attributes of color, flavor, chewiness and moistness were set values that served as a guide for assessing the test samples. Data was analyzed using a factorial design and least squares difference to determine significance among treatments.

The statistical analysis revealed the following:

1. Significant ($p=.05$) differences existed in flavor, chewiness, texture and desirability among the test samples.

2. Panelists preferred the 100% fillet and 75% fillet blocks over the 50% and 0% fillet blocks.

3. Texture scores indicated that panelists preferred the higher mince ratios over the 100% and 75% fillet forms, but that the fillet forms were more chewy.

4. Considerable differences existed in overall desirability. The taste panelists preferred the 100% fillet block over all others. The differences between the 100% fillet block and the 25% and 0% fillet blocks were significant ($p=.05$).

5. No differences were detected in moistness or color.

6. Scores indicated that the all samples were acceptable.

Chemical Analysis: Samples of the fillet and mince used for the product forms were analyzed for proximate composition, salt content, pH and rancidity. Rancidity was measured using Lemons modified TBA method. Results are presented in Table 2.

The proximate analysis data correlated well with published figures for pink salmon. The fat content was higher in the mince as it contained trimmings from the skin and belly. TBA values were small indicating low rancidity development in the fresh fish. This was expected since the fish were less than two days old at the time of processing and had been held at refrigerated temperatures since catch. The absence of rancidity was further confirmed by the taste panel.

Table 1. Mean[1] Sensory Scores from Pink Salmon Products Held at 0°F for One Month

| Form | Sensory Attribute | | | | | |
|---|---|---|---|---|---|---|
| | Color | Flavor | Chewiness | Texture | Moistness | Desirability |
| 100% Fillet | 3.9[a] | 6.6[ab] | 3.3[ab] | 3.2[cd] | 3.9[a] | 6.5[a] |
| 75% Fillet | 3.9[a] | 6.3[b] | 3.9[ab] | 3.6[bc] | 3.9[a] | 6.1[ab] |
| 50% Fillet | 3.6[a] | 6.2[b] | 3.3[b] | 3.9[ab] | 3.7[a] | 5.8[bc] |
| 0% Fillet | 3.6[a] | 5.5[c] | 3.4[ab] | 4.0[a] | 3.4[a] | 5.0[c] |
| Control | 4.0[a] | 7.0[a] | 4.0[a] | 3.0[d] | 4.0[a] | 6.6[a] |

[1] n=10
Mean values in a column with the same exponent letter did not vary significantly (p=.05) from one another.

Table 2. Chemical Data of Mince and Fillet Pink Salmon

| | Fillet | Mince |
|---|---|---|
| Protein (%) | 19.90% | 18.79% |
| Fat (%) | 1.98 | 3.4 |
| Moisture (%) | 76.64 | 76.48 |
| Ash (%) | 1.26 | 1.13 |
| Salt (%) | 0.21 | 0.23 |
| TBA(umoles/100g) | 0.83 | 0.84 |
| pH | 6.8 | 6.8 |

Physical Analysis: Physical analysis performed on the product forms included thaw drip, color and shear/stress measurement. Thaw drip test was conducted using a one hour water thaw method at 58°F. Color was measured using a Minolta reflectance meter. Shear/stress was measured using an Instron Model 1000 equipped with a punch. Thaw drip data is presented in Table 3 and color values in Table 4.

Table 3. Thaw Drip for One Month Frozen Pink Salmon Blocks

| Form | % Thaw Drip |
|---|---|
| 100 % fillet | 2.42 % |
| 75 % fillet | 4.84 |
| 50 % fillet | 2.98 |
| 0 % fillet | 2.85 |

Thaw drip among the forms did not vary significantly. The 75% fillet sample showed higher thaw drip but should not be considered abnormal. Thaw drips under five percent are acceptable.

Table 4. Hunter Color Values for Fillet and Mince Pink Salmon

| | Hunter Parameter | | |
|---|---|---|---|
| | L | a | b |
| Fillet | 48.0 | 10.8 | 12.2 |
| Mince | | | |
| shallow skin | 57.4 | 10.5 | 14.7 |
| deep skin | 56.4 | 12.8 | 15.1 |

The Hunter color values were similar with the mince samples slightly lighter than the fillet sample.

Microbiological Analysis: Fresh samples of all products were examined for microbial loads. Aerobic plate count (APC), total coliform (TC), fecal coliform (FC) and coagulase positive Staphylococcus aureus counts were performed. The data from these tests are presented in Table 5.

Table 5. Microbial Loads of Pink Salmon Forms

| Form | Aerobic Plate Count/g (APC) | Total Coliforms/g (TC) | Fecal Coliforms/g (FC) | Staphylococcus aureus (presence/absence) |
|---|---|---|---|---|
| Fillet | 820000 | 12 | 0.4 | - |
| Fillet | 350000 | 240 | 0.4 | - |
| Mince | 890000 | 240 | 0.4 | + |
| Mince | 960000 | 93 | 0.7 | + |
| Fillet/Mince | 1500000 | 240 | 0.9 | + |
| Fillet/Mince | 1700000 | 240 | 150 | + |

Aerobic plate counts were high indicating that the sanitation of the processing area could have been improved. The addition of mince to fillet also produced high plate counts suggesting that the mixing operation should have been carried out in a more sanitary manner. The presence of Staphylococcus aureus indicated contamination of human origin present in the samples. Overall, the product was not handled as well as it could have been.

## Evaluation of Three Month Fresh Frozen and Reprocessed Pink Salmon Products

Dressed pink salmon held in frozen storage at $0^{\circ}F$ for three months were reprocessed into fillet, mince and combination fillet/mince blocks and evaluated with fresh frozen products.

Sensory Evaluation: The sensory evaluation tests compared fresh frozen product after three months storage and reprocessed product. Mean taste panel scores are presented in Tables 6 to 11. The panels used a seven point scoring scale for all attributes except texture which was reduced to a five point scale. A copy of the score sheet is shown as Appendix A. As part of the experimental design, values for the control samples were anchored. The attributes of color, flavor, chewiness and moistness were set values that served as a guide for assessing the test samples. Data was analyzed using a factorial design and least squares difference to determine significance among treatments.

The statistical analysis revealed significant ($p=.05$) differences between the fresh frozen and reprocessed samples. Fresh frozen samples scored significantly ($p=.05$) higher in color, flavor, chewiness and desirability. This implied that the fresh frozen samples had better flavor and were lighter in color, more tender and more desirable. The reprocessed forms had higher

texture scores indicating a firmer product. No difference was found in the moistness between the two treatments.

Some differences existed between the product forms. The 100% fillet block had significantly (p=.05) higher scores in flavor. The 0% fillet block was found to have a more fibrous texture and less overall desirability. No significant (p=.05) differences existed between the 100%, 75% and 50% fillet blocks in overall desirability although the 100% fillet had the highest scores.

Chemical Analysis: Samples were tested for rancidity. This was measured using the Lemons modified TBA test. Values for TBA are presented in Table 12. The TBA values for the fresh/frozen blocks were higher than the reprocessed forms. This was probably due to the three month storage period. The fresh/frozen samples having more exposed surface area were more susceptible to rancidity development. The reprocessed forms were held as dressed fish that had been protected by glaze and superior packaging, consequently less rancidity developed.

Table 6. Mean[1] Color Scores for Three Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.90 | 3.90 | 4.14 | 4.10 |
| Reprocessed Block | 3.65 | 3.60 | 3.60 | 3.65 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 10.72[2] | Fresh Frozen > Reprocessed |
| Form (F) | 0.27[3] | 0% > 50% > 75% >100% |
| T X F | 0.30[3] | |

[1] n=10 [2] Sig p>.005 [3] NS p<.05
Level means with the same underline did not vary significantly (p=.05) from one another.

Table 7. Mean[1] Flavor Scores for Three Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 6.05 | 5.63 | 5.71 | 5.57 |
| Reprocessed Block | 5.75 | 5.15 | 5.15 | 5.20 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 7.50[2] | Fresh Frozen > Reprocessed |
| Form (F) | 2.06[3] | 100% > 75%> 50% > 0% |
| T X F | 0.20[3] | |

[1] n=10 [2] Sig p>.01 [3] NS p<.05

Level means with the same underline did not vary significantly (p=.05) from one another.

Table 8. Mean[1] Chewiness Scores for Three Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.71 | 3.48 | 3.52 | 3.24 |
| Reprocessed Block | 3.25 | 3.05 | 3.05 | 3.50 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 7.07[2] | Fresh Frozen > Reprocessed |
| Form (F) | 0.83[3] | 100% > 75%> 50% > 0% |
| T X F | 2.26[3] | |

[1] n=10 [2] Sig $p>.05$ [3] NS $p<.05$

Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 9. Mean[1] Texture Scores for Three Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.14 | 3.33 | 3.24 | 4.05 |
| Reprocessed Block | 3.25 | 3.55 | 3.85 | 3.90 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 5.23[3] | Reprocessed > Fresh Frozen |
| Form (F) | 13.86[2] | 0% > 75%> 50% > 100% |
| T X F | 3.21[3] | |

[1]n=10 [2]Sig p>.001 [3]Sig p>.05
Level means with the same underline did not vary significantly (p=.05) from one another.

