# Quality of Squid, *Illex illecebrosus*, Mantles Canned in Oil

BOHDAN M. SLABYJ, GORDON E. RAMSDELL, and RUTH H. TRUE

*ABSTRACT—Squid,* Illex illecebrosus, *mantles with skin removed were canned in oil, using quarter-pound aluminum sardine cans. The product had a good appearance, a mild flavor, and a firm texture; however, the mantles required blanching prior to canning. Ten minute blanching in 3 percent boiling brine resulted in about 45 percent shrinkage. Addition of polyphosphate to the blanch water did not reduce shrinkage. Presence of citric acid in blanch water or the use of different oils in the can did not improve the quality of the canned mantle strips. Frozen storage temperature (-23° and -40°C) of the raw material had no significant effect on the quality of the canned product. Squid mantle strips canned in oil had an acceptable shelf life.*

The authors are with the Department of Food Science, University of Maine, Orono, ME 04469. Views or opinions expressed are those of the authors and do not necessarily reflect the position of the National Marine Fisheries Service, NOAA.

## Introduction

Squid meat is equal to fish meat in protein content (16-20 percent) and amino acid composition and can be considered as an excellent source of protein (Takahashi, 1965). Compared with other marine animals eaten by man, squid provide a relatively higher yield of edible parts. With vertebrate fishes, the recoverable edible portion ranges from 20 to 50 percent; and in the commonly eaten shellfish, the edible parts are from 20 to 40 percent. In squid, the edible portion, which consists of the mantle, fins, and tentacles, is from 60 to 80 percent of the weight of the animal, depending on the species and its size (Ampola, 1974). In this period when more abundant food resources are urgently needed, it is time for concerted action for the utilization of squid in the United States.

The utilization of squid from the New England squid fishery has been limited to supplying bait for domestic fishing or frozen whole for sale on foreign markets. For centuries, squid have been used as an important and palatable source of food in the countries bordering the Mediterranean Sea and in the Orient. There has been considerable market resistance on the part of the U.S. consumer who has been slow to try nontraditional seafoods. The present day U.S. consumer is well oriented to processed foods and will accept a growing variety of foods if they are made ready for use either through the canning or freezing process. Frozen breaded squid shows promise as a consumer item. Studies by marketing personnel of the National Marine Fisheries Service and by personnel at the NMFS Northeast Utilization Research Center indicate excellent acceptance of this product (Ampola, 1974).

The only commercially canned squid product produced in the United States is canned with or without its ink in brine, in oil, and in tomato sauce and this is used essentially in ethnic markets (Ampola, 1974). A satisfactory canned squid product must be developed as frozen foods cannot serve the needs of all merchandizing and consumption patterns. The canning of squid will require considerable research to determine portions of squid and processing procedures that will result in an acceptable consumer product. We believe that canning of squid must follow the direction of the frozen squid industry and utilize selected portions of the squid.

The objectives of this investigation were to examine the extent of shrinkage during thermal processing of squid mantles, to evaluate the quality of canned mantle strips, to determine the shelf life of the canned product, and to examine the effect of preprocess frozen storage conditions on the quality of the canned material.

## Materials and Methods

Fresh squid, *Illex illecebrosus,* were obtained from a fisherman on the day of catch or on the second day of catch from a processor. At all times the squid were iced well. Frozen squid were obtained in 4.54 kg (10-pound) blocks measuring 6.4 ×23.5×31.8 cm (2.5×9.25×12.5 inches) which were blast frozen by the processor at -34.4°C (-30°F) and stored at -20.5° to -23.3°C (-5° to -10°F) for 1 month before purchase. In the laboratory the frozen squid were thawed for 24 hours at 7.2°C (45°F) before being taken to the pilot plant for further processing.

Commercially frozen squid were used to determine the effect of polyphosphate on shrinkage. The effects of citrate and frozen storage on the quality of the canned product were also studied using commercially frozen squid. The remainder of the experiments were performed using fresh squid.

