
taming the WILD thing

# REPORT OF PINK SALMON BLOCK STABILITY TRIALS

Prepared for:
**Alaska Fisheries Development Foundation, Inc.**
508 West Second Avenue, Suite 212
Anchorage, Alaska 99501
(907)276-7315

Principal Investigator:
Chuck Crapo
University of Alaska
Fishery Industrial Technology Center
Kodiak, Alaska
April 1995

This information was produced with funds provided through the Alaska Science and Technology Foundation under Grant No. 93-1-026.


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## Antioxidants Increase Shelf Life In Frozen Salmon

A recent study shows that treating salmon fillets with antioxidants substantially increases their frozen shelf life. Short shelf life has limited alternative uses for salmon. Secondary processors require that any raw material have acceptable quality for up to twelve months to assure consistency in their finished products. The shelf life of untreated salmon blocks and fillets ranges from six to eight months.

The project, conducted by the Fishery Industrial Technology Center for the Alaska Fisheries Development Foundation, evaluated the effectiveness of two antioxidants, Duralox and L-900, on the shelf life of pink salmon blocks. Duralox, made by Kalsec of Kalamazoo, Michigan, is a rosemary extract combined with tocopherols and ascorbic acid. L-900, made by Specialty Foods of Tacoma, Washington, is a polyphosphate, citric acid and sodium erythorbate mixture.

Fillets were dipped in 10% solutions for 30 seconds as well as the trimmings and frames prior to mincing. Both treated and untreated material were made into fillet, mince and laminated (85% fillet/15% mince) blocks, which were plate frozen and stored at -20°C for up to thirteen months. At 1½, 3, 6, 10 and 13 months storage, the **once-frozen** blocks were tested for rancidity, sensory and texture changes. Six months later, additional blocks were made from frozen dressed pink salmon to determine if antioxidants were effective in reprocessed products. These **twice-frozen** blocks were examined after 1, 4, 7 and 9 months frozen storage. Finally, dressed **frozen fish** were dipped in a 10% Duralox and evaluated after 1½, 6, 9, 13 and 16 months to determine its use as a glaze.

Rancidity in **once-frozen** fillet blocks developed much slower in treated samples (Figure 1). After ten months storage, the L-900

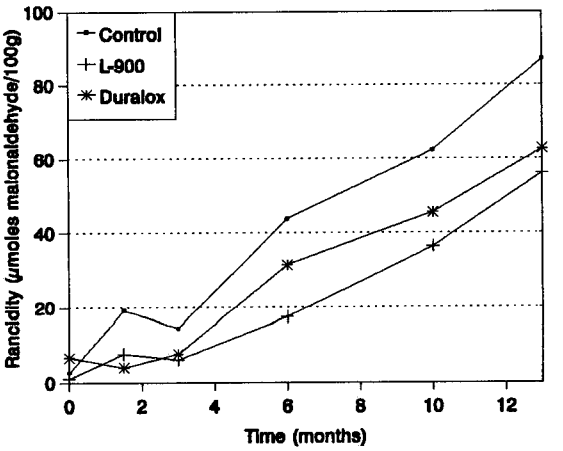

Figure 1. Rancidity in Fillet Blocks

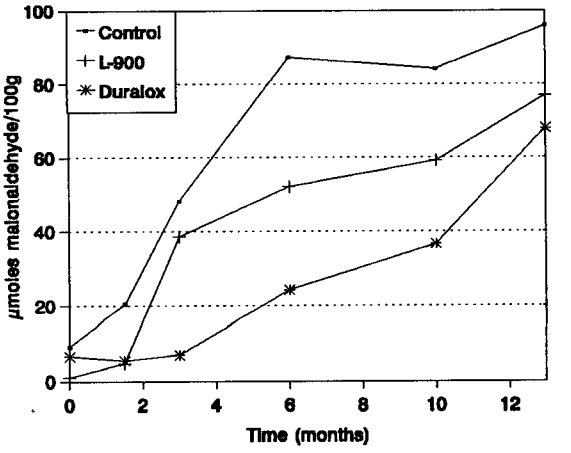

Figure 2. Rancidity in Mince Blocks

treated blocks were half as rancid and Duralox blocks were one-third less rancid than untreated blocks. As a result, antioxidant treatment provided an additional four months shelf life. In contrast to fillet blocks, mince blocks showed Duralox was most effective in maintaining quality (Figure 2) and laminated blocks had rancidity levels similar to fillet blocks.

The addition of antioxidants to mince, fillet and laminated blocks proved effective in reducing rancidity. Sensory evaluation indicates that Duralox addition imparts subtle to subliminal herb flavors. L-900 treatment produces a moist product that is desirable. Mince blocks were undesirable after thirteen months of frozen storage and only slightly desirable after ten months.

The reprocessed or **twice-frozen** blocks started with higher levels of rancidity. Again, fillet blocks benefitted from antioxidant treatment, with about half the rancidity of untreated blocks after seven months frozen storage (Figure 3). Duralox was most effective on mince blocks while L-900 had no effect (Figure 4).

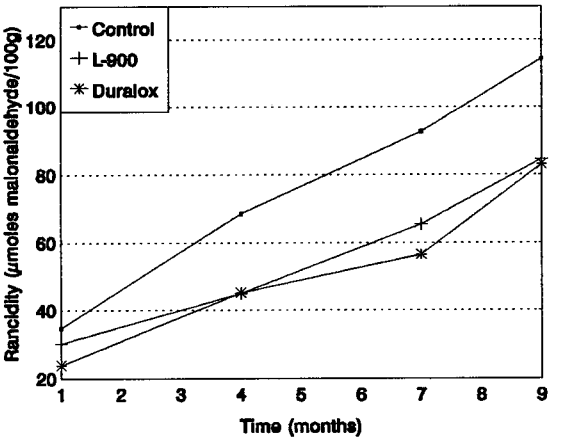


Figure 3. Rancidity in Twice Frozen Fillet Blocks

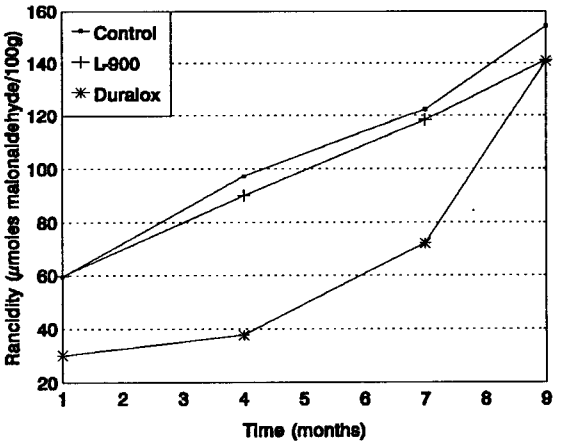


Figure 4. Rancidity in Twice Frozen Mince Blocks

Antioxidant treatment is also effective in reducing rancidity in reprocessed blocks as confirmed by both sensory and chemical tests. After nine months the levels of rancidity were very similar to once-frozen blocks. This implies there is limited shelf life of reprocessed blocks if the raw material is held more than six months in frozen storage. At nine months, sensory tests showed noticeable off flavors and odors indicating a limit to antioxidant treatment. The raw material was sixteen months old at this time, far beyond most common storage periods for pink salmon. It is recommended that reprocessed salmon blocks be held less than six months.

Using Duralox as a glaze was effective in slowing rancidity in **frozen fish** (Figure 5). After six months storage, treated fish had only half the rancidity of those glazed with water. This difference narrowed after nine months where Duralox glazed salmon were only one-third less rancid than untreated fish. Beyond thirteen months, the condition of the glaze limited the effectiveness of the antioxidant dip and there were no differences between Duralox and water glazes.

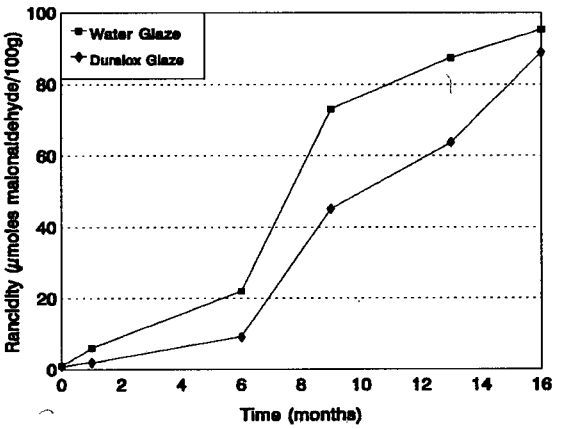


Figure 5. Rancidity in Dressed Headed Salmon

This project has demonstrated that antioxidants can provide the additional shelf life that will meet the needs of many secondary processors. More information is available from the Alaska Fisheries Development Foundation at (907) 276-7315.

# Report of Pink Salmon Block Stability Trials

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**March 10, 1995**

Samples Evaluated. Pink salmon blocks produced in Cordova during August, 1993 were evaluated after six weeks, three, six, nine and thirteen months frozen storage at -20°F. The following samples were judged for color, rancidity, texture and sensory attributes:

Untreated fillet block
L-900 fillet block
Duralox fillet block

Untreated frame mince block
L-900 frame mince block
Duralox frame mince block

Untreated combination (85% fillet/15% frame mince) block
L-900 combination block
Duralox combination block

Commercial fillet and mince blocks provided by International Seafoods of Alaska, Golden Age Fisheries, Glacier Fish Company and Silver Lining Seafoods were also compared to the experimental samples.

Experimental Treatment. Pink salmon fillets were either untreated or treated for 30 seconds in a 10% Duralox or L-900 solution. Frames were soaked 30 seconds in L-900 or Duralox solutions prior to mincing. Soak times were selected to obtain a 5% uptake of antioxidant solutions.

Sample Preparation and Analytical Procedures. Blocks were band sawed into pieces approximately 0.5" by 2" by 3" for analysis. Twenty pieces were used for sensory evaluation and thirty pieces for rancidity and color measurements and texture analysis.

Sensory evaluation was done using a ten to fifteen member panel. Samples were wrapped in foil and steamed for 10 minutes prior to serving. Two panels were done

for each storage period. One panel compared fillet and combination blocks while the other evaluated mince blocks. Panelists were asked to evaluate samples for off-odor, off-flavor, texture moistness and desirability using a seven point hedonic scale (a copy of the score sheet is included in the appendix).