Table 10. Mean[1] Moistness Scores for Three Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.47 | 3.43 | 3.62 | 2.86 |
| Reprocessed Block | 3.45 | 3.15 | 2.95 | 3.00 |

Factorial Analysis of Variance

| F Values | | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 2.83[3] | Fresh Frozen > Reprocessed |
| Form (F) | 3.70[2] | 100% > 75%> 50% > 0% |
| T X F | 2.66[3] | |

[1] n=10 [2] Sig $p>.05$ [3] NS $p<.05$

Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 11. Mean[1] Desirability Scores for Three Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 5.76 | 5.43 | 5.52 | 4.80 |
| Reprocessed Block | 5.35 | 4.75 | 4.65 | 4.15 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 13.33[2] | Fresh Frozen > Reprocessed |
| Form (F) | 5.28[3] | 100% > 75%> 50% > 0% |
| T X F | 0.29[4] | |

[1] n=10 [2] Sig p>.001 [3] Sig p>.005 [4] NS p<.05
Level means with the same underline did not vary significantly (p=.05) from one another.

Table 12. TBA Values (umoles/100g) for Three Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 1.61 | 1.31 | 1.50 | 1.48 |
| Reprocessed Block | 0.71 | 0.78* | 0.85* | 0.98 |

* estimated values

Physical Analysis: Samples were tested for thaw drip and shear/stress measurements. Thaw drip values are shown in Table 13.

Table 13. Thaw Drip (%) for Three Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 2.96% | 4.46% | 2.65% | 3.06% |
| Reprocessed Block | 4.38 | 3.60 | 3.64 | 5.39 |

Thaw drip for the reprocessed blocks was higher than the fresh frozen samples. This could be attributed the double freezing of the reprocessed product. Other studies suggest that excessive thaw drip occurs when frozen products are thawed and then refrozen. The values for the reprocessed blocks, while being higher than the fresh frozen, are not excessive.

Shear/stress analysis revealed that the reprocessed forms had a higher resistance to shear than the fresh frozen. This implied that the reprocessed forms were tougher and it was probably as a result of the double freezing.

Microbiological Analysis: Reprocessed forms were sampled for microbiological testing. Aerobic plate count (APC), total coliform (TC), fecal coliform (FC) and coagulase positive Staphylococcus aureus counts were performed. The data from these tests are shown in Table 14.

Table 14. Microbial Loads of Pink Salmon Forms

| Form | Aerobic Plate Count/g (APC) | Total Coliforms/g (TC) | Fecal Coliforms/g (FC) | Staphylococcus aureus (presence/absence) |
|---|---|---|---|---|
| Fillet | 2700 | 0.4 | <0.3 | - |
| Fillet | 7200 | 0.4 | <0.3 | + |
| Mince | 110000 | 1.5 | <0.3 | - |
| Mince | 210000 | 1.5 | <0.3 | - |

The microbial counts for the fillets were low and indicative of good processing and proper handling techniques. Once the product was minced, aerobic plate counts increased substantially. This could be an indication that the mincing equipment was poorly cleaned. It also revealed that mince can be easily contaminated. Low counts of coliforms are also indicative of good processing hygiene. The presence of Staphylococcus aureus in one fillet sample indicated some possible contamination from human sources.

## Evaluation of Six Month Fresh Frozen, Three Month and Six Month Reprocessed Pink Salmon Products

Dressed pink salmon held in frozen storage at $0^{o}F$ for six months were processed into fillet, mince and combination fillet/mince blocks and compared with three month reprocessed product and fresh frozen product.

Sensory Evaluation: Sensory evaluation compared six month fresh frozen product with the three and six month reprocessed product. The three month reprocessed product had been held in $0^{o}F$ storage for three months prior to evaluation. Mean taste panel scores are presented in Tables 15 to 20. The panels used a seven point scoring scale for all attributes except texture which was reduced to a five point scale. A copy of the score sheet is shown as Appendix A. As part of the experimental design, values for the control samples were anchored. The attributes of color, flavor, chewiness and moistness were set values using a factorial design and least squares difference to determine significance among treatments.

The data from the sensory analysis revealed the following:

1. Reprocessed samples were significantly ($p=.05$) darker than the fresh frozen samples. Darkening may have been a result of discoloration of the fat layer during frozen storage of the dressed fish.

2. Fresh frozen product was more tender than the six month reprocessed samples. No significant ($p=.05$) difference existed between the fresh frozen and three month reprocessed samples although fresh frozen product had higher scores.

3. Fresh frozen products had significantly ($p=.05$) firmer texture than the reprocessed products. No texture difference was noted between the reprocessed samples, but the three month product had higher scores indicating a less tough product.

4. No significant ($p=.05$) differences existed between the fresh frozen and reprocessed samples in flavor and overall desirability; however, the fresh frozen samples had slightly higher acceptability scores.

Table 15. Mean[1] Color Scores for Six Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 4.00 | 3.82 | 4.18 | 3.81 |
| 3 Month Reprocessed Block | 3.55 | 3.28 | 3.18 | 3.09 |
| 6 Month Reprocessed Block | 3.55 | 3.28 | 3.45 | 2.90 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 8.71[2] | Fresh Frozen > 6 Month > 3 Month |
| Form (F) | 1.50[3] | 0% > 50% > 75% >100% |
| T X F | 0.32[3] | |

[1] n=11 [2] Sig p>.005 [3] NS p<.05

Level means with the same underline did not vary significantly (p=.05) from one another.

Table 16. Mean[1] Flavor Scores for Six Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 5.73 | 5.55 | 5.27 | 4.19 |
| 3 Month Reprocessed Block | 5.09 | 4.54 | 4.82 | 4.54 |
| 6 Month Reprocessed Block | 4.72 | 5.36 | 4.73 | 4.82 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 1.76[2] | Fresh Frozen > 6 Month > 3 Month |
| Form (F) | 2.61[3] | 100% > 75% > 50% > 0% |
| T X F | 1.65[2] | |

[1] n=11 [2] NS $p<.05$ [3] Sig. $p>.05$
Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 17. Mean[1] Chewiness Scores for Six Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 4.18 | 3.45 | 3.00 | 2.87 |
| 3 Month Reprocessed Block | 3.18 | 3.36 | 3.00 | 3.09 |
| 6 Month Reprocessed Block | 2.72 | 3.09 | 3.18 | 3.00 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 2.20[2] | Fresh Frozen > 3 Month > 6 Month |
| Form (F) | 1.77[2] | 100% > 75%> 50% > 0% |
| T X F | 2.68[3] | |

[1] n=11 [2] NS $p<.05$ [3] Sig $p>.05$

Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 18. Mean[1] Texture Scores for Six Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.00 | 3.09 | 3.54 | 4.09 |
| 3 Month Reprocessed Block | 3.55 | 3.36 | 3.09 | 4.09 |
| 6 Month Reprocessed Block | 3.27 | 3.27 | 3.54 | 4.09 |

Factorial Analysis of Variance

| F Values | | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 3.21[3] | 3 Month > 6 Month > Fresh Frozen |
| Form (F) | 19.88[2] | 0% > 50% > 100% > 75% |
| T X F | 0.68[4] | |

[1] n=11 [2] Sig p>.001 [3] Sig p>.05 [4] NS p<.05

Level means with the same underline did not vary significantly (p=.05) from one another.

Table 19. Mean[1] Moistness Scores for Six Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.64 | 3.27 | 3.09 | 2.64 |
| 3 Month Reprocessed Block | 3.18 | 3.18 | 3.00 | 2.73 |
| 6 Month Reprocessed Block | 2.73 | 3.00 | 2.91 | 3.00 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.78[2] | Fresh Frozen > 3 Month > 6 Month |
| Form (F) | 1.20[2] | 100% > 75% > 50% > 0% |
| T X F | 0.85[2] | |

[1] n=11 [2] NS $p<.05$

Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 20. Mean[1] Desirability Scores for Six Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 5.64 | 5.18 | 4.54 | 3.55 |
| 3 Month Reprocessed Block | 4.64 | 4.36 | 4.27 | 4.00 |
| 6 Month Reprocessed Block | 4.00 | 5.18 | 4.00 | 4.18 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 1.39[3] | Fresh Frozen > 6 Month > 3 Month |
| Form (F) | 4.15[2] | 75% > 100% > 50% > 0% |
| T X F | 1.92[3] | |

[1]n=11 [2]Sig p>.005 [3]NS p<.05
Level means with the same underline did not vary significantly (p=.05) from one another.

5. Differences existed between product forms. The 100% and 75% fillet blocks had better flavor than the 50% and 0% fillet blocks. A significant (p=.05) difference existed between the 0% fillet and 100%/75% fillet blocks.