Cleaned squid mantles with fins and skin removed were blanched in a boiling solution of 1 and 3 percent NaCl with or without sodium tripolyphosphate or citric acid. The mantles were cooled, cut in 1.5 cm wide strips, placed in rectangular aluminum cans (405×301×014.5 inches) and 20 ml of oil were added. The cans were sealed without vacuum and retorted 45 minutes at 115.5°C (240°F).

Shrinkage was determined on large samples (about 3 kg) and dry weight on several small samples (about 100 g) by weighing before and after blanching and retorting. Vacuum ovens at 70°C were used for drying.

Heat penetration was determined by inserting flexible thermocouples in a squid mantle strip located in the geometric center of the can and recording the temperature of the different cans at 15-second intervals, using a Minneapolis-Honeywell[1] multipoint recorder (Model 153×64P16-X-41). Eight thermocouples were used to monitor the canned material and two to monitor the retort. The cycle was repeated at 4-minute intervals. Process time was calculated using the heat penetration data of the coldest can according to the formula method of Ball (National Canners Association, 1968).

Bellows-Valvair hydraulics (Model DC-50A) equipped with a 100-pound transducer (Daytronic Corp., Model 152A), and X-Y recorder (Mosley, division of Hewlett-Packard, Model 135A), and a single blade shear cell (Food Technology Corp., Model CA-1) were used to determine texture of 6 cm long mantle strips (raw and processed).

Coded samples were presented in a randomized complete block design with three replications to a sensory panel of six members. Appearance, odor, and flavor were evaluated on a 6-point scale with 5 representing the best quality product and 2 or less denoting unacceptable samples. Texture was scored on a 5-point scale, with 3 representing the best texture, 5 indicating tough tissue, and 1 indicating very soft mantles.

[1]Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

## Results and Discussion

Yield data for various anatomical parts of squid, *Illex illecebrosus,* are given in Table 1. The edible parts, which include mantles, fins, and tentacles, represent about 66 percent of the total weight of squid. The total edible portions (62 percent) reported by Schwartz (1972) as well as individual weights (33, 9, and 20 percent) of various anatomical parts (mantle, fins, and tentacles, respectively) compare closely with the data presented here. Data reported by Berk (1974) were significantly higher for total edible parts (75 percent) for the same species of squid caught off the New England coast. This difference is due to heavier mantles (47 percent) and fins (14 percent), but the tentacles accounted for a smaller portion of the total weight (14 percent). Estimate of edible parts of squid excludes the weight of the head, although in practice the consumer is known to remove the eyes, beak, and cartilage from the head portion, thus recovering additional edible meat.

### Shrinkage During Thermal Processing

Packing raw mantle strips in oil and retorting 35 minutes at 115.5°C (240°F) resulted in a 38 percent shrinkage. (Heat penetration of this pack was performed in this laboratory; $f_h$ = 10.0 minutes.) A similar loss in weight (31 percent) was reported by Berk (1974) for mantles canned in 2 percent brine using No. 1 picnic cans and retorting 40 minutes at 115°C (239°F). Since the above product was not acceptable for commercial markets due to excessive shrinkage, Berk (1974) recommended a 2-minute blanch at 65°C prior to canning. This investigator reported a 6 percent shrinkage during blanching and an additional 10 percent shrinkage during canning with an overall loss of 15 percent of the total weight. Heating mantle strips to an internal temperature of 65°C for 2 minutes was observed in the present study to result in a 33 percent shrinkage, with an additional weight loss of 34 percent during retorting. Such a product was not considered acceptable and a 10-minute blanch in boiling 3 percent brine reported by Schwartz (1972) was adopted. This procedure resulted in a product which underwent minimal additional shrinkage during retorting.

A 10-minute blanch in 3 percent boiling brine was reported to result in a 37-56 percent shrinkage, depending on preprocess holding conditions (Slabyj and True, 1980). It is important to note that during blanching 15-42 percent of the dry weight of tissue is lost in the blanch water.

