Quality Comparison of Thermoprocessed Fishery Products in Cans and Retortable Pouches

S. S. Chaia, R. C. Baker, and J. H. Hotchkiss

ABSTRACT

The physical, chemical and sensory properties of rainbow trout, pollock and shrimp processed at equal lethality in cans and retortable pouches were compared at 51 storage periods. Pouched rainbow trout, pollock and shrimp required respectively 34%, 32% and 37% less thermal processing time than the canned products. The pouch products had lower amounts of ammonia, trimethylamine and total carbonyl compounds than the canned products. The pouch products retained 17%, 9% and 15% more Vitamin B1 than the canned products for rainbow trout, pollock and shrimp, respectively. Pouched products had a firmer texture and lighter color than the canned products. In sensory evaluations, the pouch products were scored higher, in most cases, for color, flavor and overall acceptability.

INTRODUCTION

The research efforts of several workers (Hu et al., 1955; Pflug et al., 1963; Goldfarb, 1970; Trope and Amsden, 1972; Tung et al., 1975; Lyon and Klose, 1981) have shown the technical and commercial feasibility of using the retortable pouch for thermoprocessed foods. Because of the advantages of retortable pouches such as shelf stability, weight, storage space, ease of opening and preparation, reduced heat exposure resulting in improved quality and eventually packing economy, several researchers have reported the desirability of using retortable pouches for various products.

Heidaubaug and Karel (1970) utilized 0.5 ml polyester/3 mil aluminum foil/2 mil polyethylene, metal cans and two plastic films as packaging materials to compare chemical and sensory characteristics of crabberry sauce, vegetable with bacon mixture and pork with pork broth. For crabberry sauce there was no significant difference in sensory scores or the destruction rate of ascorbic acid in the pouch and canned products after 24 wk of storage. Similar findings were reported for the vegetable with bacon mixture and the pork samples except that the pouch products showed a lower degree of oxidation measured by the thiobarbituric acid test (TBA) and peroxide values. Szczelkowski (1971) studied various meats in retortable pouches for military rations and found there were no significant changes in product quality over a 2 yr period at 21°C or even at 38°C for 12 months. Dymit (1973) reported that after 8 yr, shrimp in retortable pouches were superior in flavor and color to canned products. Tung et al. (1975) compared cream style corn in pouches and cans over a 6 month storage period. They concluded that the pouch product was significantly lighter in color but found no significant difference in overall acceptability or storage stability. Tung et al. (1977) showed that corn in butternut sauce and other vegetable products processed in pouches were highly acceptable and had a normal storage stability. The corn product in pouches had a score of 77.7 out of 100 for overall acceptability, while a commercial frozen product was rated at about 50.

Greene (1979) showed that the shorter processing time of the retortable pouch was responsible for a greater retention of thiamin and riboflavin than canned sweet potato puree. He also found that the two packaging systems showed comparable stability characteristics for retaining nutrients during 24 wk of storage at room temperature. Gomez et al. (1980) compared mango slices processed in jars, boil-in-bag transparent pouches and retort pouches. They found that the retort pouch products retained quality better at 23°C and 10°C storage for 24 wk. Chen and George (1981) showed that green beans processed in cans retained slightly more ascorbic acid than in pouches. Similarly, benefits offered better ascorbic acid retention during 11 wk of storage at 21°C. However, the flavor, texture, and overall acceptability of the pouch products were better than the can but the color of the canned beans was preferred.

Lyon and Klose (1981) studied heat effects on sensory properties of chicken meat processed in retortable pouches and cans. They conducted the study with the Quantitative Descriptive Analysis technique to evaluate the samples and found the retort pouch chicken meat after heat processing showed less shredding, less stringiness and was less fibrous than the canned products. They concluded that the retort pouch process offered a method for improving the texture of processed chicken meat from spent hen by adequately cooking to tenderize the meat but not overcooking it to the extent that the meat chunks were reduced to fibrous, shredded or stringy pieces.

Relatively few comparisons of the retortable pouch and the tin-plated can, in terms of processing times required and product quality through storage, have been reported in the seafood area. This study was therefore undertaken with the objective of comparing the relative physical, chemical and sensory properties of three fishery products packaged and processed in retort pouches and cans as well as the relative storage stability of the products.