6. The 100% and 75% fillet blocks had the best texture. The 0% and 50% fillet block was found to be significantly (p=.05) more mealy.

7. Significant (p=.05) differences existed in overall desirability between the 75%/100% fillet forms and 0% fillet form. Panelists preferred the higher fillet ratio over the mince.

Chemical Analysis: Samples were tested for rancidity. This was measured using Lemons modified TBA test. Values for TBA are presented on Table 21. The TBA values were highest for the three month reprocessed forms and lowest for the six month reprocessed forms. This is an indication that thawing, refreezing and subsequent storage accelerates the development of rancidity. Initially, at zero time, the three month reprocessed product had lower TBA values than the fresh frozen product. Very little difference existed between the six month and fresh frozen samples.

Table 21. TBA Values (umoles/100g) for Six Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) | | | |
|---|---|---|---|---|
| | 100% | 75% | 50% | 0% |
| Fresh/Frozen Block | 1.33 | 1.32 | 1.12 | 1.38 |
| 3 Month Reprocessed Block | 1.68 | 1.54 | 1.44 | 1.75 |
| 6 Month Reprocessed Block | 1.26 | 1.02 | 1.21 | 0.87 |
| Control | 0.80 | | | |

Physical Analysis: Samples were tested for thaw drip and values are shown in Table 22. Thaw drips were highest in the reprocessed products as a result of the double freezing during the process.

Table 22. Thaw Drip (%) for Six Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) | | | |
|---|---|---|---|---|
| | 100% | 75% | 50% | 0% |
| Fresh/Frozen Block | 2.70% | 3.55% | 3.56% | 4.45% |
| 3 Month Reprocessed Block | 8.04 | 5.58 | 5.77 | 7.34 |
| 6 Month Reprocessed Block | 5.60 | 5.77 | 6.31 | 6.29 |
| Control | 2.06 | | | |

Microbiological Analysis: Three and six month reprocessed forms and fresh frozen products were sampled for microbiological testing. Aerobic plate count (APC), total coliform (TC), fecal coliform (FC), salmonella and coagulase positive Staphylococcus aureus counts were performed. The data from these tests are shown in Table 23.

The aerobic plate counts for all products were low, representing bacterial die off during frozen storage. Mince continued to have higher counts indicating that it is more easily contaminated than fillets. Coliform counts were all well within international standards although the counts for two of the six month reprocessed samples were fairly high. These two samples had high percentage of mince indicating possible contamination from the deboning equipment. All Staphylococcus aureus counts were low indicating good handling practices. The available Salmonella tests indicated no presence of these organisms in the products.

Table 23. Microbial Loads of Pink Salmon Forms

| Form | Aerobic Plate Count/g (APC) (cfu/g) | Total Coliforms/g (TC) (MPN/g) | Fecal Coliforms/g (FC) (MPN/g) | Staphylococcus aureus (MPN/g) | Salmonella (presence/absence) |
|---|---|---|---|---|---|
| Fresh Frozen | | | | | |
| Fillet | 2100 | 4.3 | <0.3 | <0.3 | - |
| Fillet | 1300 | 2.3 | <0.3 | 4.3 | - |
| Mince | 7200 | 1.5 | 0.4 | 2.3 | - |
| Mince | 3900 | 4.3 | <0.3 | <0.3 | - |
| 3 Month Reprocessed | | | | | |
| 0 % Fillet | 34000 | 9.3 | 0.3 | 3.9 | - |
| 50% Fillet | 25000 | 9.3 | <0.3 | 0.4 | - |
| 75% Fillet | 8900 | 9.3 | <0.3 | 4.3 | - |
| 100% Fillet | 5100 | 4.3 | <0.3 | 4.3 | - |
| 6 Month Reprocessed | | | | | |
| 0 % Fillet | 3400 | 43 | <0.3 | <0.3 | - |
| 50% Fillet | 4500 | 23 | 0.7 | 0.4 | - |
| 75% Fillet | 3900 | 1.5 | <0.3 | 0.4 | - |
| 100% Fillet | 1300 | 1.5 | <0.3 | <0.3 | - |

Evaluation of Twelve Month Fresh Frozen, Three Month, Six Month and Twelve Month Reprocessed Pink Salmon Products

Dressed pink salmon held in frozen storage at $0^{o}F$ for twelve months were processed into fillet, mince and combination fillet/mince blocks and compared with six and three month reprocessed products and the fresh frozen blocks.

Sensory Evaluation: Sensory evaluation compared twelve month fresh frozen product with the three, six, and twelve month reprocessed product. The three and six month reprocessed product had been held in $0^{o}F$ storage for nine and six months, respectively, prior to evaluation. Mean taste panel scores are presented in Tables 24 to 29. The panels used a seven point scoring scale for all attributes except texture which was reduced to a five point scale. A copy of the score sheet is shown as Appendix A. As part of the experimental design, evaluation was based on anchored values for the control samples. The attributes of color, flavor, chewiness and moistness were set values that served as a guide for assessing the test samples. Data was analyzed using a factorial design and least squares difference to determine significance among treatments.

The data from the sensory analysis revealed the following:

1. All scores from the taste panels indicated noticeable decline when compared to scores obtained for products stored for three and six months.

2. Reprocessed samples were significantly ($p=.05$) darker than the fresh frozen samples. Twelve month samples were the darkest of all treatments. The 100% mince samples showed the greatest changes in color over the storage periods. Darkening may have been a result of discoloration of the fat layer during frozen storage of the dressed fish.

3. No significant ($p=.05$) differences existed in chewiness, texture and desirability between the samples, but the fresh frozen samples had slightly better desirability. Reprocessed forms were more chewy than fresh frozen samples. One result of long term storage is the leveling out of any differences among the treatments.

4. Differences existed between product forms. The 100% fillet blocks were significantly ($p=.05$) more desirable than other forms. No difference existed between the 75% and 50% fillet blocks. The 100% mince block had the lowest desirability scores.

5. The 100%, 75% and 50% fillet blocks had better color and flavor than the 100% mince block. The 100% mince block was found to be significantly ($p=.05$) more mealy.

Table 24. Mean[1] Color Scores for Twelve Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.82 | 3.91 | 4.18 | 4.18 |
| 3 Month Reprocessed Block | 3.82 | 3.73 | 3.45 | 3.18 |
| 6 Month Reprocessed Block | 4.00 | 3.64 | 3.45 | 2.45 |
| 12 Month Reprocessed Block | 3.64 | 2.91 | 3.18 | 2.18 |

Factorial Analysis of Variance

| F Values | | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 24.65[2] | Fresh Frozen > 6 Mo. > 3 Mo. > 12 mo. |
| Form (F) | 15.69[3] | 100% > 50% > 75% > 0% |
| T X F | 14.86[3] | |

[1] n=11 [2] Sig p>.005 [3] Sig p>.05
Level means with the same underline did not vary significantly (p=.05) from one another.

Table 25. Mean[1] Flavor Scores for Twelve Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 5.18 | 4.36 | 4.54 | 4.45 |
| 3 Month Reprocessed Block | 4.18 | 4.27 | 3.91 | 3.36 |
| 6 Month Reprocessed Block | 4.54 | 3.73 | 4.73 | 3.55 |
| 12 Month Reprocessed Block | 5.00 | 4.45 | 4.18 | 3.64 |

Factorial Analysis of Variance

| F Values | | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 11.78[2] | 12 Mo. > Fresh Frozen > 6 Mo. > 3 Mo. |
| Form (F) | 21.47[3] | 100% > 50% > 75% > 0% |
| T X F | 10.59[2] | |

[1] n=11 [2] NS $p<.05$ [3] Sig. $p>.05$
Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 26. Mean[1] Chewiness Scores for Twelve Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.55 | 3.00 | 2.54 | 2.45 |
| 3 Month Reprocessed Block | 3.09 | 3.18 | 3.18 | 2.82 |
| 6 Month Reprocessed Block | 3.45 | 3.00 | 3.18 | 2.82 |
| 12 Month Reprocessed Block | 3.36 | 3.00 | 2.91 | 3.09 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 1.46[2] | 6 Mo. > 12 Mo. > 3 Mo. > Fresh Frozen |
| Form (F) | 7.56[3] | 100% > 75% > 50% > 0% |
| T X F | 2.68[3] | |

[1] n=11 [2] NS $p<.05$ [3] Sig $p>.01$

Level means with the same underline did not vary significantly ($p=.05$) from one another.

Thaw drip appeared to be in a normal range. It is noted that the deep skinned product had significantly higher thaw drip than shallow skin. Perhaps the difference in deep and shallow may be the removal of the fat layer that helps protect the moisture within the fillet. The addition of sodium erythrobate did not affect the thaw drip.