To evaluate the effect of polyphosphates on weight loss during blanching and subsequent canning,

**Table 1.—Percent yield of anatomical parts of squid, *Illex illecebrosus*.**

| | September 1977 | | October 1977 | | November 1977[1] | | August 1977[1] | |
|---|---|---|---|---|---|---|---|---|
| Anatomical parts | Percent | SD | Percent | SD | Percent | SD | Percent | SD |
| Mantle | 33.1 | 2.0 | [2]32.6 | 2.8 | 36.3 | 3.0 | 35.8 | 0.9 |
| Fins | 11.4 | 0.6 | [2]9.4 | 0.8 | 10.2 | 1.1 | 10.7 | 0.6 |
| Tentacles | 22.4 | 2.0 | 22.1 | 2.9 | 20.7 | 2.2 | 25.4 | 2.3 |
| Head | 18.1 | 0.6 | 14.7 | 1.7 | 13.6 | 0.6 | 14.1 | 1.4 |
| Viscera | 14.1 | 2.1 | 15.3 | 2.1 | 20.1 | 3.6 | 12.5 | 2.0 |
| Skin | — | | 2.8 | 0.4 | — | | — | |
| Pen | 0.21 | 0.2 | 0.18 | 0.02 | — | | — | |
| Mantle length (cm) | 26.5 | — | 25.9 | 1.6 | 25.9 | 2.3 | 24.7 | 1.4 |
| Individual weight (g) | 420.1 | 39.4 | 375.9 | 62.6 | 422.1 | 90.3 | 364.0 | 39.6 |
| Determinations | 6 | | 12 | | 6 | | 5 | |

[1]Frozen squid.
[2]Skinned.

blanch waters containing 1 and 3 percent NaCl with 0, 0.3, and 1.0 percent sodium tripolyphosphate (FREEZ GARD FP-19) were used (Table 2). There was no noticeable change in shrinkage due to the phosphate concentration either during blanching or subsequent canning. However, squid mantles blanched in 1 percent brine lost on the average 37 percent of the total weight as compared with those blanched in 3 percent brine which lost 48 percent. The advantage in yield noticed when blanching in 1 percent brine is lost during canning. Additional shrinkage during canning was observed to be about 23 percent for mantles blanched in 1 percent NaCl solution, as compared with 11 percent for mantles blanched in 3 percent brine. The use of polyphosphates and different concentrations of salt in blanch waters had no significant effect on the loss of dry material during blanching, which varied between 24 and 32 percent (Table 2).

It may be of interest to indicate that commercially frozen squid held an additional 6 months at -23.3°C (-10°F) or -40°C (-40°F) were also examined. Samples held at -23.3°C lost 48±2 percent. This difference was not significant at the 5 percent level.

**Table 2.—Effect of polyphosphate and salt concentration in blanch waters on shrinkage and loss of dry weight of squid, *Illex illecebrosus*, mantles.**

| 1 percent NaCl | | | 3 percent NaCl | | |
|---|---|---|---|---|---|
| Polyphosphate | | | Polyphosphate | | |
| 0 | 0.3 | 1.0% | 0 | 0.3 | 1.0% |
| *Shrinkage due to blanching (%)* | | | | | |
| 37 | 35 | 39 | 48 | 46 | 49 |
| *Dry weight loss due to blanching (%)* | | | | | |
| 28 | 26 | 24 | 26 | 28 | 32 |
| *Shrinkage due to canning (%)* | | | | | |
| 23 | 25 | 22 | 10 | 13 | 11 |
| *Shrinkage due to blanching and canning (%)* | | | | | |
| 49 | 49 | 46 | 47 | 40 | 41 |

**Table 3.—Texture of skinned squid, *Illex illecebrosus*, mantles.**

| Item | Mantle thickness (mm) | Shear force[1] (kg/6 cm strip) | No. of determinations |
|---|---|---|---|
| Raw | 4-5 | 51.10 (5.03) | 9 |
| Blanched | 3-4 | 9.21 (2.17) | 11 |
| Canned in oil | 3-4 | 9.20 (1.06) | 11 |
| Spanish oil pack | 5-10 | 4.80 (1.16) | 3 |

[1]Values in parentheses indicate standard deviation.