Rancidity was measured by the thiobarbuturic acid (TBA) test using Lemon's modification. This procedure measures the amount of malondialdehyde, a chemical that appears as fat oxidizes. Ten randomly selected pieces were combined and triplicate subsamples taken to obtain a representative sample.

Texture of the blocks was determined by the Instron Universal Testing Machine. Pieces were wrapped in foil and steamed for 10 minutes. A ten blade Kramer-Lee cell was used to shear across the muscle fibers of fillet and combination blocks and through mince blocks. The amount of peak force required was recorded and used as an indication of texture. Fifteen samples from each treatment were tested in this manner.

Color measurement of raw blocks was made using the Minolta Chromameter. Three randomly selected pieces were measured. Ten measurements were made for each treatment sample. The values were averaged and analyzed for any differences.

Results. During the first six weeks of frozen storage, little change in the quality of the various treatments was detected. The color of all blocks remained similar. TBA development was only starting. Texture as measured by shear force did not change. Sensory evaluation detected no differences between one week and six week product

Six Week Storage. After six weeks frozen storage showed little change from the one week samples. All samples except those treated with L-900 had noticeable drip between 5% and 7%. L-900 treated samples were much firmer after cooking.

Colors for the six week samples were very similar to the one week samples. No significant changes could be detected in any of the samples. The same comparisons made for the one week samples remained accurate for the six week samples.

Rancidity started to develop in the untreated samples. It was highest in mince blocks and lowest in fillet blocks. There were some changes in the antioxidant treated samples, but before any definitive trends can be established, the products must be evaluated after 3 and 6 months. The commercial samples had much higher levels of rancidity than the Cordova samples. The commercial minces had noticeable odors. Since the history of the blocks is unknown (i.e. quality of fish and processing conditions), it is difficult to compare against our samples..

Six week taste panels indicated no significant differences between samples. The

analysis indicated that panelists could not tell any differences between the fillet and combination blocks. The mince blocks were graded as mealy and less desirable than the fillet or combination blocks. Trim mince was preferred over the treated and untreated frame mince blocks. Scores for the six week were almost identical to the one week sample. While small amounts of rancidity are beginning to show in some samples, it is still below perception levels.

Texture as measured by shear values indicated the L-900 treated samples were firmer than others. Mince continued to be firmer than fillets. No trends in firming or softening could be detected.

**Shear values**
**(pounds peak shear force)**

| Sample | 1 Week | 6 Weeks |
|---|---|---|
| Untreated fillet block | 38.5 | 38.4 |
| L-900 fillet block | 46.4 | 48.1 |
| Duralox fillet block | 35.2 | 38.6 |
| Untreated frame mince block | 44.2 | 44.9 |
| L-900 frame mince block | 54.9 | 59.3 |
| Duralox frame mince block | 40.6 | 45.0 |
| Untreated trim mince block | 46.5 | 44.8 |
| Duralox trim mince block | 43.7 | 42.1 |

Three and Six Month Storage.

Sensory Evaluation The sensory scores for three and six month samples changed noticeably. After three months frozen storage, fillet and combination blocks were preferred over mince blocks (Tables 1,2,3). Among mince blocks, L-900 had the highest desirability although there were no significant differences between any treatment. The trim mince sample had the rating for odor, flavor and texture. The commercial blocks, made only with trim mince, had much higher scores that those using frame mince. Little differences existed between fillet and combination blocks. Panelists could not detect the 15% mince of the combination blocks as evidenced by the similar texture scores. The commercial fillet samples were rated slightly higher than the experimental samples, but these differences were not significant. Duralox treated fillet blocks had the lowest flavor scores. Testers indicated that the slight

Table 1. Sensory Scores for Mince Blocks
Held for Three Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 4.2 | 4.1 | 3.5 | 5.3 | 3.3 |
| L-900 | 4.4 | 3.8 | 2.9 | 6.2 | 3.8 |
| Duralox | 4.2 | 4.1 | 3.5 | 5.3 | 3.3 |
| Trim | 4.9 | 5.5 | 5.4 | 3.9 | 4.7 |
| Commercial A | 3.4 | 3.3 | 4.7 | 4.7 | 3.2 |
| Commercial B | 4.6 | 3.9 | 5.6 | 4.0 | 4.8 |
| Commercial C | 4.6 | 5.0 | 5.8 | 4.5 | 5.3 |

Table 2. Sensory Scores for Fillet Blocks
Held for Three Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 5.4 | 5.1 | 4.9 | 5.0 | 5.3 |
| L-900 | 5.2 | 5.0 | 4.4 | 5.4 | 4.8 |
| Duralox | 5.4 | 4.4 | 5.1 | 4.8 | 4.8 |
| Commercial A | 4.4 | 4.1 | 5.3 | 3.8 | 4.4 |
| Commercial B | 5.5 | 5.3 | 5.4 | 4.6 | 5.5 |
| Commercial C | 5.4 | 5.4 | 5.4 | 5.2 | 5.0 |
| Commercial D | 5.7 | 5.8 | 6.2 | 4.8 | 5.7 |

Table 3. Sensory Scores for Combination Blocks
Held for Three Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 5.2 | 4.9 | 5.2 | 4.5 | 4.8 |
| L-900 | 5.3 | 5.4 | 5.1 | 5.1 | 5.2 |
| Duralox | 4.9 | 4.5 | 4.5 | 4.8 | 4.9 |

Table 4. Sensory Scores for Mince Blocks
Held for Six Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 4.2 | 4.0 | 3.7 | 5.4 | 3.8 |
| L-900 | 4.5 | 3.8 | 2.8 | 5.8 | 3.4 |
| Duralox | 3.8 | 3.4 | 3.3 | 5.5 | 3.3 |
| Trim | 4.3 | 4.4 | 5.8 | 4.2 | 4.8 |
| Commercial B | 4.3 | 3.9 | 5.4 | 3.7 | 4.2 |
| Commercial C | 4.8 | 5.2 | 6.2 | 4.5 | 5.1 |

Table 5. Sensory Scores for Fillet Blocks
Held for Six Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 4.2 | 4.2 | 5.3 | 4.3 | 4.3 |
| L-900 | 5.3 | 5.4 | 5.0 | 5.8 | 5.6 |
| Duralox | 5.1 | 4.6 | 5.3 | 4.6 | 5.0 |
| Commercial A | 4.3 | 3.9 | 5.4 | 3.7 | 4.2 |
| Commercial B | 5.2 | 5.0 | 5.2 | 4.6 | 4.9 |
| Commercial C | 5.1 | 5.1 | 5.0 | 5.2 | 4.8 |
| Commercial D | 4.8 | 5.2 | 6.2 | 4.5 | 5.1 |

"spice" or rosemary taste made the samples less desirable.

After six months frozen storage, there was slight deterioration in all samples (Tables 4,5,6). Mince samples were judged slightly worse than the three month samples. However, this difference was not significant. L-900 treated mince was judged as highest moistness while trim and commercial minces were slightly drier. Duralox treated mince, although the lowest in rancidity, rated the lowest in sensory scores. Again, this was due to the unexpected flavor of the antioxidant. Trim maintained had the highest scores of the experimental minces. Among the fillet and combination blocks, the L-900 treatment rated the highest flavor. The control fillet blocks deteriorated noticeably between three and six months storage. This caused the perception of the treated blocks to be better than the three month fish. It appears

that the antioxidants maintained product quality while the control deteriorated. Similar loss of desirability was observed in the commercial samples. This deterioration correlates well with rancidity measurements.

Table 6. Sensory Scores for Combination Blocks Held for Six Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 5.3 | 4.9 | 5.5 | 4.8 | 5.2 |
| L-900 | 5.5 | 5.9 | 5.7 | 5.8 | 5.8 |
| Duralox | 5.1 | 5.0 | 4.9 | 5.3 | 4.8 |

Rancidity. As frozen storage is extended, rancidity increases. Control blocks experienced the fastest development of rancidity (Figures 1,2,3). Blocks treated with L-900 and Duralox had significantly lower rancidity. Mince blocks had higher fat oxidation than combination and fillet blocks.

At three months storage, both L-900 and Duralox were effective in reducing the rancidity in combination and fillet blocks. After six months frozen storage, L-900 treated combination and fillet blocks had the lowest rancidity. Duralox has proved slightly more effective in maintaining the stability of the mince blocks.

Rancidity of the commercial blocks showed the typical patterns of increase over storage time (Figures 4,5). Mince blocks developed higher levels of rancidity than the fillet blocks. One commercial sample (A) had much higher levels than other blocks. Fillet sample D had the lowest rancidity.

Color. Color measurements were difficult to interpret. The variation in fillet color in the blocks made a simple statistical analysis impossible. However, anecdotal observations seem to indicate that antioxidant treated samples are losing color less rapidly than the control sample. Color in the commercial samples has changed only slightly. Overall, the meat is becoming slightly darker and more pink, less red. Additional analysis of the data using other means will be conducted to determine if any statistical differences between the samples exist.

Texture. Cooked texture changed slightly between three and six months frozen storage (Table 7). In general, fillet blocks toughened during this period while the mince blocks become slightly softer. The addition of L-900, a phosphate based antioxidant, firmed both fillet and mince blocks. The action of the phosphates on muscle fibers and as a water binder apparently contributes to the increased texture. The L-900 blocks changed very little between three and six months storage. Texture

of the control and Duralox treated blocks were very similar.

Table 7
**Cooked Texture**
**(pounds peak shear force)**

| Sample | 3 Months | 6 Months |
|---|---|---|
| Untreated fillet block | 40.2 | 40.1 |
| L-900 fillet block | 50.1 | 52.3 |
| Duralox fillet block | 38.6 | 42.3 |
| Untreated frame mince block | 40.6 | 38.5 |
| L-900 frame mince block | 53.2 | 55.6 |
| Duralox frame mince block | 36.5 | 38,4 |

Conclusions after Three and Six Months Storage. The control samples are deteriorating rapidly while the antioxidant treated blocks are maintaining better quality. The addition of antioxidants to mince, fillet and combination blocks has been effective in reducing rancidity. Sensory evaluation indicates that Duralox addition produces flavors that are unexpected and perhaps less desirable. L-900 treatment produces a moist product that is desirable. The commercial samples maintained quality for the first three months and then began deteriorating in the next three months.