Table 28. Mean[1] Moistness Scores for Twelve Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.45 | 3.00 | 2.91 | 2.64 |
| 3 Month Reprocessed Block | 2.91 | 3.09 | 3.00 | 2.55 |
| 6 Month Reprocessed Block | 2.82 | 2.45 | 3.18 | 2.64 |
| 12 Month Reprocessed Block | 3.18 | 3.00 | 3.27 | 2.91 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 2.52[2] | 12 Mo. > Fresh Frozen > 3 Mo. > 6 Mo. |
| Form (F) | 5.06[3] | 100% > 50% > 75% > 0% |
| T X F | 4.73[2] | |

[1] n=11 [2] NS $p<.05$ [3] Sig. $p>.05$

Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 29. Mean[1] Desirability Scores for Twelve Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 4.73 | 3.82 | 3.54 | 3.27 |
| 3 Month Reprocessed Block | 3.82 | 3.72 | 3.18 | 2.27 |
| 6 Month Reprocessed Block | 4.18 | 3.36 | 4.00 | 2.91 |
| 12 Month Reprocessed Block | 4.64 | 3.82 | 3.55 | 3.09 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 9.20[3] | Fresh Frozen > 12 Mo. > 6 Mo. > 3 Mo. |
| Form (F) | 46.83[2] | 100% > 75% > 50% > 0% |
| T X F | 8.19[3] | |

[1] n=11 [2] Sig p>.001 [3] NS p<.05

Level means with the same underline did not vary significantly (p=.05) from one another.

Chemical Analysis: Rancidity for all samples was determined using Lemons modified TBA test and presented in Table 30. The values were highest for the three and six month reprocessed forms and lowest for the twelve month reprocessed forms. This is an indication that thawing, refreezing and subsequent storage contributes significantly to the development of rancidity. Very little difference existed between the twelve month and fresh frozen samples.

Table 30. TBA Values (umoles/100g) for Twelve Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) | | | |
|---|---|---|---|---|
| | 100% | 75% | 50% | 0% |
| Fresh/Frozen Block | 0.80 | 0.68 | 1.24 | 1.05 |
| 3 Month Reprocessed Block | 0.99 | 1.22 | 1.15 | 1.16 |
| 6 Month Reprocessed Block | 0.88 | 1.23 | 1.05 | 1.26 |
| 12 Month Reprocessed Block | 0.67 | 0.81 | 0.91 | 1.01 |
| Control | 1.05 | | | 0.83 |

Physical Analysis: Samples were tested for thaw drip and values are given in Table 31. Thaw drips were highest in the reprocessed products as a result of double freezing the raw material. The fresh frozen product, having only been frozen once, had significantly lower thaw drips. The excessive loss of drip adversely affected the texture and moistness of the reprocessed products making them less desirable.

Table 31. Thaw Drip (%) for Twelve Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.43% | 5.85% | 5.26% | 4.61% |
| 3 Month Reprocessed Block | 9.40 | 9.49 | 6.91 | 8.28 |
| 6 Month Reprocessed Block | 11.74 | 8.29 | 9.46 | 10.90 |
| 12 Month Reprocessed Block | 7.78 | 10.21 | 11.80 | 11.07 |
| Control | 3.43 | | | 5.33 |

# PART III

## Packaging/Antioxidant Study

Combination blocks of 75% fillet and 25% mince were prepared for the packaging/additive study. The objective of this study was to effectively control rancidity development using barrier packaging (vacuum bags vs. plastic liners) and/or antioxidants.

Fillets used in the blocks were either deep skinned or shallow skinned. Deep skinning removed approximately 80% fat line from the fillet surface. Shallow skinning left the fat line intact.

Two antioxidants were chosen for this study, 0.5% sodium erythrobate and 0.45% ascorbic acid plus 0.05% citric acid. Sodium erythrobate was selected because it had been used in the previous OCFD study with acceptable success. The ascorbic acid/citric acid mixture was chosen as a possible alternative to the sodium erythrobate. It was felt that ascorbic acid might be preferred in labelling of a new product.

Product was packaged in four mil vacuum bags or two mil plastic bags and cardboard cartons. Product was held in frozen storage for one, seven, and fourteen months at $0^{o}F$ before analysis.

## Packaging and Antioxidant Effects on Combination Fillet/Mince Pink Salmon Blocks after One Month Frozen Storage

Sensory Analysis: The mean taste panel scores after one month of frozen storage are presented in Tables 1 to 6. The data revealed the following differences among the different treatments:

1. The addition of ascorbic/citric acid to the product adversely affected the flavor, moistness, chewiness and desirability. There were significantly ($p=.05$) lower scores for these samples. The ascorbic/citric acid produced a sharp acid bite that was not pleasant and resulted in a more chewy product.

2. No significant ($p=.05$) differences existed between the samples with sodium erythorbate and no additive. However, the samples with erythrobate were scored slightly higher in flavor and desirability.

3. No significant ($p=.05$) differences were noted between packaging material although the vacuum packaged product had slightly higher sensory scores. This preference may be an indication that the vacuum packaging may be preserving the flavor and reducing the rate of rancidity development.

4. No significant ($p=.05$) differences existed between shallow skinned and deep skinned products. However, the shallow skinned products had higher scores. There were indications that shallow skinned product had better flavor and desirability that may be attributed to the 'fat line' of the fillet.

Table 1. Mean[1] Color Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skinned | | Shallow Skinned | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 3.6 | 3.6 | 4.2 | 3.9 |
| 0.5% ascorbic/ citric acid | 3.9 | 3.5 | 3.3 | 3.6 |
| 0.5% sodium erythorbate | 3.9 | 4.0 | 4.0 | 4.1 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 1.38[2] | Erythrobate > None > Ascorbic |
| Package (P) | 0.06[2] | Vacuum > Plastic |
| Fillet Form (S) | 0.24[2] | Shallow > Deep |
| T X P | 0.45[2] | |
| T X S | 1.95[2] | |
| P X S | 0.00[2] | |

[1] n=10 [2] NS $p<.05$

Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 2. Mean[1] Flavor Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 5.9 | 5.9 | 4.8 | 5.0 |
| 0.5% ascorbic/ citric acid | 4.0 | 4.2 | 3.7 | 4.3 |
| 0.5% sodium erythorbate | 5.5 | 5.6 | 6.0 | 6.4 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 14.76[2] | Erythrobate > None > Ascorbic |
| Package (P) | 0.54[3] | Vacuum > Plastic |
| Fillet Form (S) | 0.01[3] | Shallow > Deep |
| T X P | 0.44[3] | |
| T X S | 2.90[4] | |
| P X S | 0.97[3] | |

[1] n=10 [2] Sig. $p>.001$ [3] NS, $p<.05$ [4] Sig. $p>.05$
Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 3. Mean[1] Texture Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 3.5 | 3.0 | 3.4 | 3.2 |
| 0.5% ascorbic/ citric acid | 3.8 | 3.7 | 3.7 | 3.4 |
| 0.5% sodium erythorbate | 3.3 | 3.8 | 3.2 | 3.2 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 6.06[2] | Ascorbic > Erythrobate > None |
| Package (P) | 0.05[4] | Vacuum > Plastic |
| Fillet Form (S) | 1.60[4] | Shallow < Deep |
| T X P | 2.32[3] | |
| T X S | 0.16[4] | |
| P X S | 0.09[4] | |

[1] n=10 [2] Sig. p>.005 [3] Sig. p>.05 [4] NS p<.05
Level means with the same underline did not vary significantly (p=.05) from one another.

Table 4. Mean[1] Moistness Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 4.4 | 3.9 | 3.5 | 3.4 |
| 0.5% ascorbic/ citric acid | 2.9 | 3.4 | 2.9 | 3.2 |
| 0.5% sodium erythorbate | 3.7 | 3.6 | 3.9 | 3.9 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 15.70[2] | None > Erythrobate > Ascorbic |
| Package (P) | 0.38[3] | Vacuum < Plastic |
| Fillet Form (S) | 1.40[3] | Shallow > Deep |
| T X P | 2.48[3] | |
| T X S | 1.51[3] | |
| P X S | 1.66[3] | |

[1] n=10 [2] Sig. p>.005 [3] NS p<.05

Level means with the same underline did not vary significantly (p=.05) from one another.

Table 5. Mean[1] Chewiness Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 4.3 | 4.2 | 3.7 | 3.4 |
| 0.5% ascorbic/ citric acid | 3.2 | 3.4 | 3.1 | 3.3 |
| 0.5% sodium erythorbate | 4.0 | 3.6 | 3.6 | 3.6 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 14.79[2] | None > Erythrobate > Ascorbic |
| Package (P) | 0.15[3] | Vacuum > Plastic |
| Fillet Form (S) | 1.60[3] | Shallow < Deep |
| T X P | 1.13[3] | |
| T X S | 1.13[3] | |
| P X S | 0.67[3] | |

[1] n=10 [2] Sig. $p>.005$ [3] NS $p<.05$

Level means with the same underline did not vary significantly ($p=.05$) from one another.