## Quality of Canned Mantles

The linear portion of the heat penetration curve for mantle strips sealed in aluminum cans had a slope of 17.8 minutes ($f_h$) for squid mantles blanched 10 minutes in boiling 3 percent brine. Using the formula method of Ball (National Canners Association, 1968) with $F = 4.5$ and $z = 18$, the process time was calculated to be 40 minutes. However, since the above product was of experimental nature and since Thermal Death Time Curves were not available, process time on routine basis was set at 45 minutes.

Raw squid mantle is somewhat textured, having a rubbery-like consistency, but becomes soft upon blanching (Table 3). Additional softening of tissue upon retorting has not been observed, although the texture of mantles in the Spanish oil pack is rather soft. The color of the raw, skinned mantle is cream-like, but becomes lighter in color during blanching, provided the skin has been removed prior to blanching. Blanching mantles with the skin on, does facilitate subsequent removal of the skin, but this procedure has an undesirable effect in that the red pigment of the skin permeates the mantle tissue.

Canning mantle strips in soybean oil results in light, cream-colored tissue, and a mild aroma. Prolonged holding of refrigerated, raw squid will result in a discolored product. Bruised tissue becomes strongly discolored during blanching and retorting. Also, it becomes tough in texture and develops a "dry" taste. It was noticed that a delay in canning blanched mantles will allow development of strong odors.

Canned squid mantle strips were firm in texture and had a mild flavor. Because of the mild flavor of the canned material, it was thought desirable to evaluate the quality of the product using various vegetable oils. Mantle strips canned in cottonseed, olive, and soybean oil, when examined by a panel of judges for appearance, texture, odor, and flavor, were noted not to be significantly different at the 5 percent level ($P < 0.05$). Spanish processors add citric acid to squid tissues when canning it in natural juices (Schwartz, 1972). To evaluate the effect of citric acid on the quality of the canned material, citric acid was added to the blanch water at different concentrations (0, 0.3, and 1.0 percent). Sensory evaluation of the canned material for appearance, texture, odor, and flavor revealed no significant difference among the treatment means ($P < 0.05$).

## Shelf Life of Canned Mantles

Shelf life of canned squid mantles was studied using mantles canned in soybean oil. The canned material was stored at 7.2°C (45°F) for 6 months, while control samples were held for the same period at 0°C (32°F). The average sensory score for odor, appearance, and flavor of cans held at 7.2°C was 4.26±0.12 (SD), while control samples received an average score of 3.91±0.18. The average sensory scores for texture of the two lots of cans were 3.44 and 2.84, respectively. Although samples stored at 7.2°C received noticeably higher scores, this difference for individual attributes (Duncan, 1955) was statistically not significant ($P < 0.05$).

An accelerated storage study was also performed by incubating the canned material at 37.8°C (100°F) for 3 months. The average sensory score for odor, appearance, and flavor for samples held at 37.8°C was 3.26±0.21, while the similar score for control samples was 3.15±0.36. Average texture scores for the above canned mantles were

3.08 and 3.29, respectively. Again, the statistical analysis of the data indicated that the judges did not detect quality differences between the treated and control lots of canned squid mantles ($P < 0.05$).

**Effect of Preprocess Frozen Storage**

The effect of frozen storage of raw material on the quality of squid mantles canned in oil has been investigated using squid which was held 6 months at -23.3°C (-10°F) and -40°C (-40°F). The canned product was examined by a panel of judges for odor, appearance, texture, and flavor. The average sensory score for odor, appearance, and flavor for samples held before canning at -10°C was $3.90 \pm 0.20$, while the average score for samples held at -40°C was $3.68 \pm 0.31$. The texture scores for the two lots were 4.13 and 4.38, respectively. Statistical analysis of the data detected no significant difference ($P < 0.05$) between the two treatments of the raw material, indicating the inability of the panelists to detect quality difference due to preprocess frozen storage conditions.


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