Nine and Thirteen Month Storage Results.

Sensory Evaluation The sensory scores for nine and thirteen month samples changed noticeably. After nine months frozen storage, fillet and combination blocks were preferred over mince blocks (Tables 8,9,10). Among mince blocks, many of the differences from earlier analyses had disappeared. Most of the scores were very similar although the Duralox and L-900 had slightly higher desirability scores. Trim mince blocks continued to have slightly higher sensory values in all categories when compared to the blocks using frame mince. The commercial blocks, made only with trim mince, had scores similar to other blocks. The differences seen between commercial and the test mince blocks during the six month examinations had disappeared. The scores indicated the slight presence of off-odors, off-flavors and undesirability. Fillet blocks had higher scores than the mince blocks. Commercial fillet blocks had a firmer texture indicating perhaps the use of slightly higher quality fish at the beginning. They did not suffer the noticeable loss of quality of the mince blocks between six and nine months. Most of the fillet blocks maintained good

Table 8. Sensory Scores for Mince Blocks
Held for Nine Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 3.6 | 3.4 | 3.2 | 4.6 | 3.0 |
| L-900 | 3.7 | 3.2 | 3.5 | 5.2 | 3.9 |
| Duralox | 3.8 | 3.2 | 3.8 | 5.1 | 4.0 |
| Trim | 4.5 | 4.5 | 4.4 | 4.5 | 4.1 |
| Commercial A | 2.8 | 2.5 | 3.8 | 4.8 | 3.0 |
| Commercial B | 4.2 | 3.9 | 4.6 | 4.4 | 4.2 |
| Commercial C | 4.1 | 3.6 | 4.8 | 4.5 | 4.8 |

Table 9. Sensory Scores for Fillet Blocks
Held for Nine Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 4.8 | 4.9 | 4.6 | 5.2 | 4.8 |
| L-900 | 5.2 | 5.2 | 4.9 | 5.1 | 4.5 |
| Duralox | 5.2 | 5.0 | 5.0 | 4.8 | 4.8 |
| Commercial A | 3.3 | 3.1 | 4.1 | 4.0 | 2.8 |
| Commercial B | 5.2 | 5.4 | 4.8 | 4.5 | 4.8 |
| Commercial C | 5.4 | 5.1 | 5.1 | 5.0 | 5.2 |
| Commercial D | 5.4 | 5.2 | 5.4 | 4.6 | 5.2 |

Table 10. Sensory Scores for Combination Blocks
Held for Nine Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 5.0 | 4.6 | 5.2 | 4.8 | 5.0 |
| L-900 | 5.3 | 4.8 | 5.1 | 4.8 | 5.2 |
| Duralox | 5.2 | 4.8 | 5.1 | 4.8 | 4.9 |

quality through nine months storage. The only noticed changes was in commercial sample "A" which had lower scores than others and was considered slightly to moderately undesirable. Little differences existed between fillet and combination blocks. Panelists could not detect the 15% mince of the combination blocks as evidenced by the similar texture scores. The commercial fillet samples were rated slightly higher than the experimental samples, but these differences were not significant. Duralox and L-900 treated fillet blocks had the lowest flavor scores.

Table 11. Sensory Scores for Mince Blocks
Held for Thirteen Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 3.2 | 3.0 | 3.2 | 5.3 | 3.0 |
| L-900 | 3.1 | 2.8 | 3.0 | 5.6 | 2.8 |
| Duralox | 3.6 | 2.8 | 3.3 | 5.4 | 2.9 |
| Trim | 3.8 | 3.6 | 4.5 | 4.2 | 3.5 |
| Commercial A | 2.2 | 2.1 | 4.1 | 3.2 | 2.4 |
| Commercial B | 3.6 | 3.4 | 5.4 | 3.8 | 3.4 |
| Commercial C | 3.5 | 3.5 | 5.5 | 3.7 | 3.6 |

Table 12. Sensory Scores for Fillet Blocks
Held for Thirteen Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 4.2 | 3.8 | 5.0 | 4.2 | 4.0 |
| L-900 | 4.5 | 4.2 | 4.5 | 4.9 | 4.6 |
| Duralox | 4.6 | 4.2 | 4.3 | 4.6 | 4.5 |
| Commercial A | 3.8 | 4.0 | 4.6 | 4.0 | 3.2 |
| Commercial B | 4.8 | 4.6 | 4.6 | 4.4 | 4.5 |
| Commercial C | 4.7 | 4.8 | 4.0 | 4.2 | 4.5 |
| Commercial D | 4.6 | 4.4 | 5.1 | 4.5 | 4.8 |

After thirteen months frozen storage, there was more deterioration in all samples (Tables 11,12,13). Mince samples were judged worse than the nine month samples.

All samples has undesirable characteristics, ranging from slight to moderate defects. The mince block after thirteen months have reached their limit of shelf life. Commercial sample A had moderate off odors and flavors. Duralox and L-900 treated were not significantly different from the control. It appears from the sensory view, the antioxidants have lost their effectiveness at thirteen months storage. Trim maintained had the highest scores of the experimental minces.

However, among the fillet blocks, there was little deterioration between nine and thirteen months. Very similar sensory scores appeared for both samples. Among the fillet and combination blocks, antioxidant treatments rated good flavor. It appears that the antioxidants maintained product quality while the control deteriorated. Similar loss of desirability was observed in the commercial samples. Only commercial sample A had deteriorated to slightly undesirable. This deterioration correlates well with rancidity measurements. Combination fillet/mince samples had almost identical scores to the fillet blocks. It appears that the addition of mince did not detract from the sensory attributes even after thirteen months frozen storage. Perhaps the antioxidant treatments protected the small amount of mince in these block better than the 100% mince blocks. L-900 and Duralox had higher desirability scores than the control blocks for both fillet and combination. This indicates that the antioxidant treatments have been effective in these forms.

Table 13. Sensory Scores for Combination Blocks
Held for Thirteen Months at -20°F

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 3.8 | 4.0 | 5.2 | 4.5 | 3.9 |
| L-900 | 4.2 | 4.5 | 5.2 | 5.0 | 4.5 |
| Duralox | 4.4 | 4.2 | 5.1 | 5.1 | 4.6 |

Rancidity. As frozen storage extended, rancidity increases. Control blocks continued to have the fastest development of rancidity (Figures 1,2,3). Blocks treated with L-900 and Duralox had significantly lower rancidity. Mince blocks had higher fat oxidation than combination and fillet blocks.

At nine months storage, both L-900 and Duralox were effective in reducing the rancidity in combination and fillet blocks. After thirteen months frozen storage, L-900 treated combination and fillet blocks had the lowest rancidity. Duralox has proved slightly more effective in maintaining the stability of the mince blocks.

After thirteen months frozen storage, it appears that the antioxidant effects are changing. While control blocks continue to have higher rancidity, the rate of increase

of L-900 and Duralox treated blocks seemed to accelerate between six and ten months. This occurred in mince and combination blocks. Rancidity in the fillet blocks still appeared to be increasing at the same rates.

Overall, mince and combination blocks treated with Duralox have much less rancidity than either L-900 treated or control blocks. L-900 treated fillets maintained slightly lower rancidity levels than Duralox treated fillets. In any case, both antioxidant blends have been effective in lowering the rate of rancidity in all blocks.

Rancidity of the commercial blocks showed the typical patterns of increase over storage time (Figures 4,5). Mince blocks developed higher levels of rancidity than the fillet blocks. One commercial sample (A) had much higher levels than other blocks. Fillet sample D had the lowest rancidity while sample B experienced a rapid increase in its rancidity level.

Color. Color measurements were difficult to interpret. The variation in fillet color in the blocks made a simple statistical analysis impossible. However, anecdotal observations seem to indicate that antioxidant treated samples are losing color less rapidly than the control sample. Color in the commercial samples has changed only slightly. Overall, the meat is becoming slightly darker and more pink, less red. Additional analysis of the data using other means will be conducted to determine if any statistical differences between the samples exist.

Texture. Cooked texture changed slightly between nine and thirteen months frozen storage (Table 14). In general, fillet blocks continued to toughen during this period while the mince blocks become slightly softer. The addition of L-900, a phosphate based antioxidant, firmed both fillet and mince blocks. The action of the phosphates on muscle fibers and as a water binder apparently contributes to the increased texture. The L-900 blocks changed very little between nine and thirteen months storage. Texture of the control and Duralox treated blocks were very similar.

Table 14
**Cooked Texture**
**(pounds peak shear force)**

| Sample | 9 Months | 13 Months |
|---|---|---|
| Untreated fillet block | 41.5 | 44.6 |
| L-900 fillet block | 52.6 | 55.1 |
| Duralox fillet block | 40.6 | 41.8 |
| Untreated frame mince block | 38.4 | 33.2 |
| L-900 frame mince block | 54.5 | 58.9 |
| Duralox frame mince block | 37.8 | 33.5 |

Conclusions after Nine and Thirteen Months Storage. The control samples are deteriorating rapidly while the antioxidant treated blocks are maintaining better quality. The addition of antioxidants to mince, fillet and combination blocks has been effective in reducing rancidity. Sensory evaluation indicates that Duralox addition produces flavors that are unexpected and perhaps less desirable. L-900 treatment produces a moist product that is desirable. The commercial samples maintained quality for the first six months and then began deteriorating in the next three months. Mince blocks were undesirable after thirteen months of frozen storage and only slightly desirable after nine months. This was the case for blocks that contained both frame and trim mince.