Table 6. Mean[1] Desirability Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 5.5 | 5.3 | 4.4 | 4.6 |
| 0.5% ascorbic/ citric acid | 3.3 | 3.2 | 3.7 | 4.2 |
| 0.5% sodium erythorbate | 5.0 | 5.3 | 5.8 | 5.6 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 11.21[2] | Erythrobate > None > Ascorbic |
| Package (P) | 0.01[3] | Vacuum < Plastic |
| Fillet Form (S) | 1.14[3] | Shallow > Deep |
| T X P | 0.22[3] | |
| T X S | 2.06[3] | |
| P X S | 1.52[3] | |

[1] n=10 [2] Sig. p>.005 [3] NS p<.05
Level means with the same underline did not vary significantly (p=.05) from one another.

Chemical Analysis: Chemical analysis performed on the packaging samples included moisture and rancidity measurement. The values obtained are presented in Tables 7 and 8.

Table 7. TBA Values (umoles/100g) for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 0.96 | 1.01 | 0.87 | 1.21 |
| 0.5% ascorbic/ citric acid | 0.85 | 0.79 | 0.76 | 0.81 |
| 0.5% sodium erythorbate | 0.74 | 0.74 | 0.71 | 0.73 |
| control | - | 0.97 | - | 1.49 |

All samples had small amounts of malonaldehyde (the oxidation compound detected by the TBA test) present. It appeared that the products treated with sodium erythrobate had lower initial values than the untreated and control samples. All levels of TBA were indicative of good quality product.

Table 8. Selected Moistures (%) for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 76.1% | - | 75.5% | - |
| 0.5% ascorbic/ citric acid | 76.4 | - | 74.0 | - |
| 0.5% sodium erythorbate | 76.6 | - | - | - |
| control | - | 76.0 | - | 75.1 |

Little differences were found in the moisture levels of any of the products.

Physical Analysis: Thaw drip was performed on all samples. The results are presented in Table 9.

Table 9. Thaw Drip (%) for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 4.09% | 4.02% | 4.10% | 3.24 |
| 0.5% ascorbic/ citric acid | 10.50 | 11.10 | 7.30 | 5.84 |
| 0.5% sodium erythorbate | 4.74 | 3.75 | 2.63 | 2.56 |

Thaw drip was adversely affected by the addition of the ascorbic/citric acid mixtures. It is apparent that the acids lowered the pH of the product sufficiently to reduce the water binding capacity. This resulted in much higher thaw drips.

Microbial Analysis: Bacterial analysis was performed on the fresh samples. Samples were taken of the fillet/mince blocks after the various additives had been mixed. Aerobic plate count (APC), total coliform (TC), fecal coliform (FC) and coagulase positive Staphylococcus aureus counts were performed. The data from these tests are found in Table 10.

All values indicated poor sanitation and handling control. The high plate counts could be indicative of dirty equipment and poor hygiene. High levels of total coliform and presence of S. aureus are also indicative of poor handling practices.

Table 10. Microbial Loads from Pink Salmon Forms Treated with Antioxidants

| Product Form | Aerobic Plate Count/g (APC) | Total Coliforms/g (TC) | Fecal Coliforms/g (FC) | Staphylococcus aureus (absence/presence) |
|---|---|---|---|---|
| Mince (+A)[1] | 780000 | 15 | <0.3 | - |
| Mince (+E)[2] | 2100000 | 1100 | 0.9 | + |
| Fillet/Mince (+A) | 290000 | 75 | 0.4 | - |
| Fillet/Mince (+E) | 1200000 | 460 | 0.4 | + |

[1]+A = 0.45% ascorbic acid/0.05% citric acid
[2]+E = 0.50% sodium erythorbate

Packaging and Antioxidant Effects on Combination Fillet/Mince Pink Salmon Blocks after Seven Months Frozen Storage

Sensory Analysis: The mean taste panel scores for the seven month storage trial are presented in Tables 11 to 16. The data from these panels revealed the following differences among the samples:

1. Vacuum packaged product had significantly (p=.10) better flavor and desirability than plastic wrapped product. This difference can be attributed to slower fat oxidation in the vacuum package.

2. No significant (p=.10) differences existed between erythrobate treated and untreated samples. All samples scored equally in color, texture, flavor and desirability. This is an indication that erythrobate could be added to these product forms without affecting the sensory attributes.

3. No significant (p=.10) differences were found between skinning styles. However, panelists rated deep skinned product slightly higher in flavor and desirability. This preference is probably due to the lack of a fat layer in the deep skinned product.

4. Factorial analysis revealed an interaction between vacuum packaging and deep skinning. Vacuum packaged, deep skinned samples had higher scores in flavor and desirability. Panelists preferred these samples over the shallow skinned, plastic wrapped products.

Table 11. Mean[1] Color Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type: Deep Skinned Vacuum | Deep Skinned Plastic | Shallow Skinned Vacuum | Shallow Skinned Plastic |
|---|---|---|---|---|
| None | 4.1 | 4.3 | 3.9 | 3.1 |
| 0.5% sodium erythorbate | 3.8 | 3.5 | 4.0 | 3.6 |
| Control | | 4 | | 4 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.47[2] | None > Erythrobate |
| Package (P) | 2.57[2] | Vacuum > Plastic |
| Fillet Form (S) | 1.31[2] | Deep > Shallow |
| T X P | 0.00[2] | |
| T X S | 3.35[3] | |
| P X S | 1.89[2] | |

[1] n=10 [2] NS $p<.10$ [3] Sig. $p>.10$

Level means with the same underline did not vary significantly ($p=.10$) from one another.

Table 12. Mean[1] Flavor Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 5.4 | 3.9 | 4.2 | 3.5 |
| 0.5% sodium erythorbate | 4.8 | 3.9 | 3.0 | 3.0 |
| Control | | 7 | | 7 |

Factorial Analysis of Variance

| F Values | | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.31[3] | Erythrobate > None |
| Package (P) | 7.75[2] | Vacuum > Plastic |
| Fillet Form (S) | 1.07[3] | Deep > Shallow |
| T X P | 0.02[3] | |
| T X S | 2.94[4] | |
| P X S | 0.16[3] | |

[1] n=10 [2] Sig. p>.001 [3] NS, p<.10 [4] Sig. p>.10
Level means with the same underline did not vary significantly (p=.10) from one another.

Table 13. Mean[1] Texture Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 3.5 | 3.7 | 3.7 | 3.9 |
| 0.5% sodium erythorbate | 3.8 | 3.7 | 3.7 | 3.6 |
| Control | | 3.3 | | 2.9 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.00[2] | None > Erythrobate |
| Package (P) | 0.08[2] | Plastic > Vacuum |
| Fillet Form (S) | 0.08[2] | Shallow > Deep |
| T X P | 0.75[2] | |
| T X S | 0.75[2] | |
| P X S | 0.00[2] | |

[1] n=10 [2] NS $p<.10$

Level means with the same underline did not vary significantly ($p=.10$) from one another.

Table 14. Mean[1] Moistness Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 3.5 | 3.4 | 3.3 | 2.8 |
| 0.5% sodium erythorbate | 3.3 | 3.4 | 3.0 | 3.4 |
| Control | | 4 | | 4 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.00[2] | None > Erythrobate |
| Package (P) | 0.06[2] | Vacuum < Plastic |
| Fillet Form (S) | 2.28[2] | Deep > Shallow |
| T X P | 1.58[2] | |
| T X S | 0.25[2] | |
| P X S | 0.06[2] | |

[1] n=10 [2] NS $p<.10$

Level means with the same underline did not vary significantly ($p=.10$) from one another.

Table 15. Mean[1] Chewiness Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 3.3 | 3.1 | 2.8 | 2.5 |
| 0.5% sodium erythorbate | 3.1 | 2.7 | 3.0 | 3.0 |
| Control | | 4 | | 4 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.02[2] | Erythrobate > None |
| Package (P) | 1.41[2] | Vacuum > Plastic |
| Fillet Form (S) | 1.41[2] | Deep > Shallow |
| T X P | 0.02[2] | |
| T X S | 2.94[3] | |
| P X S | 0.16[2] | |

[1] n=10 [2] NS $p<.10$ [3] Sig, $p>.10$
Level means with the same underline did not vary significantly ($p=.10$) from one another.

Table 16. Mean[1] Desirability Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 4.9 | 3.6 | 3.6 | 3.1 |
| 0.5% sodium erythorbate | 4.3 | 3.2 | 4.2 | 3.8 |
| Control | | 5.9 | | 6.4 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.06[4] | Erythrobate > None |
| Package (P) | 7.33[2] | Vacuum > Plastic |
| Fillet Form (S) | 1.14[4] | Deep > Shallow |
| T X P | 0.06[4] | |
| T X S | 3.56[3] | |
| P X S | 1.52[4] | |

[1]n=10 [2]Sig. p>.01 [3]Sig. p>.10 [4]NS p<.10
Level means with the same underline did not vary significantly (p=.10) from one another.