MATERIALS & METHODS

Rainbow Trout and pollock arrived gutted and unfiltered. The shrimp arrived shelled and frozen. Special arrangements were made with each source to secure product in the freshnest condition possible. All products were carefully inspected upon arrival, immediately washed and the fin fish filleted. All samples were randomly divided into two batches, one for canning and the other for pouch processing. The fillets of rainbow trout and pollock were precooked on a steam tray with steam for 10 min while the shrimp was precooked for 4 min. After precooking, the fish and shrimp were hand-filled without added liquid (170g for fish and 150g for shrimp) into cans (100 x 117, American Can Co.) and retortable pouches (6.5 in x 4 in, Reynolds Metals Co.). Residual air was removed from the pouch by vacuum prior to sealing. The cans were sealed with a Dixie Automatic Can Sealer. Both canned and pouch products were given a 100°C process (z = 181°F) at a retort temperature of 290°F (121°C). The thermal processing times were determined by the methods of Heidorn et al. (1968) using computer derived tables. The thermocouple was inserted at the center of the pouch and can. Time-temperature relationships were monitored by a strip-chart recorder (Honeywell, type 153) throughout the process. Cans were processed in a laboratory autoclave (Thermadry 60, Wilmot Castel, 1002 S. Sierra Lane Ave, Walnut, CA 91789).
FISH RETORTED IN POUCHES AND CANS...

Co.) and pouches in a modified pressure cooker (Fristo Co., Model No. 21-B) under 100% steam. Nitrogen overpressure was added during cooling. Pouches were loaded into a restraining rack (vertical position) with spacing.

Processed canned and pouched samples were stored at room temperature (23°C). Test periods for rainbow trout and pollock were immediately after processing, 60 and 120 days of storage; and for shrimp, immediately after processing and 90 days of storage. At least three cans and pouches were chosen at random and triplicates were run for each analysis. The raw and precooked fish and shrimp were also analyzed to serve as controls.

Chemical and physical analyses were undertaken on the edible solids after draining off the cook-out. Ammonia was determined by the method of Fernandez-Flores and Salvin (1969). The method of Murray and Gibor (1972) was used to analyze the trimethylamine. Quantification of total carbonyls was carried out using the procedure of Mai (1978). TBA values were determined by the method of Lemen (1975). Vitamin B1 was determined by the AOAC (1980) method.

Protein in the cook-out was determined by adding 20% trichloroacetic acid (TCA) and centrifugation for 10 min at 10,000 rpm at 2°C (Sorvall, SS34 rotor). The precipitate was weighed and the protein content of the precipitate was determined by kjeldahl (AOAC, 1975). The cook-out volume was determined by drainin the samples using a funnel containing a nylon screen (0.1 cm²) and a graduated cylinder. Total solids of well mixed cook-out were determined by oven drying (110°C). Sulfur precipitates were determined using the Kramer Shear Press (Model 434E) with a compression and shear cell. A maximum shear force (lb/g) was recorded using a texture gauge (Model T648, Food Technology Corp.). Changes in color were measured by the Hunter Color Difference Meter (Hunter Assoc. Inc.) equipped with a signal processor (Model D-29-2) and an optical sensor (Model D-25-6A).

The sensory quality of the products was evaluated by a panel of eight untrained persons. The samples were served warm in a coded aluminum dish. Water and crackers were provided to restore taste sensitivity. The room was darkened so that the panelist would not let color bias their judgments. Panelists were asked to assign a score of 1 to 9 to each sample for aroma, flavor, texture, juiciness, and overall acceptability, where 1 was least desirable and 9 most desirable. Except for tenderness and juiciness, where 5 was optimum, 9 too tender or juicy and 1 too tough or dry. Panelists then moved to a lighted area and were asked to evaluate desirability of color. Raw scores obtained from the panel for each attribute were analyzed by a Randomized Complete Block Analysis of Variance (RCB-ANV) and an F test was performed at P < 0.05 and P < 0.01 to determine if difference between treatment means existed.

RESULTS & DISCUSSION

FOR CANNED TROUT AND POLLOCK, the processing time was 50 min. For canned shrimp the processing time was determined to be 38 minutes. The shorter processing time for shrimp was due to the smaller quantity used (150g vs 170g) and the differences in heat transfer parameters. For canned products, the reduction of processing time for trout, pollock and shrimp was 32, 34, and 37%, respectively. The trimethylamine and increases in the area of the retort pouches are responsible for the reduction in the heating time. There is no information available on the heat processing time for these three products in pouches. However, reduction of heating time using pouches has been reported by a number of workers (Thierpe and Aniberton, 1972; Saigo et al., 1974; Tung et al., 1975; Lampi, 1977; Przybysz, 1980).

Heat processing caused an increase in the amount of ammonia in all products (Fig. 1). This agreed with the work done on canned albacore (Tokunaga, 1975), sardines (Ota and Nakamura, 1952) and herring (Hughes, 1959). Heat caused an increase in the rate of the breakdown of proteins, amino acids and other nitrogenous compounds such as nucleic acids and amines to free ammonia (Vyncke, 1970). Higher amounts of ammonia were observed in raw, canned and cooked pollock when compared to trout and shrimp. Canned samples had a higher amount of ammonia than the precooked samples for all three species tested (Fig. 1). However, the amount of ammonia in both canned and precooked products decreased with storage. With rainbow trout, there was a sharp decrease in ammonia in the initial 30 days storage period, and additional storage for 60 days produced little change. Both pollock and shrimp followed the same trend as trout during storage. The decrease in ammonia content for the stored product could be due to the solubilization of ammonia from the fish into the cook-out.

The amount of trimethylamine (TMA) in raw, canned and pouched pollock and shrimp was determined (Table 1). Although the significance of TMA is subject to controversy, it is generally thought to be a fairly good indicator of freshness in fish (Gould and Peters, 1971). However, shrimp generally contain much less TMA than raw fish in the Gadoid family (pollock) and TMA content may not be a good indicator of freshness for shrimp. In our work, the shrimp showed an increased amount of TMA in canned and pouched

<table>
<thead>
<tr>
<th>Fish species</th>
<th>Raw</th>
<th>Precooked</th>
<th>After Processing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollock</td>
<td>39.3</td>
<td>4.2</td>
<td>27.2</td>
</tr>
<tr>
<td>Shrimp</td>
<td>5.4</td>
<td>10.9</td>
<td>22.3</td>
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</table>

<table>
<thead>
<tr>
<th>Storage time (days)</th>
<th>C</th>
<th>P</th>
<th>C</th>
<th>P</th>
<th>C</th>
<th>P</th>
<th>C</th>
<th>P</th>
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<tbody>
<tr>
<td>60</td>
<td>24.3</td>
<td>24.5</td>
<td>15.5</td>
<td>11.5</td>
<td>25.2</td>
<td>26.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>120</td>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

*Each value is the mean of at least three determinations; C = Canned sample; P = Pouched sample.
products following heat processing. This increase in TMA agreed with the work of Hughes (1959) and Tokunaga (1975). For pollock, there was a decrease in TMA content which was probably due to volatilization during the longer precocooning with steam. Nevertheless, canned products which were heat processed for longer periods of time showed a higher amount of TMA than pouched samples. There was no significant change in TMA content in the canned and pouched pollock at 120 days of storage, but the shrimp showed a slight increase in TMA content at 90 days of storage.

The amount of carbonyl compounds including volatiles and non-volatiles was measured for raw, canned and pouched fish and shrimp products (Table 2). The raw pollock and raw shrimp contained a higher concentration of carbonyl compounds than raw trout. Following heat processing, an increase in carbonyl content was observed in both the canned and pouched products of rainbow trout and shrimp. This is in agreement with Lovern (1970) who showed that cooking of fish increased the carbonyl compound content. The increase was greater in the canned products than in the pouched which was probably related to the longer heating of the cans. However, a decrease in carbonyl was observed in the processed pollock as compared to the raw pollock; thus it is difficult to conclude that heating solely caused an increase in carbonyl compounds. This may be related to loss of moisture and concomitant dissolution of carbonyl in the liquid. Nevertheless, the canned pollock showed a higher carbonyl content than the pouched.

Malonaldehyde content was determined by the thiobarbituric acid (TBA) procedure on raw, canned and pouched fish and shrimp. Heat processing resulted in a decrease in TBA values in the canned and pouched samples. For example, raw rainbow trout had a TBA value of 0.67 μmole malonaldehyde/100g of tissue which decreased to 0.32 μmole in canned samples after processing, approximately a 50% reduction. The pouched products showed a smaller reduction. Results with pollock and shrimp were similar. Siewhuber and Yu (1958) also showed that processing of fish caused a rapid drop in TBA values. Higher values were observed in raw rainbow trout samples, probably due to the higher fat content. During storage, canned samples had a faster rate of increase in TBA values compared to the pouched samples. This is likely due to the presence of more space or more residual oxygen in the cans.

Vitamin B₁ (thiamin) content was measured using the raw and precocooned canned and pouched samples (Table 3). Rainbow trout contained 0.18 mg of thiamin per 100g of raw flesh; the precocooned samples contained 0.14 mg of thiamin showing a 22% reduction in Vitamin B₁ due to precocooning. After heat processing, the canned and pouched samples retained about 50 and 67% of Vitamin B₁, respectively.

The storage studies of Vitamin B₁ of rainbow trout in cans and pouches showed that the canned samples had about the same rate of loss of Vitamin B₁ as the canned samples during the 120 days of storage. The differences in Vitamin B₁ retention were due to the difference in heating time rather than the effect of storage. The results with pollock and shrimp showed a similar trend, but the relative values were different (Table 3).

There is very little data concerning the change in Vitamin B₁ content due to processing and storage on the specific species of fish studied. However, Komato et al. (1956) reported that canned mackerel and tuna showed no loss in riboflavin, niacin, and B₁₂, while a considerable amount of thiamin was lost. Igiisama (1963) reported a loss of 70% of the thiamin in the canning of tuna. He also found that about 50% of the thiamin was lost after sterilization. During storage for 1, 3, and 5 months, it was found that the canned tuna retained 50.6, 43.9, and 40.3% of thiamin, respectively. The canning of swordfish resulted in a 75% loss of thiamin as reported by Lovern (1948). Gordon et al. (1979) showed a 40% reduction of thiamin content in cooked shrimp and 68% in canned shrimp.

The cook-out or "pot liquor" was analyzed for volume.

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**Table 2**—Effect of processing and storage on total carbonyl content

<table>
<thead>
<tr>
<th>Fish species</th>
<th>Raw</th>
<th>Precocooned</th>
<th>After Processing</th>
<th>Storage time (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>C</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P</td>
<td>C</td>
</tr>
<tr>
<td>Rainbow Trout</td>
<td>27.2</td>
<td>–</td>
<td>45.1</td>
<td>43.6</td>
</tr>
<tr>
<td>Pollock</td>
<td>69.5</td>
<td>43.2</td>
<td>42.1</td>
<td>39.8</td>
</tr>
<tr>
<td>Shrimp</td>
<td>41.8</td>
<td>60.6</td>
<td>60.6</td>
<td>57.3</td>
</tr>
<tr>
<td>Total carbonyl content (μmol carbonyl/100g)</td>
<td>55.1</td>
<td>51.1</td>
<td>–</td>
<td>30.4</td>
</tr>
</tbody>
</table>

*Each value is the mean of at least three determinations; C = Canned sample; P = Pouched sample.

**Table 3**—Effect of processing and storage on vitamin B₁ content

<table>
<thead>
<tr>
<th>Fish species</th>
<th>Raw</th>
<th>Precocooned</th>
<th>After processing</th>
<th>Storage time (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>C</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P</td>
<td>C</td>
</tr>
<tr>
<td>Rainbow Trout</td>
<td>0.18</td>
<td>0.14</td>
<td>0.09</td>
<td>0.12</td>
</tr>
<tr>
<td>Pollock</td>
<td>0.17</td>
<td>–</td>
<td>0.09</td>
<td>0.11</td>
</tr>
<tr>
<td>Shrimp</td>
<td>0.02</td>
<td>0.017</td>
<td>0.004</td>
<td>0.007</td>
</tr>
<tr>
<td>Rainbow Trout</td>
<td>100</td>
<td>77.8</td>
<td>50.0</td>
<td>66.7</td>
</tr>
<tr>
<td>Pollock</td>
<td>100</td>
<td>85</td>
<td>52.9</td>
<td>61.1</td>
</tr>
<tr>
<td>Shrimp</td>
<td>100</td>
<td>85</td>
<td>21.4</td>
<td>35.7</td>
</tr>
<tr>
<td>% Retention (based on raw material)</td>
<td>38.9</td>
<td>55.6</td>
<td>–</td>
<td>33.3</td>
</tr>
<tr>
<td>Vitamin B₁ (mg/100g wet)</td>
<td>–</td>
<td>0.06</td>
<td>0.08</td>
<td>–</td>
</tr>
<tr>
<td>% Retention (based on processed material)</td>
<td>77.8</td>
<td>83.8</td>
<td>–</td>
<td>65.7</td>
</tr>
</tbody>
</table>

*Each value is the mean of at least three determinations; C = Canned sample; P = Pouched sample.
FISH RETORTED IN POUCHES AND CANS...

total solids and protein content. In all products, the volume of cook-out did not change with the method of processing or storage time. The solids content of the cook-out from the pouched and canned products was about the same for a given product up to 60 days of storage. The volume for the finish was 18–28 ml, and for the shrimp 28–30 ml. However, longer storage periods (120 days) resulted in an increase in the solids and protein content of the cook-out. In general, the protein content of the cook-out from the canned products was higher (by 3–7% of dry solids) when compared to the pouched products.