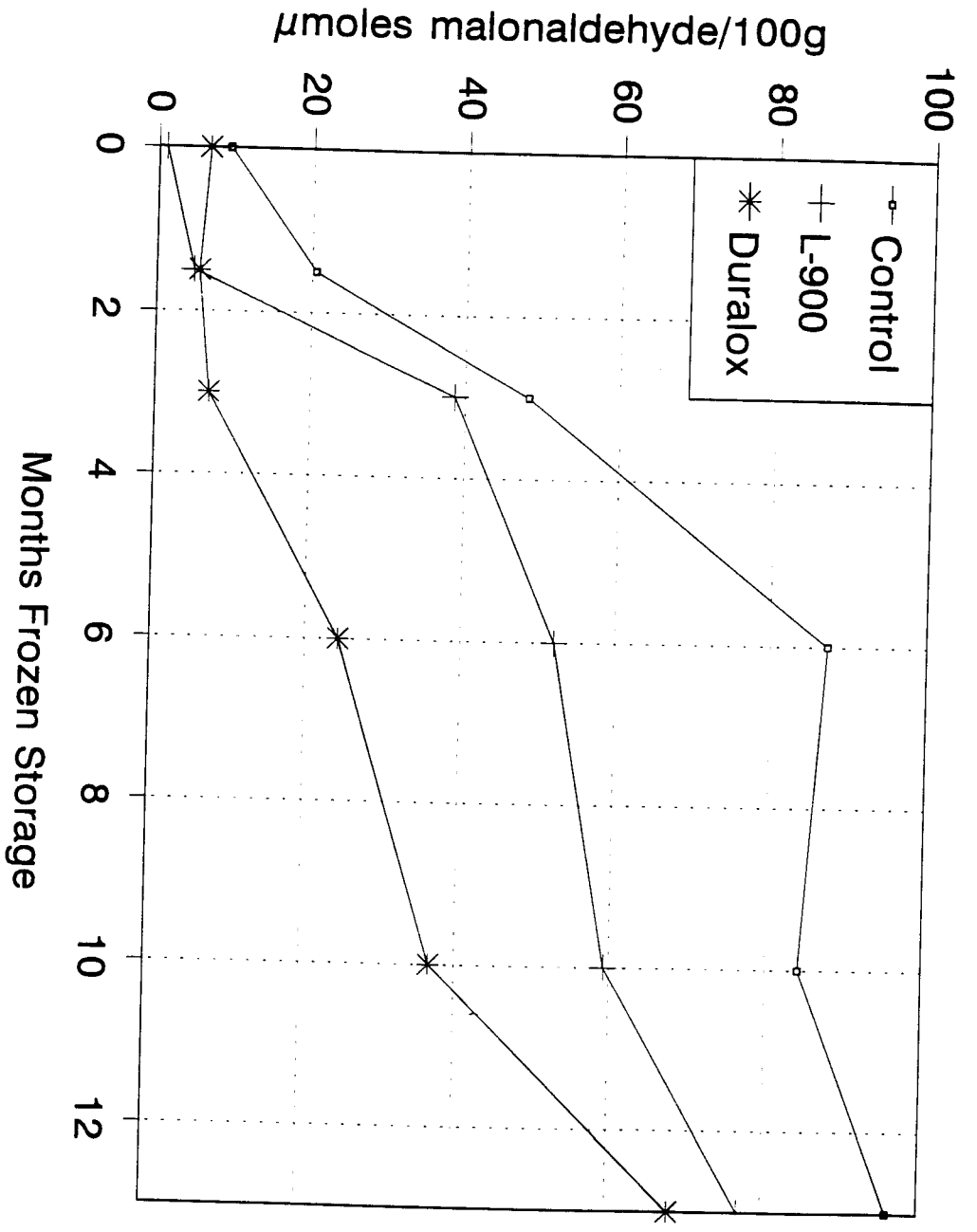


Figure 1. Rancidity in Pink Salmon Mince Blocks

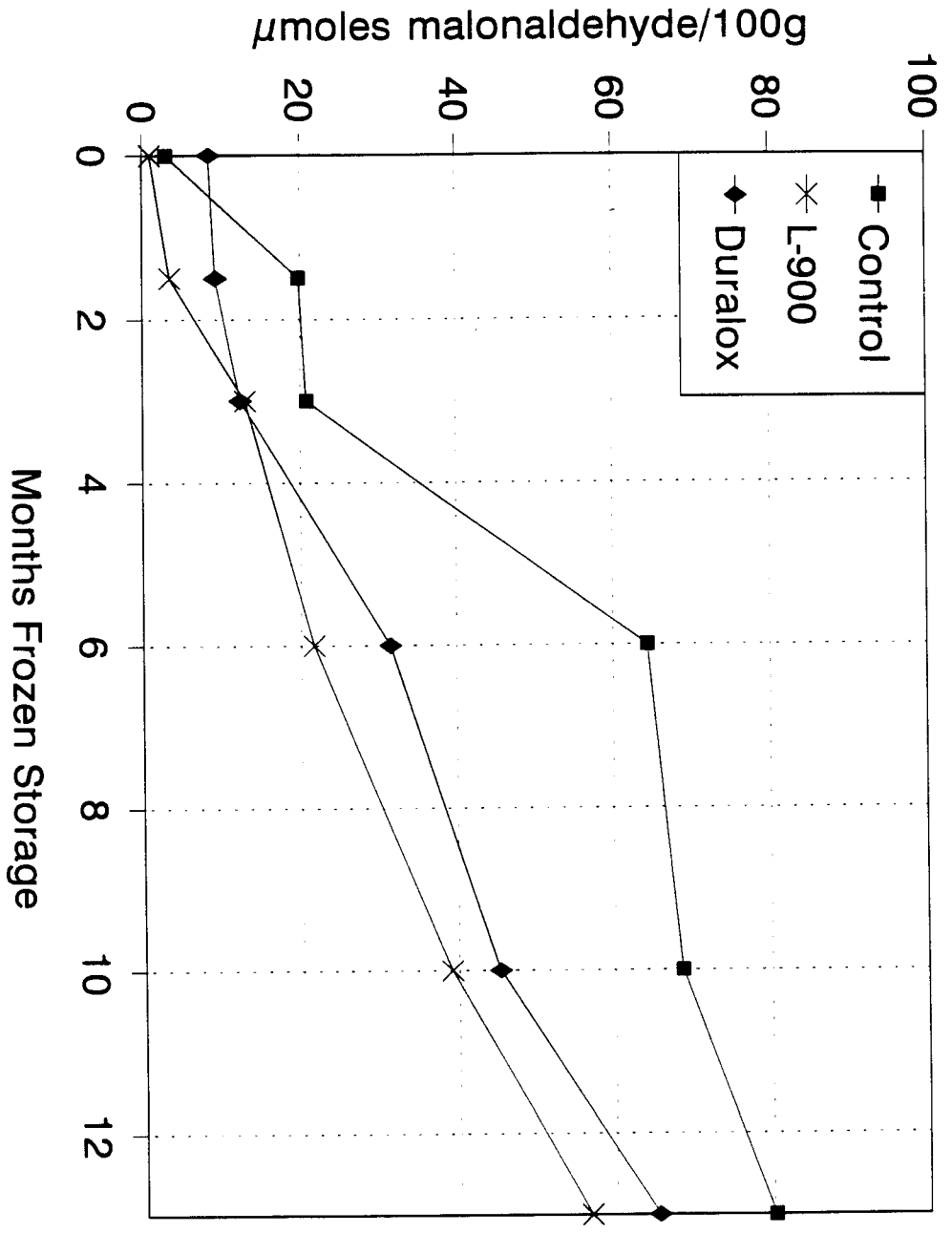


Figure 2. Rancidity in Pink Salmon Combination Blocks

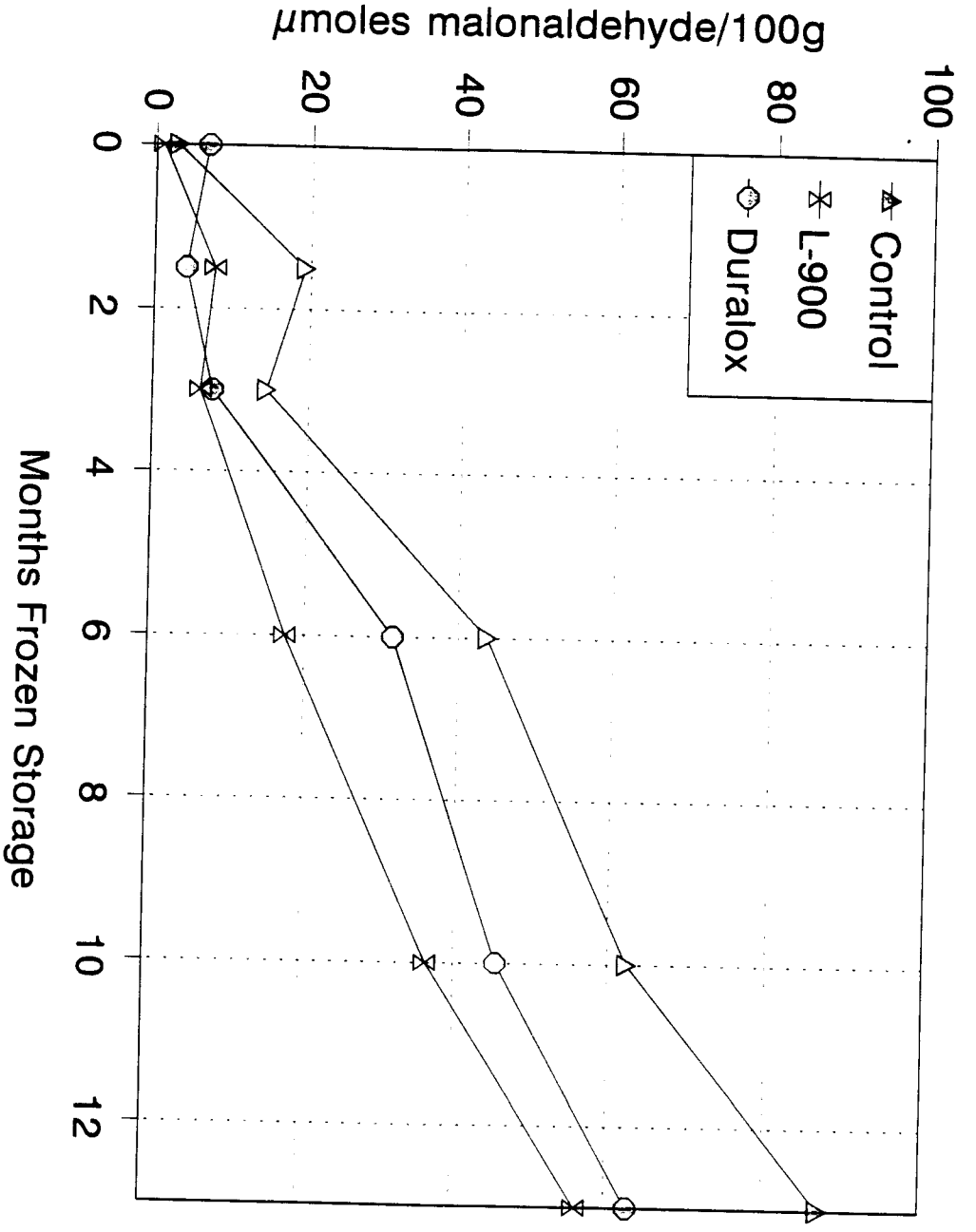


Figure 3. Rancidity in Pink Salmon Fillet Blocks

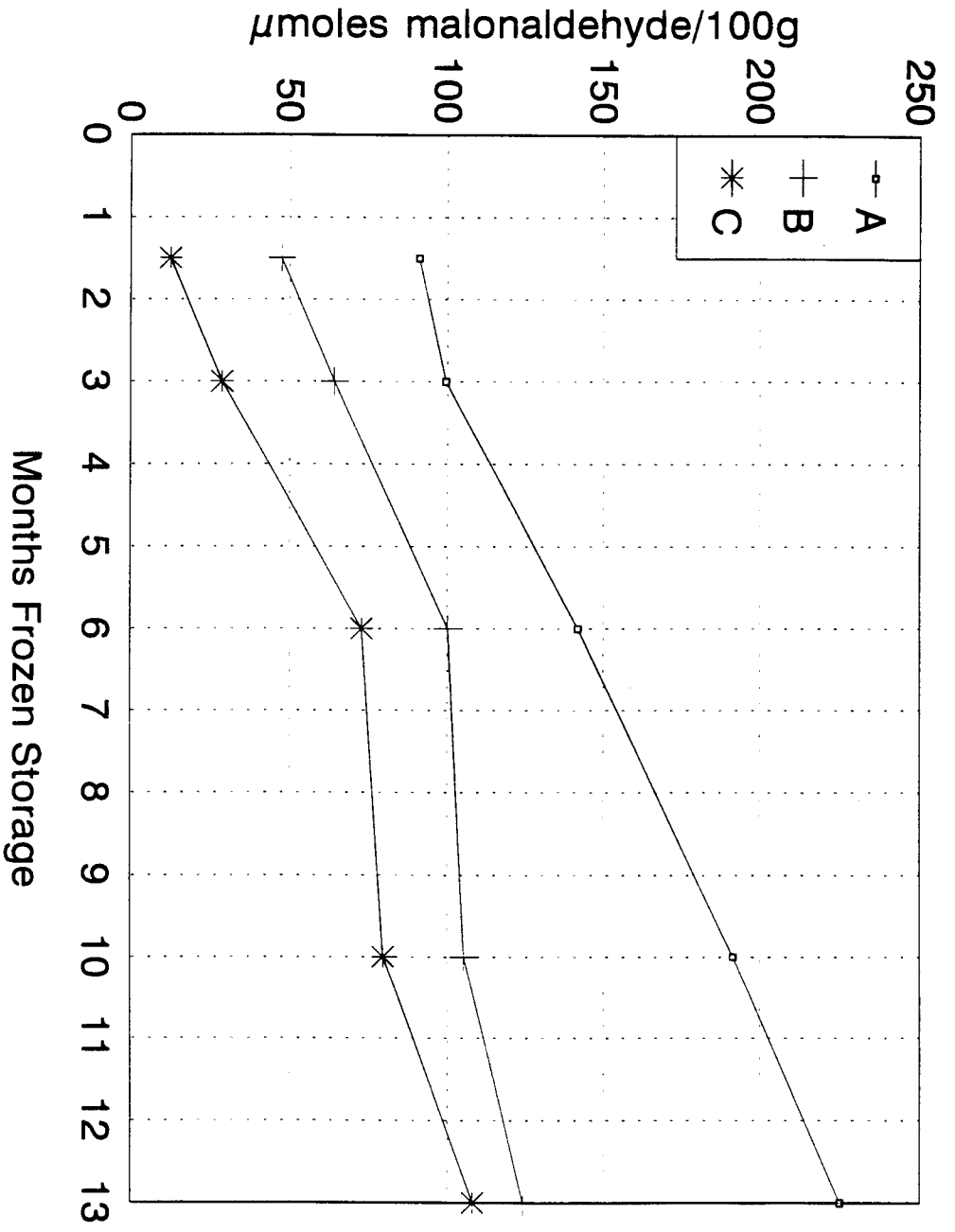


Figure 4. Rancidity in Commercial Mince Blocks

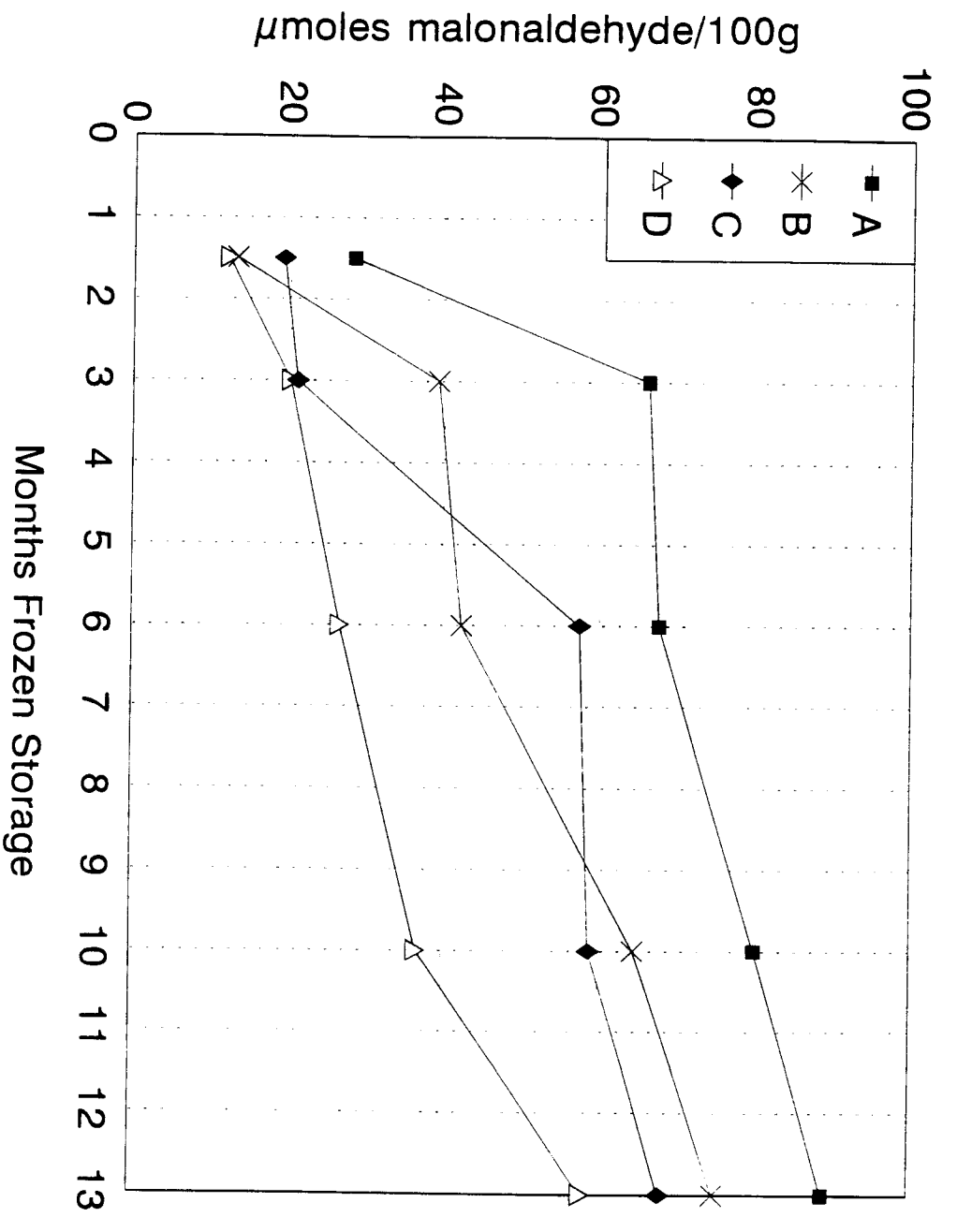


Figure 5. Rancidity in Commercial Fillet Blocks

# Report of Pink Salmon Block Stability Trials

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**March 10, 1995**

## Reprocessed Blocks

Samples. Pink salmon were reprocessed after six months frozen storage (-20°F) at Peter Pan in Algona, Washington and shipped to Kodiak for storage and evaluation. Samples were analyzed after an additional four weeks frozen storage at -20°F and then at four,six and nine months. The samples evaluated for color, rancidity, texture and sensory attributes included:

Untreated fillet block
L-900 fillet block
Duralox fillet block

Untreated frame mince block
L-900 frame mince block
Duralox frame mince block

Untreated combination (85% fillet/15% frame mince) block
L-900 combination block
Duralox combination block.

Frozen dressed/headed pink salmon glazed in ice water and a Duralox glaze and held for up to twelve months also were evaluated. Rancidity was measured to determine the effectiveness of an antioxidant glaze.

Treatment. Blocks were prepared from fillets soaked for 30 seconds in 10% Duralox or 10% L-900 solution. Mince blocks made from trimmings and frames treated for 30 seconds in either L-900 or Duralox solutions. These soak times provided a 5% uptake of the antioxidant solution.

Sample Preparation and Analytical Procedures. Blocks were band sawed into pieces approximately 0.5" by 2" by 3" for analysis. Twenty pieces were used for sensory evaluation and thirty pieces for rancidity and color measurements and texture analysis.

Sensory evaluation was done using a ten to fifteen member panel. Samples were wrapped in foil and steamed for 10 minutes prior to serving. Two panels were conducted for each storage period. One panel compared fillet and combination blocks and another panel evaluated mince blocks. Panelists were asked to evaluate samples for off-odor, off-flavor, texture moistness and desirability using a seven point hedonic scale (a copy of the score sheet is included).

Rancidity was determined by the thiobarbuturic acid (TBA) test. This procedure measures the amount of malondialdehyde, a chemical that appears as fat oxidizes. Ten randomly selected pieces were combined and triplicate subsamples taken to obtain a representative sample. Six fish from standard ice glaze or Duralox glaze were thawed and sampled for rancidity.

Texture of the blocks was determined by the Instron Universal Testing Machine. Pieces were wrapped in foil and steamed for 10 minutes. A ten blade Kramer-Lee cell was used to shear across the muscle fibers of fillet and combination blocks and through mince blocks. The amount of peak force required was recorded and used as an indication of texture. Fifteen samples from each treatment were tested in this manner.

Color measurement of raw blocks was made using the Minolta Chromameter. Three randomly selected pieces were measured. Ten measurements were made for each treatment sample. The values were averaged and analyzed for any differences. Proximate composition of the raw material was determined using standard methods.

Zero and Three Months Storage. The analysis of the blocks produced from frozen salmon will provide the baseline for subsequent product holding trials for the next six months. The quality of these blocks are comparable to blocks produced from fresh fish and held in frozen storage for six months. Sensory scores, rancidity and color are similar for both samples.

Sensory Evaluation. Sensory panels tested fillet and combination blocks separately from mince blocks (Table 1,2). Combination blocks scored higher in desirability than fillets blocks. However, no significant differences existed between any fillet or combination block. The highest desirability score was found in the L-900 combination block. Among fillet blocks, the control was rated the highest flavor and desirability with the firmest texture. Duralox treated fillets had the lowest flavor score as in previous tests.

Mince blocks generally had lower flavor and desirability scores than the fillet blocks. The control mince block was rated the most desirable. The odor and flavor were judged to be slightly off. This may be a result of frozen storage and mincing. It was not reflected in scores for the fillet products.

Table 1. Sensory Scores for Fillet and Combo Blocks from Reprocessed Pink Salmon

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| FILLET BLOCK | | | | | |
| Control | 4.2 | 4.0 | 3.7 | 5.4 | 3.8 |
| L-900 | 4.5 | 3.8 | 2.8 | 5.8 | 3.4 |
| Duralox | 3.8 | 3.4 | 3.3 | 5.5 | 3.3 |
| COMBO BLOCK | | | | | |
| Control | 4.3 | 3.9 | 5.4 | 3.7 | 4.2 |
| L-900 | 4.9 | 4.6 | 5.0 | 4.5 | 4.4 |
| Duralox | 4.8 | 4.2 | 6.2 | 4.5 | 4.1 |

Table 2. Sensory Scores for Mince Blocks from Reprocessed Pink Salmon

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 3.2 | 3.3 | 3.7 | 5.4 | 3.5 |
| L-900 | 3.2 | 3.6 | 3.3 | 5.5 | 3.3 |
| Duralox | 3.8 | 3.2 | 6.2 | 4.5 | 3.1 |

Rancidity. Rancidity in the reprocessed blocks varied as a result of the antioxidant glazed raw product (Table 3). Control and two of the L-900 blocks were produced primarily from pink salmon with a fresh water glaze. The Duralox blocks and L-900 fillet blocks used fish that were glazed in the Duralox solution. The higher values are similar to those from the six month blocks produced from fresh fish.

After four months frozen storage, all samples had increased levels of rancidity. Rancidity levels doubled in control fillet and mince blocks. L-900 treated blocks showed lower increases for fillet blocks. The L-900 mince blocks had rancidity levels similar to the control. Duralox treated blocks, while having lower overall rancidity, still experienced a doubling of values. The only exception was the Duralox mince block. These blocks had only slightly higher values after four months storage.

It appears that the antioxidant treatment of reprocessed blocks is not as effective as

treatment of fresh product.

The effect of the Duralox glaze on the dressed headed pink salmon was dramatic (Table 4). The fish glazed in a 5% Duralox glaze solution had less than half the rancidity of the standard fresh water glaze. It appears that Duralox was very effective in maintaining the glaze. Examination of the fish prior to thawing revealed the Duralox glaze was intact on most fish. By contrast, the standard glaze was cracked and had sublimated. The Duralox glaze was much more durable and its antioxidant properties slowed the rate of rancidity.

After ten months frozen storage, Duralox glazed fish had much lower rancidity levels than the fresh water glaze. Duralox appears to be effective in lowering the rate of rancidity development in frozen storage.

Table 3. TBA Values for Reprocessed Blocks

| Sample | μmoles malonaldehyde/100g | |
|---|---|---|
| | 1 month | 4 months |
| Control Fillet | 34.72 | 68.59 |
| Control Combo | 46.22 | 51.16 |
| Control Mince | 59.56 | 97.38 |
| L-900 Fillet | 30.29 | 44.93 |
| L-900 Combo | 60.45 | 41.48 |
| L-900 Mince | 59.78 | 90.21 |
| Duralox Fillet | 24.02 | 45.24 |
| Duralox Combo | 22.52 | 49.73 |
| Duralox Mince | 30.29 | 37.72 |

Table 4. TBA Values for Glazed Pink Salmon

| Sample | μmoles malonaldehyde/100g | |
|---|---|---|
| | 6 month | 9 months |
| Control Glaze | 22.04 | 73.03 |
| Duralox Glaze | 9.12 | 45.18 |

Cooked Texture. Cooked texture was in the range observed for the six month frozen blocks made from fresh fish (Table 5). The L-900 blocks were slightly firmer than either the control or Duralox blocks. The action of the phosphate in the L-900 appears to firm the meat.

Zero and Three Month Storage Conclusions. It appears that the blocks are very similar to those produced from fresh fish and held for six months in frozen storage. The key to reprocessing will be the subsequent storage for another three and six months. The most interesting result was that of the Duralox glaze. There was dramatic improvement in fat stability when the antioxidant was used in the glaze tank.

Table 5. Cooked Texture

| Sample | Peak shear force (lbs) |
|---|---|
| Control fillet block | 43.6 |
| L-900 fillet block | 51.8 |
| Duralox fillet block | 47.6 |
| Control mince block | 44.3 |
| L-900 mince block | 48.9 |
| Duralox mince block | 38.7 |

Six Months Storage. After six months frozen storage, the reprocessed blocks compared favorably with blocks processed from fresh fish. Little differences existed in sensory or chemical quality.

Sensory Evaluation. Sensory panels tested fillet and combination blocks separately from mince blocks (Table 6,7). Treated fillet blocks scored slightly higher in desirability than control blocks. However, no significant differences existed between any fillet or combination block. The highest desirability score was found in the L-900 combination block. Among fillet blocks, the control was rated the highest flavor and firmest texture. Duralox treated fillets had the lowest flavor score as in previous tests.

Mince blocks generally had lower flavor and desirability scores than the fillet blocks. The control mince block was rated the most desirable. The odor and flavor were judged to be slightly to moderately off. This may be a result of frozen storage and mincing. It was not reflected in scores for the fillet products. There was no

advantage to antioxidant addition in reprocessed mince products after six months frozen storage.

Table 6. Sensory Scores for Fillet and Combo Blocks from Reprocessed Pink Salmon After Six Months Frozen Storage

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| FILLET BLOCK | | | | | |
| Control | 4.2 | 4.1 | 3.8 | 5.2 | 3.9 |
| L-900 | 4.6 | 3.5 | 3.1 | 4.9 | 4.5 |
| Duralox | 4.2 | 3.3 | 3.3 | 5.5 | 4.2 |
| COMBO BLOCK | | | | | |
| Control | 3.7 | 3.9 | 5.1 | 3.9 | 3.9 |
| L-900 | 4.2 | 4.6 | 5.1 | 5.0 | 4.1 |
| Duralox | 4.6 | 4.0 | 5.0 | 4.4 | 4.3 |

Table 7. Sensory Scores for Mince Blocks from Reprocessed Pink Salmon After Six Months Frozen Storage

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 3.0 | 2.8 | 3.7 | 5.1 | 3.1 |
| L-900 | 3.1 | 2.8 | 3.2 | 5.5 | 2.8 |
| Duralox | 3.4 | 2.9 | 5.1 | 4.9 | 3.0 |

Rancidity. Rancidity in the reprocessed blocks varied as a result of the antioxidant glazed raw product (Table 8). The control and two of the L-900 blocks were produced primarily from pink salmon with a fresh water glaze. The Duralox blocks and L-900 fillet blocks used fish that were glazed in the Duralox solution. The higher values are similar to those from the month blocks produced from fresh fish.

Rancidity increased over time (Figures 1, 2 and 3). Minces had higher rancidity levels than either fillet or combination blocks. Control blocks had higher levels than

either antioxidant treatment. It is difficult to compare antioxidant treatments as the raw material had varying levels of rancidity as a result of the glaze. Among L-900 and Duralox fillet and combination blocks, there was no difference in the rancidity level. Generally, it appears that antioxidants were effective in slowing development of rancidity. However, the rancidity levels after six months frozen storage were very similar to blocks produced from fresh fish. It appears that there is no benefit from producing these blocks from fresh fish.

The effect of the Duralox glaze on the dressed headed pink salmon was dramatic (Table 9). The fish glazed in a 5% Duralox glaze solution had less than half the rancidity of the standard fresh water glaze. It appears that Duralox was very effective in maintaining the glaze. Examination of the fish prior to thawing revealed the Duralox glaze was intact on most fish. By contrast, the standard glaze was cracked and had sublimated. The Duralox glaze was much more durable and its antioxidant properties slowed the rate of rancidity.

After ten months frozen storage, Duralox glazed fish had much lower rancidity levels than the fresh water glaze. At thirteen months of frozen storage, levels were slightly higher and based on earlier testing, reaching the limits of shelf life. Duralox appears to be effective in lowering the rate of rancidity development in frozen storage.

Table 8. TBA Values for Reprocessed Blocks After One, Four and Six Months Frozen Storage

| Sample | μmoles malonaldehyde/100g | | |
|---|---|---|---|
| | 1 month | 4 months | 7 months |
| Control Fillet | 34.72 | 68.59 | 92.65 |
| Control Combo | 46.22 | 51.16 | 80.52 |
| Control Mince | 59.56 | 97.38 | 122.51 |
| L-900 Fillet | 30.29 | 44.93 | 65.47 |
| L-900 Combo | 60.45 | 41.48 | 56.44 |
| L-900 Mince | 59.78 | 90.21 | 118.47 |
| Duralox Fillet | 24.02 | 45.24 | 53.58 |
| Duralox Combo | 22.52 | 49.73 | 52.96 |
| Duralox Mince | 30.29 | 37.72 | 72.13 |

Cooked Texture. Cooked texture was in the range observed for the frozen blocks made from fresh fish (Table 10). The L-900 blocks were slightly firmer than either the control or Duralox blocks. The action of the phosphate in the L-900 appears to firm the meat.