Chemical Analysis: Rancidity values as measured by Lemon's TBA method were obtained on the packaging samples and are presented in Table 17.

Table 17. TBA Values (umoles/100g) for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 0.69 | 0.87 | 0.86 | 1.31 |
| 0.5% sodium erythorbate | 0.55 | 0.72 | 0.78 | 0.85 |
| Control | - | 0.86 | - | 1.30 |

All samples had small amounts of malonaldehyde (the oxidation compound detected by the TBA test) present. Products with added sodium erythrobate had lower initial values than either the untreated or control samples. Vacuum packaged products had lower values than plastic wrapped samples. Deep skinned product had less oxidation than the shallow skinned product. It appears that skinning, antioxidant and packaging are all effective in reducing oxidation and that combinations have an additive effect.

Physical Analysis: Thaw drip was performed on all samples. The results are presented in Table 18.

Table 18. Thaw Drip (%) for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 4.80% | 4.34% | 2.95% | 2.98% |
| 0.5% sodium erythorbate | 5.41 | 3.70 | 2.90 | 3.04 |
| Control | 4.33 | | 2.69 | |

Thaw drip appeared to be in a normal range. It is noted that the deep skinned product had significantly higher thaw drip than shallow skin. This is probably due to variation between the groups of fish rather than the skinning method. The addition of sodium erythrobate did not affect the thaw drip.

## Packaging and Antioxidant Effects on Combination Fillet/Mince Pink Salmon Blocks after Fourteen Months Frozen Storage

Sensory Analysis: The mean taste panel scores for the fourteen month storage trial are presented in Tables 19 to 24. The data revealed the following differences among the samples:

1. Deep skinned products had significantly ($p=.10$) better flavor, moistness and desirability than shallow skinned treatments indicating that the removal of the fat line was a positive factor in maintaining quality during the fourteen months storage.

2. No significant ($p=.10$) differences were found between erythrobate and untreated samples. All samples scored equally for color, flavor, texture, and desirability. This indicated that erythrobate was no longer effective after fourteen months of frozen storage.

3. No significant differences ($p=.10$) existed between vacuum packaged and plastic wrapped products. The storage time had levelled out any differences that had existed although the vacuum packaged product had higher scores in flavor, moistness, chewiness and desirability.

4. It appears that the fourteen month storage period has produced product of the same quality despite any treatments. The recommendation from this would be to hold product less than fourteen months.

Table 19. Mean[1] Color Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skinned | | Shallow Skinned | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 4.4 | 4.0 | 3.7 | 3.8 |
| 0.5% sodium erythorbate | 3.5 | 3.9 | 3.6 | 3.6 |
| Control | | 4 | | 4 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 1.90[2] | None > Erythrobate |
| Package (P) | 0.01[2] | Plastic > Vacuum |
| Fillet Form (S) | 1.36[2] | Deep > Shallow |
| T X P | 0.50[2] | |
| T X S | 2.55[2] | |
| P X S | 0.10[2] | |

[1] n=11 [2] NS $p<.10$

Level means with the same underline did not vary significantly ($p=.10$) from one another.

Table 20. Mean[1] Flavor Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 4.4 | 3.8 | 3.4 | 2.6 |
| 0.5% sodium erythorbate | 3.5 | 3.5 | 3.5 | 3.2 |
| Control | | 7 | | 7 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.17[2] | None > Erythrobate |
| Package (P) | 1.51[2] | Vacuum > Plastic |
| Fillet Form (S) | 3.66[3] | Deep > Shallow |
| T X P | 0.87[2] | |
| T X S | 1.87[2] | |
| P X S | 0.07[2] | |

[1] n=11 [2] NS, p<.10 [3] Sig. p>.10
Level means with the same underline did not vary significantly (p=.10) from one another.

Table 21. Mean[1] Texture Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 3.5 | 2.9 | 3.7 | 3.6 |
| 0.5% sodium erythorbate | 3.9 | 3.8 | 3.6 | 3.9 |
| Control | | 3.3 | | 3.3 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 4.41[3] | Erythrobate > None |
| Package (P) | 0.38[2] | Plastic > Vacuum |
| Fillet Form (S) | 1.23[2] | Shallow > Deep |
| T X P | 2.58[2] | |
| T X S | 1.23[2] | |
| P X S | 1.23[2] | |

[1] n=11 [2] NS $p<.05$ [3] Sig. $p>.05$
Level means with the same underline did not vary significantly ($p=.10$) from one another.

Table 22. Mean[1] Moistness Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 3.6 | 3.5 | 2.9 | 3.0 |
| 0.5% sodium erythorbate | 3.1 | 2.8 | 3.0 | 2.6 |
| Control | | 4 | | 4 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 3.26[2] | None > Erythrobate |
| Package (P) | 0.71[3] | Vacuum > Plastic |
| Fillet Form (S) | 3.26[2] | Deep > Shallow |
| T X P | 0.71[3] | |
| T X S | 1.17[3] | |
| P X S | 0.01[2] | |

[1] n=11 [2] Sig p>.10 [3] NS p<.10
Level means with the same underline did not vary significantly (p=.10) from one another.

Table 23. Mean[1] Chewiness Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 3.1 | 2.9 | 2.8 | 2.6 |
| 0.5% sodium erythorbate | 2.5 | 2.2 | 2.5 | 2.5 |
| Control | | 4 | | 4 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 5.94[3] | None > Erythrobate |
| Package (P) | 1.83[2] | Vacuum > Plastic |
| Fillet Form (S) | 0.29[2] | Deep > Shallow |
| T X P | 0.02[2] | |
| T X S | 1.83[3] | |
| P X S | 0.07[2] | |

[1] n=11 [2] NS $p<.05$ [3] Sig, $p>.05$
Level means with the same underline did not vary significantly ($p=.10$) from one another.

Table 24. Mean[1] Desirability Scores for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 4.0 | 3.5 | 3.2 | 2.2 |
| 0.5% sodium erythorbate | 3.4 | 3.0 | 3.0 | 2.9 |
| Control | | 5.6 | | 5.9 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.19[4] | None > Erythrobate |
| Package (P) | 2.52[2] | Vacuum > Plastic |
| Fillet Form (S) | 4.05[4] | Deep > Shallow |
| T X P | 0.74[4] | |
| T X S | 1.67[4] | |
| P X S | 0.02[4] | |

[1] n=11 [2] Sig. p>.10 [3] Sig. p>.05 [4] NS p<.05
Level means with the same underline did not vary significantly (p=.05) from one another.

Chemical Analysis: Rancidity values as measured by Lemon's TBA method are presented in Table 25.

Table 25. TBA Values (umoles/100g) for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 0.95 | 1.74 | 0.89 | 2.95 |
| 0.5% sodium erythorbate | 1.05 | 1.42 | 0.78 | 1.73 |
| Control | - | 1.62 | - | 1.90 |

All samples had small amounts of malonaldehyde (the oxidation compound detected by the TBA test) present. Products with added sodium erythrobate had slightly lower values than either the untreated and control samples. Vacuum packaged products had lower values than plastic wrapped samples. In general, deep skinned product had less oxidation than the shallow skinned product. It appears that skinning, antioxidant and packaging are all effective in reducing oxidation and that combinations have an additive effect, however this difference is small after the fourteen month storage period.

Physical Analysis: Thaw drip was performed on all samples. The results are presented in Table 26.

Table 26. Thaw Drip (%) for Pink Salmon Products Treated With Various Additives and Packaging

| Treatment | Fillet Form/Package Type | | | |
|---|---|---|---|---|
| | Deep Skin | | Shallow Skin | |
| | Vacuum | Plastic | Vacuum | Plastic |
| None | 5.85% | 5.32% | 4.22% | 3.98% |
| 0.5% sodium erythorbate | 5.61 | 5.03 | 3.90 | 4.25 |
| Control | 6.33 | | 3.69 | |

Table 27. Mean[1] Texture Scores for Twelve Month Fresh Frozen and Reprocessed Pink Salmon Blocks

| Treatment | Form (% fillet) 100% | 75% | 50% | 0% |
|---|---|---|---|---|
| Fresh/Frozen Block | 3.18 | 3.64 | 3.64 | 4.00 |
| 3 Month Reprocessed Block | 3.27 | 3.36 | 3.82 | 3.91 |
| 6 Month Reprocessed Block | 3.45 | 3.64 | 3.18 | 4.09 |
| 12 Month Reprocessed Block | 3.09 | 3.91 | 3.82 | 4.09 |

Factorial Analysis of Variance

| | F Values | Ranking of Level Means |
|---|---|---|
| Treatment (T) | 0.56[3] | 12 Mo. > Fresh Frozen > 3 Mo. > 6 Mo. |
| Form (F) | 13.15[2] | 0% > 75% > 50% > 100% |
| T X F | 5.10[3] | |

[1] n=11 [2] Sig p>.001 [3] NS p<.05

Level means with the same underline did not vary significantly (p=.05) from one another.