In general, precooking and processing of all products increased firmness as shown in Fig. 2, 3 and 4. Trout (Fig. 2) and pollock (Fig. 3) had similar shear values when raw and both products increased to a similar firmness after processing and maintained these values during storage. Raw shrimp (Fig. 4) had considerably higher shear values than the finish. Precooking and processing only slightly increased this firmness. All products demonstrated small increases in shear values during storage.

In all cases, the pouch fish products were firmer than the same products in cans. This was especially true for shrimp (Fig. 4). Canned shrimp decreased in shear values from 7.56 after precooking to 4.75 after processing. The pouched product decreased only slightly after processing and after 90 days storage increased to a value somewhat higher than the precooked shrimp. As would be expected, increased heat inputs for canned products results in a less firm, softer product.

Color measurements showed that the canned samples were generally darker in color than the pouched samples. Longer heat processing with the canned products may have caused an increase in browning reactions which were responsible for the darker color. Storage did not affect the color in the canned or pouch samples.

The sensory ratings of each product in cans were compared to the same product in pouches immediately after processing as well as during storage (Tables 4, 5 and 6). In general, statistically significant differences between the can and pouch were seen most often in flavor followed by color. In all cases where there was a significant difference in flavor or color, the pouch was judged more desirable than the same product processed in the can. We believe that these data support the physical and chemical data presented above and are a result of the lower heat input necessary for products processed in pouches.

The overall acceptability of the finish products was judged significantly higher in the pouch in two of six tests. This failure to consistently rate one container over the other, even though there were substantial differences, may be due to the fact that the panelists evaluated acceptability in terms of past experiences with canned tuna. This was not the case with shrimp; in all cases shrimp in the pouch was
Table 4—Effect of heat processing and storage on sensory evaluations of rainbow trout

<table>
<thead>
<tr>
<th>Sensory Attributes</th>
<th>Mean scores</th>
<th>Storage time (days)</th>
<th>Mean scores</th>
<th>Storage time (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>P</td>
<td>60</td>
<td>120</td>
</tr>
<tr>
<td>Color</td>
<td>6.79</td>
<td>6.86</td>
<td>6.0*</td>
<td>7.50*</td>
</tr>
<tr>
<td>Aroma</td>
<td>4.43</td>
<td>4.07</td>
<td>4.19</td>
<td>4.31</td>
</tr>
<tr>
<td>Flavor</td>
<td>6.57</td>
<td>6.64</td>
<td>5.19**</td>
<td>6.75**</td>
</tr>
<tr>
<td>Tenderness</td>
<td>5.36</td>
<td>5.53</td>
<td>5.19</td>
<td>5.0</td>
</tr>
<tr>
<td>Juiciness</td>
<td>4.93*</td>
<td>5.63*</td>
<td>4.44</td>
<td>3.38</td>
</tr>
<tr>
<td>Overall acceptability</td>
<td>5.71</td>
<td>6.43</td>
<td>5.44**</td>
<td>6.38**</td>
</tr>
</tbody>
</table>

*Mean ratings using a sensory evaluation scale where 1 is least desirable and 5 is the most desirable except for tenderness and juiciness where 6 is optimum, 9 is too tender or too juicy and 1 is too tough or dry. C = Canned product; P = Pouched product.

**Differences between cans and pouches which received the same treatment and are underlined where statistically significant.