Table 9. TBA Values for Glazed Pink Salmon After Six, Nine and Thirteen Months Frozen Storage

| Sample | μmoles malonaldehyde/100g | | |
|---|---|---|---|
| | 6 month | 9 months | 13 months |
| Control Glaze | 22.04 | 73.03 | 87.42 |
| Duralox Glaze | 9.12 | 45.18 | 63.78 |

Table 10. Cooked Texture After One and Six Months of Frozen Storage

| Sample | Peak shear force (lbs) | |
|---|---|---|
| | 1 month | 6 months |
| Control fillet block | 43.6 | 46.6 |
| L-900 fillet block | 51.8 | 54.9 |
| Duralox fillet block | 47.6 | 48.2 |
| Control mince block | 44.3 | 42.7 |
| L-900 mince block | 48.9 | 51.6 |
| Duralox mince block | 38.7 | 34.5 |

Color. Color measurements were difficult to interpret. The variation in fillet color in the blocks made a simple statistical analysis impossible. However, anecdotal observations seem to indicate that antioxidant treated samples are losing color less rapidly than the control sample.

Six Months Storage Conclusions. Antioxidant treatment is effective in reducing rancidity in reprocessed blocks. This is confirmed by both sensory and chemical tests. However, after six months the levels of rancidity were very similar to blocks produced from fresh fish. This implies there is limited shelf life from the reprocessed if the fish are held more than six months in frozen storage.

Using Duralox as a glaze additive was very effective in reducing rancidity and may be

useful in extending the shelf life of frozen pink salmon.

Nine Months Storage. After nine months frozen storage, the reprocessed blocks still compared favorably with blocks processed from fresh fish (See Nine and Thirteen Month Storage Report). Little differences existed in sensory or chemical quality.

Sensory Evaluation. Sensory panels tested fillet and combination blocks separately from mince blocks (Table 11,12). Treated fillet blocks scored slightly higher in desirability than control blocks. However, no significant differences existed between any fillet or combination block. The highest desirability score was found in the L-900 combination block. Among fillet blocks, the control was rated the highest flavor and firmest texture. Duralox treated fillets had the lowest flavor score as in previous tests.

Mince blocks generally had lower flavor and desirability scores than the fillet blocks. The control mince block was rated the most desirable. The odor and flavor were judged to be slightly to moderately off. This may be a result of frozen storage and mincing. It was not reflected in scores for the fillet products. There was no advantage to antioxidant addition in reprocessed mince products after nine months frozen storage.

Table 11. Sensory Scores for Fillet and Combo Blocks from Reprocessed Pink Salmon After Nine Months Frozen Storage

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| FILLET BLOCK | | | | | |
| Control | 4.0 | 3.5 | 3.4 | 4.8 | 2.8 |
| L-900 | 4.1 | 3.2 | 3.3 | 4.7 | 3.2 |
| Duralox | 4.1 | 3.2 | 3.3 | 4.6 | 3.4 |
| COMBO BLOCK | | | | | |
| Control | 3.6 | 3.9 | 5.2 | 4.0 | 3.1 |
| L-900 | 3.8 | 3.5 | 4.9 | 4.7 | 3.4 |
| Duralox | 3.6 | 3.7 | 5.1 | 4.6 | 3.5 |

Over the nine month storage period, there was a continual decline in sensory quality. It was not pronounced during the first six months of storage, but by six months, adverse flavors and odors were noted by most taste panelists. This was repeated in

Table 12. Sensory Scores for Mince Blocks from Reprocessed Pink Salmon After Nine Months Frozen Storage

| Sample | Odor | Flavor | Texture | Moistness | Desirability |
|---|---|---|---|---|---|
| Control | 2.7 | 2.9 | 3.5 | 5.1 | 2.8 |
| L-900 | 3.1 | 2.6 | 3.8 | 5.5 | 2.7 |
| Duralox | 3.3 | 2.5 | 4.8 | 4.9 | 2.8 |

the nine months tests with all products have noticeable off-odors and flavors. These affected the samples to the point where they were considered slightly to moderately undesirable. These results indicate that six months should be the maximum storage period for these reprocessed blocks.

Rancidity. Rancidity in the reprocessed blocks varied as a result of the antioxidant glazed raw product. The control and two of the L-900 blocks were produced primarily from pink salmon with a fresh water glaze. The Duralox blocks and L-900 fillet blocks used fish that were glazed in the Duralox solution. The higher values are similar to those from the blocks produced from fresh fish.

Rancidity increased over time (Figures 1, 2 and 3). Minces had higher rancidity levels than either fillet or combination blocks. Control blocks had higher levels than either antioxidant treatment. It is difficult to compare antioxidant treatments as the raw material had varying levels of rancidity as a result of the glaze. Among L-900 and Duralox fillet and combination blocks, there was no difference in the rancidity level. Generally, it appears that antioxidants were effective in slowing development of rancidity. However, the rancidity levels after nine months frozen storage were very similar to blocks produced from fresh fish. It appears that there is no benefit from producing these blocks from fresh fish.

The effect of the Duralox glaze on the dressed headed pink salmon appeared to come to an end after sixteen months storage. (Table 13). The fish glazed in a 5% Duralox glaze solution had slightly less rancidity than the fresh water glaze. It appears that Duralox was very effective in maintaining the glaze up to thirteen months. Examination of the fish prior to thawing revealed the Duralox glaze was starting to sublimate on most fish. By contrast, the standard glaze was cracked and had sublimated. The Duralox glaze was much more durable and its antioxidant properties slowed the rate of rancidity.

After ten months frozen storage, Duralox glazed fish had much lower rancidity levels than the fresh water glaze. At thirteen months of frozen storage, levels were slightly

Table 13. TBA Values for Glazed Pink Salmon After Six, Nine, Thirteen and Sixteen Months Frozen Storage

| Sample | μmoles malonaldehyde/100g | | | |
|---|---|---|---|---|
| | 6 month | 9 months | 13 months | 16 months |
| Control Glaze | 22.04 | 73.03 | 87.42 | 95.44 |
| Duralox Glaze | 9.12 | 45.18 | 63.78 | 88.95 |

higher and based on earlier testing, reaching the limits of shelf life. Duralox appears to be effective in lowering the rate of rancidity development in frozen storage.

Cooked Texture. Cooked texture was in the range observed for the frozen blocks made from fresh fish (Table 14). The L-900 blocks were slightly firmer than either the control or Duralox blocks. The action of the phosphate in the L-900 appears to firm the meat. Over the nine month storage period, there was little change in cooked texture. It appears that all products, except the Duralox mince blocks, became tougher over the storage period. This was probably due to a combination of protein denaturation, freezer burn, cycling storage temperatures and the effect of the phosphates in the L-900 product.

Table 14. Cooked Texture After One, Six and Nine Months of Frozen Storage

| Sample | Peak shear force (lbs) | | |
|---|---|---|---|
| | 1 month | 6 months | 9 months |
| Control fillet block | 43.6 | 46.6 | 47.3 |
| L-900 fillet block | 51.8 | 54.9 | 55.1 |
| Duralox fillet block | 47.6 | 48.2 | 50.7 |
| Control mince block | 44.3 | 42.7 | 44.6 |
| L-900 mince block | 48.9 | 51.6 | 53.4 |
| Duralox mince block | 38.7 | 34.5 | 31.0 |

Color. Color measurements continued to be uninterpretable. The variation in fillet color in the blocks made a simple statistical analysis impossible. However, anecdotal observations seem to indicate that antioxidant treated samples are losing color less rapidly than the control sample.

Nine Month Storage Conclusions. Antioxidant treatment is effective in reducing

rancidity in reprocessed blocks. This is confirmed by both sensory and chemical tests. However, after nine months the levels of rancidity were very similar to blocks produced from fresh fish. This implies there is limited shelf life from the reprocessed if the fish are held more than six months in frozen storage.

At nine months, sensory tests showed noticeable off flavors and odors indicating a limit to antioxidant treatment. The raw material was sixteen months old at this time, far beyond most common storage periods for pink salmon. It is recommended that reprocessed salmon blocks be held less than six months.

Using Duralox as a glaze additive was very effective in reducing rancidity up to thirteen months and may be useful in extending the shelf life of frozen pink salmon. Beyond thirteen months, the condition of the glaze limited the effectiveness of the antioxidant dip and there were no differences between it and the water glaze.