# PART IV

## Antioxidant Study

Combination blocks of 75% fillet and 25% mince were used for the antioxidant study. The objective of this study was to effectively control rancidity development without affecting visual or sensory characteristics of the product. Sodium erythrobate at 0.0%, 0.25%, 0.50%, and 1.00% was used and mixed into the blocks by hand before freezing. Mixing time was approximately 90 seconds. All samples were held in frozen storage for one, seven and fourteen months at 0°F before analysis.

## Effect of Antioxidant Levels on Combination Fillet/Mince Pink Salmon Blocks After One Month Frozen Storage

Sensory Analysis: Mean taste value scores for all products are presented in Table 1.

Table 1. Mean[1] Taste Panel Scores for Salmon Blocks Treated with Various Levels of Sodium Erythorbate

| Treatment | | Sensory Attribute | | | | | |
|---|---|---|---|---|---|---|---|
| Form | Sodium Erythrobate Level | Color | Flavor | Chewiness | Texture | Moistness | Desirability |
| Deep Skinned | 0.25 | 4.6 | 6.3 | 3.6 | 3.5 | 3.7 | 6.0 |
| | 0.50 | 3.9 | 5.7 | 3.7 | 3.4 | 4.0 | 5.4 |
| | 1.00 | 3.8 | 6.2 | 3.9 | 3.4 | 4.6 | 6.0 |
| Shallow Skinned | 0.25 | 3.8 | 5.7 | 4.0 | 3.1 | 3.6 | 5.7 |
| | 0.50 | 4.1 | 5.9 | 3.7 | 3.2 | 3.8 | 5.5 |
| | 1.00 | 3.9 | 5.7 | 3.4 | 3.2 | 3.3 | 5.5 |
| Control | - | - | - | - | 3.35 | - | 6.3 |

[1] n=10.

Statistical analysis of the sensory data indicated that no differences existed between the levels of sodium erythorbate or the form of skinning (deep versus shallow). That the panelists were unable to detect any differences in the samples suggested that the levels of sodium erythorbate were acceptable.

Chemical Analysis: Chemical analysis performed on the packaging samples was rancidity as measured by the TBA test. The values obtained are presented in Table 2.

Table 2. TBA Values (umoles/100g) for Pink Salmon Products Treated in Different Levels of Erythorbates

| Level of Erythrobate | Fillet Form | |
|---|---|---|
| | Deep Skin | Shallow Skin |
| 0.25% | 0.64 | 0.70 |
| 0.50% | 0.74 | 0.73 |
| 1.00% | 0.53 | 0.93 |

The TBA values were low as would be expected of fresh product. No trends can be seen in the data.

Physical Analysis: Thaw drip, color and shear/stress measurements were performed on all samples. The results of thaw drip are presented in Table 3.

Table 3. Thaw Drip (%) for Pink Salmon Products Treated in Different Levels of Erythorbates

| Level of Erythrobate | Fillet Form | |
|---|---|---|
| | Deep Skin | Shallow Skin |
| 0.25% | 3.38% | 1.88% |
| 0.50% | 3.75 | - |
| 1.00% | 1.53 | 2.56 |

Thaw drips showed the typical variation between samples that have been experienced in this project. All thaw drips are within expected ranges. It appears that the addition of sodium erythrobate did not affect the thaw drip among the samples.

Microbial Analysis: Bacterial analysis was performed on the fresh samples. Samples were taken of the fillet/mince blocks after the various antioxidants had been added. Aerobic plate count (APC), total coliform (TC), fecal coliform (FC) and coagulase positive Staphylococcus aureus counts were performed. The data from these tests are found in Table 4.

Table 4. Microbial Loads from Pink Salmon Forms Treated with Antioxidants

| Product Form | Aerobic Plate Count/g (APC) | Total Coliforms/g (TC) | Fecal Coliforms/g (FC) | Staphylococcus aureus (absence/presence) |
|---|---|---|---|---|
| Mince (+A)[1] | 780000 | 15 | <0.3 | - |
| Mince (+E)[2] | 2100000 | 1100 | 0.9 | + |
| Fillet/Mince (+A) | 290000 | 75 | 0.4 | - |
| Fillet/Mince (+E) | 1200000 | 460 | 0.4 | + |

[1]+A = 0.45% ascorbic acid/0.05% citric acid
[2]+E = 0.50% sodium erythorbate

Effect of Antioxidant Levels on Combination Fillet/Mince Pink Salmon Blocks After Seven Months Frozen Storage

Sensory Analysis: Mean taste panel scores for all products are presented in Table 5. Statistical analysis of the sensory data indicated the following:

1. No significant (p=.10) differences existed between the levels of sodium erythorbate. The panelists were unable to detect any differences among the samples which suggested that the levels of sodium erythorbate did not change the flavor or desirability of the products.

2. Deep skinned product was found to be significantly (p=.10) more desirable than shallow skinned product. This can be attributed to the fat layer present in the shallow skinned samples.

3. No significant (p=.10) differences existed between shallow and deep skinned product in color, texture, chewiness, moistness or flavor. However, deep skinned product scored higher in flavor.

Table 5. Mean[1] Taste Panel Scores for Salmon Blocks Treated with Various Levels of Sodium Erythorbate

| Treatment Form | Sodium Erythrobate Level | Sensory Attribute Color | Flavor | Chewiness | Texture | Moistness | Desirability |
|---|---|---|---|---|---|---|---|
| Deep Skinned | 0.25 | 3.7 | 5.0 | 2.9 | 3.5 | 2.9 | 4.7 |
| | 0.50 | 4.0 | 4.8 | 2.8 | 3.6 | 3.3 | 4.5 |
| | 1.00 | 3.3 | 4.5 | 2.8 | 3.7 | 3.2 | 3.9 |
| Control | - | 4 | 7 | 4 | 3.3 | 4 | 6.0 |
| Shallow Skinned | 0.25 | 3.2 | 4.5 | 2.6 | 3.5 | 3.2 | 3.7 |
| | 0.50 | 3.5 | 4.1 | 3.1 | 3.6 | 3.3 | 3.7 |
| | 1.00 | 3.6 | 4.6 | 2.5 | 3.4 | 3.2 | 3.9 |
| Control | - | 4 | 7 | 4 | 2.8 | 4 | 5.8 |

[1] n=10.

Chemical Analysis: Chemical analysis performed on the packaging samples was rancidity as measured by the TBA test. The values obtained are presented in Table 6.

All levels of erythrobate were effective in slowing oxidation in both product forms. This effect was more pronounced with the shallow skinned product where the fat layer remained intact. The data would suggest that lower amounts of erythrobate are as effective as higher amounts within the range applied.

Table 6. TBA Values (umoles/100g) for Pink Salmon Products Treated with Different Levels of Erythorbates

| Level of Erythrobate | Fillet Form | |
|---|---|---|
| | Deep Skin | Shallow Skin |
| 0.25% | 0.62 | 0.60 |
| 0.50% | 0.73 | 0.88 |
| 1.00% | 0.75 | 0.81 |
| Control | 0.86 | 1.30 |

Physical Analysis: Thaw drip was performed on all samples and is presented in Table 7.

Table 7. Thaw Drip (%) for Pink Salmon Products Treated with Different Levels of Erythorbates

| Level of Erythrobate | Fillet Form | |
|---|---|---|
| | Deep Skin | Shallow Skin |
| 0.25% | 4.25% | 2.80% |
| 0.50% | 3.52 | 2.38 |
| 1.00% | 2.10 | 2.35 |
| Control | 4.33 | 2.69 |

Thaw drip showed the typical variation between samples that have been experienced in this project. All thaw drip are within expected ranges. It appears that the addition of sodium erythrobate did not affect the thaw drip among the samples.

Effect of Antioxidant Levels on Combination Fillet/Mince Pink Salmon Blocks After Fourteen Months Frozen Storage

Sensory Analysis: Mean taste panel scores for all products are presented in Table 8. Statistical analysis of the sensory data indicated the following:

1. No significant (p=.10) differences existed between the levels of sodium erythorbate after fourteen months storage. All scores were lower than those at seven months frozen storage indicating that the time period was critical in the maintenance of the quality. The effect of sodium erythrobate was minimal. Because panelists were unable to detect any differences among the samples, this suggested that the levels of sodium erythorbate did not change the flavor or desirability of the products.

2. Deep skinned product had significantly (p=.10) more flavor and was more desirable than shallow skinned product. This can be attributed to the absence of the fat layer present in the deep skinned samples. Lower fat levels meant less off-flavors and off-odors from development of rancidity.

3. No significant (p=.10) differences existed between shallow and deep skinned product in color, texture, chewiness, and moistness.