Table 5—Effect of heat processing and storage on sensory evaluations of pollock

<table>
<thead>
<tr>
<th>Sensory Attributes</th>
<th>Mean scores</th>
<th>Storage time (days)</th>
<th>Mean scores</th>
<th>Storage time (days)</th>
</tr>
</thead>
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<tr>
<td></td>
<td>C</td>
<td>P</td>
<td>60</td>
<td>120</td>
</tr>
<tr>
<td>Color</td>
<td>5.38</td>
<td>6.63</td>
<td>5.50</td>
<td>7.50*</td>
</tr>
<tr>
<td>Aroma</td>
<td>4.38</td>
<td>4.31</td>
<td>4.56</td>
<td>3.86</td>
</tr>
<tr>
<td>Flavor</td>
<td>4.88</td>
<td>6.19</td>
<td>5.13</td>
<td>7.06</td>
</tr>
<tr>
<td>Tenderness</td>
<td>5.56</td>
<td>4.94</td>
<td>4.88</td>
<td>4.94</td>
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<tr>
<td>Juiciness</td>
<td>4.63</td>
<td>4.13</td>
<td>4.16</td>
<td>3.94</td>
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<tr>
<td>Overall acceptability</td>
<td>5.53</td>
<td>6.07</td>
<td>4.88</td>
<td>6.55</td>
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</table>

*Mean ratings using an evaluation scale where 1 is least desirable and 5 is the most desirable except for tenderness and juiciness where 6 is optimum, 9 is too tender or too juicy and 1 is too tough or dry. C = Canned product; P = Pouched product.

**Differences between cans and pouches which received the same treatment and are underlined where statistically significant (P < 0.05).

Table 6—Effect of heat processing and storage on sensory evaluations of shrimp

<table>
<thead>
<tr>
<th>Sensory Attributes</th>
<th>Mean scores</th>
<th>Storage time (days)</th>
<th>Mean scores</th>
<th>Storage time (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
<td>P</td>
<td>90</td>
<td>C</td>
</tr>
<tr>
<td>Color</td>
<td>5.50*</td>
<td>7.38*</td>
<td>6.13</td>
<td>6.63</td>
</tr>
<tr>
<td>Aroma</td>
<td>5.58**</td>
<td>6.50**</td>
<td>6.38</td>
<td>6.69</td>
</tr>
<tr>
<td>Flavor</td>
<td>6.75*</td>
<td>6.75*</td>
<td>6.56*</td>
<td>6.50**</td>
</tr>
<tr>
<td>Tenderness</td>
<td>5.81</td>
<td>5.5</td>
<td>5.81</td>
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<tr>
<td>Juiciness</td>
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<td>5.06</td>
<td>4.44</td>
<td>4.63</td>
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<tr>
<td>Texture acceptability</td>
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<td>6.05</td>
<td>5.05</td>
<td>5.06</td>
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<tr>
<td>Overall acceptability</td>
<td>5.63*</td>
<td>6.38**</td>
<td>5.60*</td>
<td>6.19**</td>
</tr>
</tbody>
</table>

*Mean ratings using an evaluation scale where 1 is least desirable and 5 is the most desirable except for tenderness and juiciness where 6 is optimum, 9 is too tender or too juicy and 1 is too tough or dry. C = Canned product; P = Pouched product.

**Differences between cans and pouches which received the same treatment and are underlined where statistically significant (P < 0.05).

CONCLUSIONS

In conclusion, this study pointed out that there is a significant reduction in the thermal processing time required to achieve an equal lethality for retortable, canned, poached fish products when compared to cans containing equal weights of product. This reduced processing time has important benefits. Heat sensitive vitamins are less liable to be destroyed or solubilized during processing and there is less chance of developing heat damage which can reduce the overall quality of the food. Chemical, physical, and sensory information was obtained for both canned and poached products. A comparison of this information showed that the retortable canned product had better nutrient retention with respect to Vitamin B1, was firmer in texture, and were lighter in color. In sensory evaluations, the panelists scored the canned products higher, though not always significantly, in flavor and overall acceptability. The poaching process produced smaller amounts of off-flavor compounds (N3H3T, MA, carbonyls) than the canning process. And finally, poached products had at least the same storage stability as canned products. We conclude that retortable canned fish products are shelf-stable fish products with a quality that is equal to, and often better than that of canned products.

REFERENCES


FISH RETORTED IN POUCHES AND CANS... From page 1525


The authors thank The New York Sea Grant Institute and National Fisheries Institute for their support. Thanks are also extended to F.L. Goldsferk (Reynold Metals Co.) for his contribution of packaging materials and to E. Elime (Idaho Valley Trout Farm) and D. Tealroy (Sunset Packing Corporation) for their contribution of trout and shrimp.

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Received 1/18/82; revised 5/18/83; accepted 5/21/83.