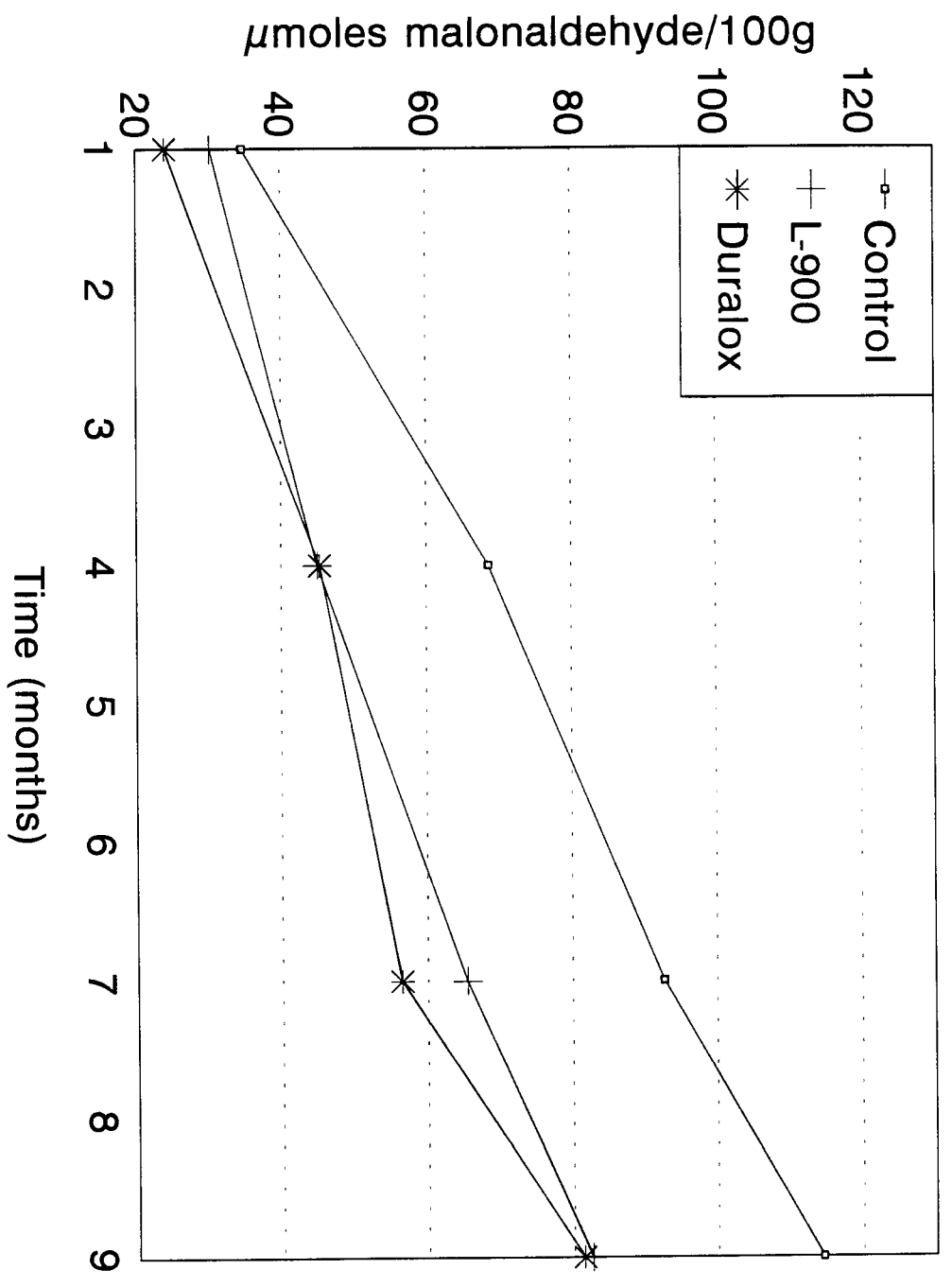


Figure 1. TBA Values for Reprocessed Fillet Blocks

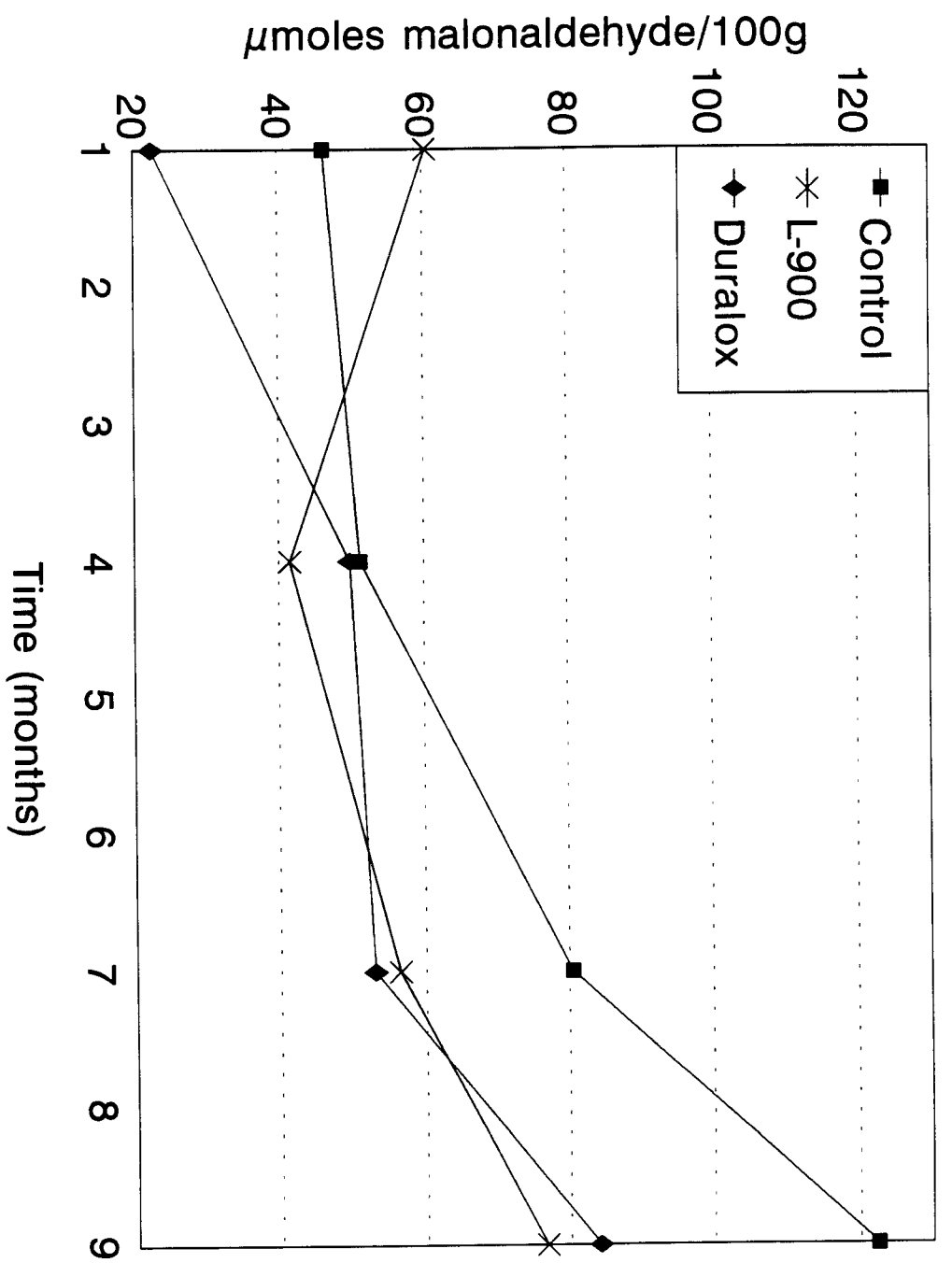


Figure 2. TBA Values for Reprocessed Combination Blocks

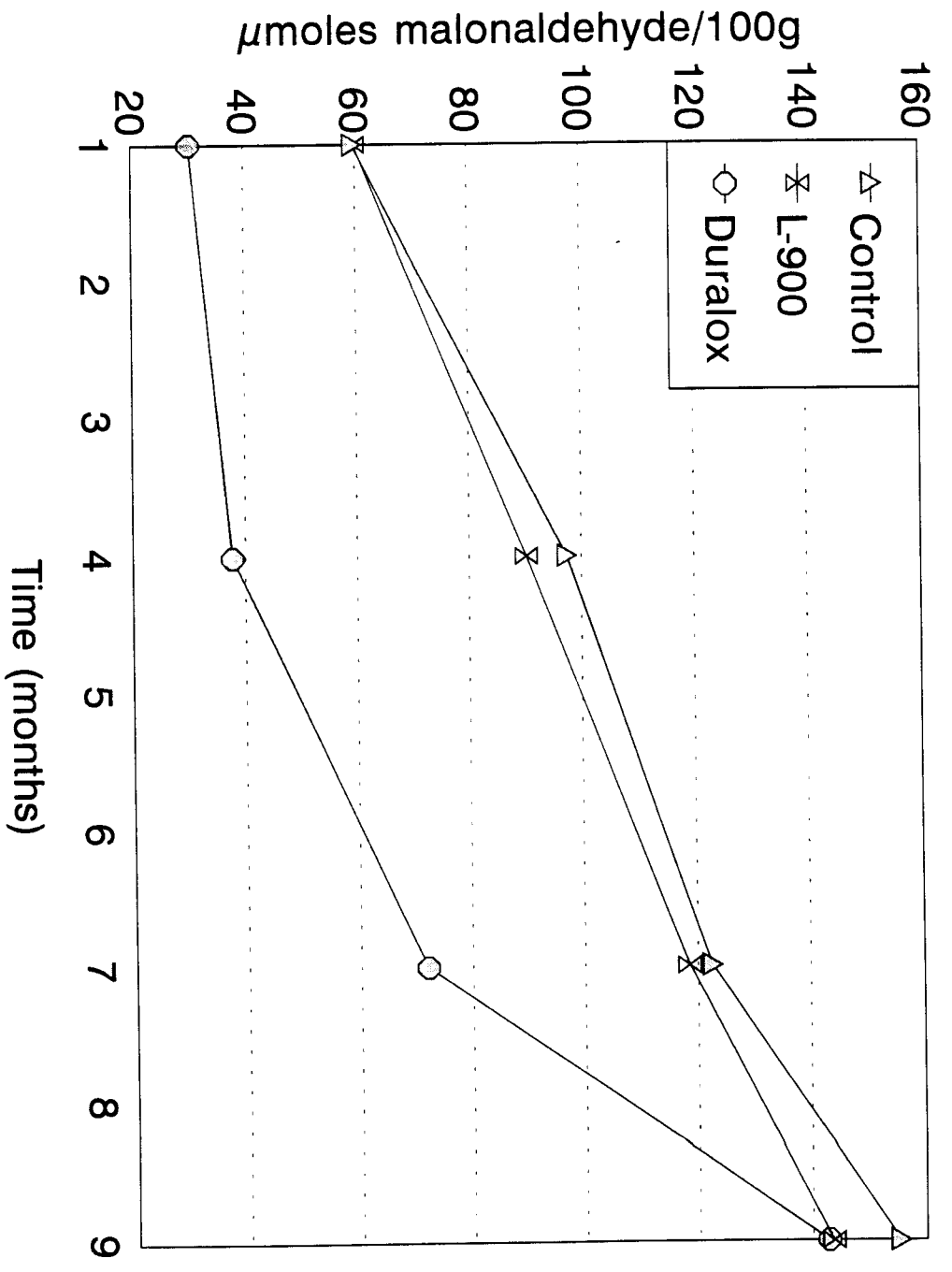


Figure 3. TBA Values for Reprocessed Mince Blocks