Table 8. Mean[1] Taste Panel Scores for Salmon Blocks Treated with Various Levels of Sodium Erythorbate

| Treatment | | Sensory Attribute | | | | | |
|---|---|---|---|---|---|---|---|
| Form | Sodium Erythrobate Level | Color | Flavor | Chewiness | Texture | Moistness | Desirability |
| Deep Skinned | 0.25 | 3.0 | 3.8 | 2.2 | 3.5 | 2.9 | 3.7 |
| | 0.50 | 3.6 | 3.0 | 2.1 | 3.9 | 2.7 | 2.7 |
| | 1.00 | 3.8 | 3.2 | 2.3 | 3.9 | 2.9 | 2.7 |
| Control | - | 4 | 7 | 4 | 3.0 | 4 | 5.7 |
| Shallow Skinned | 0.25 | 3.6 | 2.5 | 2.6 | 3.9 | 2.9 | 2.1 |
| | 0.50 | 3.3 | 2.8 | 2.4 | 3.7 | 2.8 | 2.4 |
| | 1.00 | 3.6 | 2.7 | 2.3 | 4.2 | 3.0 | 2.3 |
| Control | - | 4 | 7 | 4 | 3.2 | 4 | 6.1 |

[1] n=12.

Chemical Analysis: Chemical analysis performed on the packaging samples was rancidity as measured by the TBA test. The values obtained are presented in Table 9.

All levels of erythrobate continued to be effective in slowing oxidation in both product forms. This effect was more pronounced with the shallow skinned product where the fat layer remained intact. However, the difference between erythrobate and untreated samples was small indicating that the effectiveness was not as pronounced as in earlier storage periods. The data would also suggest that lower concentrations of erythrobate are as effective as higher amounts within the range applied.

Table 9. TBA Values (umoles/100g) for Pink Salmon Products Treated with Different Levels of Erythorbates

| Level of Erythrobate | Fillet Form | |
|---|---|---|
| | Deep Skin | Shallow Skin |
| 0.25% | 1.22 | 1.88 |
| 0.50% | 1.42 | 1.65 |
| 1.00% | 1.15 | 1.54 |
| Control | 1.74 | 2.95 |

Physical Analysis: Thaw drip was performed on all samples and is presented in Table 10.

Table 10. Thaw Drip (%) for Pink Salmon Products Treated with Different Levels of Erythorbates

| Level of Erythrobate | Fillet Form | |
|---|---|---|
| | Deep Skin | Shallow Skin |
| 0.25% | 4.86% | 3.72% |
| 0.50% | 5.03 | 4.25 |
| 1.00% | 5.50 | 3.88 |
| Control | 6.33 | 3.39 |

Thaw drips have become higher as the storage period has increased. The deep skinned product had noticeably higher drip loss perhaps indicating that the fat layer plays a role in preventing moisture loss during cold storage. It appears that the addition of sodium erythrobate did not affect the thaw drip among the samples.

# PROJECT EVALUATION

## Project Evaluation and Conclusions

Project Goals and Industry Benefits: The project goals and objectives were: 1) to prepare several styles of pink salmon blocks from skinless, boneless fillets and mince, 2) to determine the product shelf life during a twelve month period, 3) to evaluate the use of frozen dressed pink salmon for block production and 4) to assess the effects of packaging and antioxidants in extending product shelf life. By achieving these objectives, critical information for developing new products from pink salmon would be available to the Alaska processing industry. The project would help industry cut down on the time it takes to bring successful new products to market. Combined with the marketing efforts of the State of Alaska, Office of Commercial Fisheries Development, new products could have a greater chance of success.

The goals of the project were measured by the data generated during the production and storage trials. Yield figures, a critical factor in determining economic feasibility, were collected during each processing period. Chemical and sensory data provided needed information on product acceptability. All goals were met through chemical, microbiological and sensory tests conducted on the products throughout the project.

No modification to the goals was made. As the project progressed, certain tests were discontinued when it became apparent that they were meaningless.

Goals and objectives were met by the end of the project. A clear understanding of the product forms was available which would provide information to those in the Alaska seafood industry interested in developing similar products. Goals were attained by following the work plan outlined in the original proposal.

Specific Accomplishments: The specific information generated by this project that would have interest to the Alaska seafood processing industry included:

1. Recovery data for all product forms from fresh, frozen and reprocessed pink salmon and expected processing parameters for producing blocks.

2. Detailed compositional and microbiological information on fresh pink salmon and product forms.

3. Detailed shelf life profile for all products for one, three, six and twelve months in frozen storage. The profile includes changes in lipid stability, thaw drip, color, and microbial populations.

4. Detailed sensory evaluation of product forms during frozen storage. Information on consumer preference and optimum mix of fillet and mince for block acceptability.

5. Effectiveness of packaging and antioxidants in extending the shelf life of pink salmon blocks during frozen storage periods of one, seven and fourteen months.

The information generated during this project met the goals and objectives found in the original proposal and will meet the needs of the Alaska seafood processing industry. There has been very little information of this sort available to the industry and that has probably impeded its efforts in developing secondary products for the markets. The value of this information is helping those companies avoid some of the problems that are inherent in developing new products. By giving processors baseline information, they can more clearly define their needs and tailor product development projects along closely focused efforts.

Benefits to the Seafood Processing Industry: The Alaska seafood processing industry had access to the information generated by this project by the following:

1. Information published in the "Lodestar" by the Alaska Fisheries Development Foundation.

2. Information published in the "Alaska Marine Resource Quarterly" by the University of Alaska Marine Advisory Program.

3. Workshop given in Kodiak, Alaska on April 23, 1987 to a processing industry group.

4. Results presented as part of the University of Alaska Marine Advisory Salmon Quality Program workshops in June, 1987 and June, 1988. Workshops were given at Ketchikan, Anchorage, Kenai, Nikiski and Seldovia in 1987 and in Juneau, Sitka, Ketchikan, Petersburg, Anchorage and Sterling in 1988.

5. Formal presentations at the Atlantic Fisheries Technologists annual meeting in November, 1987 and Pacific Fisheries Technologists annual meeting in February, 1988.

6. Interim reports submitted to the Alaska Fisheries Development Foundation as specified in the contract.

7. Individual consultations between the investigators and interested industry personnel throughout the project.

8. Information provided by the State of Alaska Office of Commercial Fisheries Development to the processing industry.

The information generated by this project has been used by at least two processors in Alaska to produce combination fillet/mince pink salmon products. The current status of these efforts is unknown. It is expected that as pink salmon runs rebound and surpluses occur, the information from this project will be useful as the seafood industry looks to diversify its product base.

In terms of economic benefits, these can only be estimated since the information generated by this project is being used in private industry. Based on the results from the marketing study conducted by the State of Alaska, pink salmon blocks could increase product value by as much as 75%. This is a moot point since current pink salmon runs have not met expectations and markets are not oversupplied.

Economic benefits lie in the future when pink salmon returns become larger than current markets. Any increase in secondary processing operations in the state of Alaska will have positive economic impact. Increased product value, volume sales will help increase the value of the fishery.

Conclusions: The project successfully demonstrated that pink salmon blocks prepared from skinless, boneless fillets and mince could be held in frozen storage up to one year and remain acceptable. The use of 25% mince in block formulation was a desirable product and could be used to increase the recovery from pink salmon. The results indicated that fillet and fillet/mince blocks were viable alternate pink salmon products that have a potential for increasing the value of the fishery for both the processor and fishermen. What remains for this project is for the results to be used by the Alaska seafood processing industry to diversify their products made from pink salmon.

# APPENDIX

# Appendix A

## Taste Panel Score Sheet

NAME _____ DATE _____ EXPERIMENT BMX-1

| COLOR | FLAVOR | CHEWINESS | TEXTURE | MOISTNESS | DESIRABILITY |
|---|---|---|---|---|---|
| 7- Much lighter | 7- Control, excellent fresh salmon flavor | 7- Very tender | 5 Fibrous | 7- Much more moist | 7- Like extremely |
| 6- Lighter | 6- Good but not intense | 6- Moderately tender | 4 Grainy, mealy | 6- More moist | 6- Like moderately |
| 5- Sl. lighter | 5- Only mildly pleasant | 5- Slightly tender | | 5- Sl. more moist | 5- Like slightly |
| 4- Same as Control | 4- Trace of bad flavor rancid, oxidized | 4- Tender | 3 Flaky, firm | 4- Moist as control | 4- Neutral |
| 3- Sl. darker | 3- Mild bad flavor | 3- Slightly tough | 2 Soft | 3- Sl. drier | 3- Slight dislike |
| 2- Darker | 2- Strong bad flavor | 2- Moderately tough | | 2- Drier | 2- Moderate dislik |
| 1- Much darker | 1- Intense bad flavor | 1- Very tough | 1 Mushy | 1- Much drier | 1- Dislike extreme |

| SAMPLE | COLOR | FLAVOR | CHEWINESS | TEXTURE | MOISTNESS | DESIRABILITY | COMMENTS |
|---|---|---|---|---|---|---|---|
| C | 4 | 7 | 4 | | 4 | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |