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Quality Changes of Canned Smoked-Oyster in Cottonseed Oil During Storage

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Quality changes of canned smoked-oyster in cottonseed oil (SOCO) were investigated to determine an optimal F_0-value (F_0) for microbiological safety and quality stability during long-term storage. The canned SOCOs were sterilized at 105℃, 110℃, and 115℃ with various F_0-values and stored at temperature range of 5℃~50℃. No remarkable quality changes in pH, content of amino nitrogen, acid value and thiobarbituric acid value of the canned SOCOs sterilized at 110℃ with $F_0 \geq 5.92$ min, were recognized at all storage temperatures. Same tendency was also recognized in the products sterilized at 105℃ and 115℃ with $F_0 = 5.50 \pm 0.1$ min and 6.50 ± 0.1 min, while those of the canned SOCOs sterilized at 110℃ with $F_0 < 5.92$ min altered remarkably.

Key words : quality change, canned smoked-oyster

Introduction

It is well known that thermal sterilization is one of the most energy consuming process in food industry. In the case of canning industry, the excessive heating is an important factor lowering the nutritive value and sensory quality of the products and also causing the price rising. Therefore, the process should be optimized in consideration of the relation between the degree of energy consumption and other factors, such as microbiological safety, nutritive value, and sensory quality of the product (Singh, 1979; Saguy and Karel, 1979; Barreiro et al., 1984; An et al., 1992; Cho et al., 1992; Jung et al., 1994; Han et al., 1994).

We suggested in the previous paper 6.0 min (exactly $F_0 \geq 5.92$ min) as a rational F_0-value criterion for the canned SOCO (Han et al., 1995). But in conventional canning procedure, the minimal microbiological safety of the canned SOCOs required by foreign buyers has been guaranteed only by thermal sterilization in saturated steam at 113.5℃ with the holding time more than 70 min. Under these conditions the F_0-value would be greater than 10 min (Han et al., 1995), and the corresponding holding time at 113.5℃ would be prolonged more than 30 min as compared with the case of the F_0-value of 5.92 min at 113.5℃.

But Tanikawa and Doha (1965) reported 60 min as general holding time for the canned SOCO at 109.9℃ in Japan. In a reviewing paper of Heiss and Eichner (1984), they suggested that the rational F_0-values for the canned Pacific oyster products were 2.7~6.0 min. From both reports, it was revealed that the canned SOCOs in Korea has been produced by excessive heating. Such excessive heating could lead low nutritive value and sensory quality as well as high production cost of the canned SOCOs. Therefore, we investi-

gated the relationship between the microbiological safety and the quality of the products during long-term storage with respect to the F_0-values to minimize the energy consumption and undesirable quality changes.

Materials and methods

Sample treatment : The SOCOs were obtained Jinyang Fishery Co. Ltd. (Geoje island, Kyoungnam) in March 1993 and from Yeonsung Corporation (Yeosu city, Jeonnam) in March 1994. The oyster (*Crassostera gigas*) cultured on the coastal area of the Korean southern sea was used as raw materials of the canned SOCO. Immediately after harvesting, the fresh oyster was shelled, smoked and packed in a hexahedron type can (106.2 mm×74.6 mm×22.0 mm) with the same procedure described in previous paper (Han et al., 1995). Packed samples were sealed on vacuum and then stored at −40℃.

Sterilization of the SOCO : The refrigerated cans were thawed in a temperature controlled water tank for approximately 4 hours to insure the homogeneity of the oyster temperature and then sterilized in a vertical still-retort equipped with lethal rate measuring system at different temperatures. The integrated lethal rate measured during the whole sterilizing process in every 0.2 sec was regarded as F_0-value (An et al., 1992; Cho et al., 1992; Han et al., 1995; Han and Kim, 1995). The sterilized canned SOCOs were then stored at different temperatures, and the quality changes during long-term storage were determined.

Analytical procedure : Contents of moisture, protein (N×6.25), lipid and ash were determined by the standard procedures of A.O.A.C. (1982). Contents of volatile basic nitrogen (VBN) and amino nitrogen (NH_2-N) were determined by the methods of Miwa and Iida (1973) and Spies and Chamber (1951), and the acid value (AV) and thiobarbituric acid (TBA) value were determined by the methods of A.O.A.C. (1982), respectively.

Counting, isolation and identification of viable cells were carried out by the methods of A.P.H.A. (1984), Gibbs and Skinner (1966), Harrigan and MaCnee (1976), Collins and Lyne (1976) and Bergey's Manual of Systematic Bacteriology (Kreig and Holts, 1984).

Results and discussion

Proximate composition of the SOCO : The proximate composition and some values of the canned SOCO before sterilization were shown in Table 1. The concentration of viable cell of the canned SOCO before sterilization was 3.3×10^4/g. Most of the them were putrefactive and also thermoduric or thermophilic bacteria (Han et al., 1995). The average VBN content of raw oyster sample was 7.2 mg/100g (Han et al., 1995), and it was increased slightly to 9.8 mg/100g during shelling, smoking and packing. It was considered that the VBN content was little enough to guarantee the freshness of the canned SOCO before steri-lization.

Quality changes of the canned SOCO sterilized

Table 1. Proximate composition, some chemical values and viable cell count of the canned SOCO before sterilization

Moisture	54.5%	pH	5.99
Crude Protein	15.3%	NH_2-N	38.0 mg/100g
Crude Lipid	19.8%	VBN	9.8 mg/100g
Crude ash	3.0%	Viable cell count	3.3×10^4/g

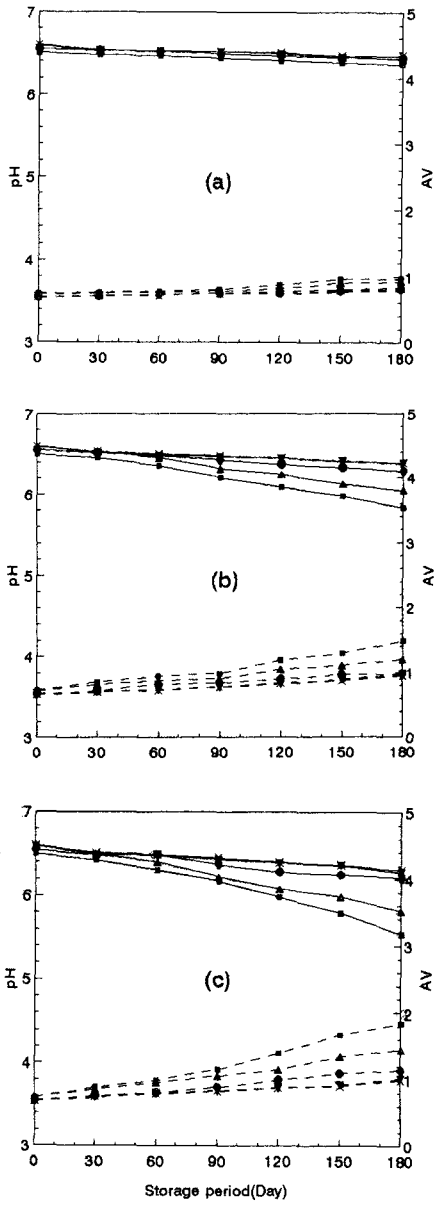

Fig. 1. Changes of pH(—) and AV(···) of the canned SOCO sterilized at 110℃ and stored at 5℃(a), 25℃(b) and 50℃(c).
■ : F_0=1.41 min, ▲ : F_0=3.09 min,
● : F_0=5.92 min, ▼ : F_0=9.42 min,
* : F_0=12.17 min

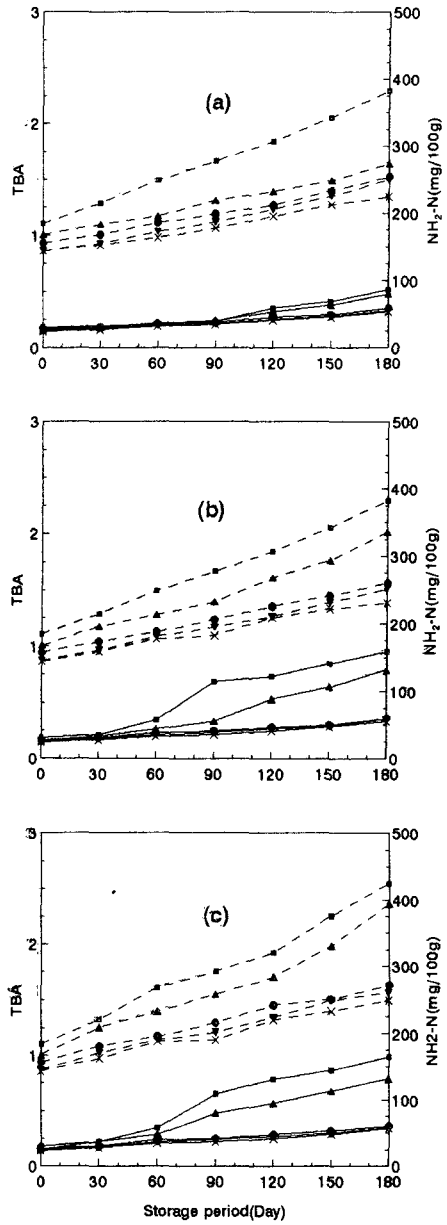

Fig. 2. Change of TBA values (—) and NH_2-N content (···) of the canned SOCO sterilized at 110℃ and stored at 5℃(a), 25℃(b) and 50℃(c).
■ : F_0=1.41 min, ▲ : F_0=3.09 min,
● : F_0=5.92 min, ▼ : F_0=9.42 min,
* : F_0=12.17 min

at 110℃ : Changes in pH and AV of the canned SOCOs sterilized at 110℃ were shown in Fig. 1. The pH values were declined slightly with increased storage temperatures. At 25℃ and 50℃, the changing degree of pH of the products with F_0=1.41 min and 3.09 min was a little greater than that with F_0=5.92 min, 9.42

min and 12.17 min. It was considered that the pH changes in the products with F_0<5.92 min and stored at higher temperatures might be caused by the growth of putrefactive microorganisms (Han et al., 19 95) which could survive after insufficient sterilization and produce acids. But no remarkable changes could be recognized in all products with $F_0 \geq 5.92$ min and stored for 6 months.

The AV of the canned SOCOs was increased slightly with increased storage temperatures. The AV changes in products with F_0<5.92 min and stored at higher temperatures were a little faster than those with $F_0 \geq 5.92$ min and stored at lower temperatures. These results meant that the acceptable F_0-value of the canned SOCO to lower the changes in pH and AV was 5.92 min.

The changes in TBA values, the indicative value of lipid oxidation, and NH_2-N content of the canned SOCOs for 6 months were shown in Fig. 2. The changing tendency of the TBA values was almost same as that of the AV. The TBA values of the products with F_0< 5.92 min were increased slightly at higher storage temperatures. But those of the products with $F_0 \geq 5.92$ min showed no remarkable changes at 5℃, 25℃ and 50℃. It was considered that the canned SOCOs with $F_0 \geq 5.92$ min were sufficiently retorted, and most of the TBA-reactive substances were decomposed (Lee et al., 1984). Jung et al., (1994) recognized same tendency in the canned tuna in cottonseed oil. They reported that the TBA value of constitutional tuna meat in oil declined rapidly with retorting time, but that of the added cottonseed oil increased only slightly.

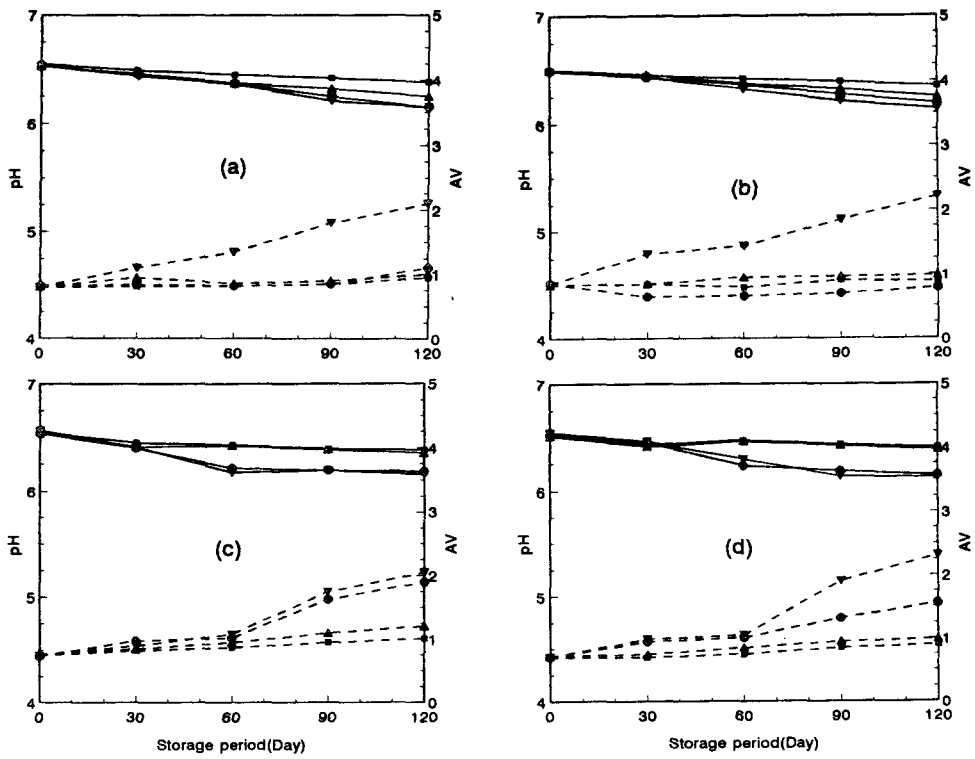

Fig. 3. Changes of pH(—) and AV(···) of the canned SOCO sterilized at 105℃ and 115℃.
(a) F_0=5.5 ± 0.1 min at 105℃, (b) F_0=6.5 ± 0.1 min at 105℃,
(c) F_0=5.5 ± 0.1 min at 115℃, (d) F_0=6.5 ± 0.1 min at 115℃.
■ : 18℃, ▲ : 25℃, ● : 37℃, ▼ : 50℃.

They could also recognize that the resulted TBA value change of the total oil in the canned tuna was negligible.

The contents of NH_2-N of the canned SOCOs were increased slowly under all storage conditions. The changes of NH_2-N contents of the products with $F_0<5.92$ min and stored at higher temperatures were faster than those with $F_0 \geq 5.92$ min and stored at lower temperatures. The changes in the products with $F_0 \geq 5.92$ min were much slower than those with $F_0<5.92$ min. Taguchi et al., (1982) and Cho (1993) could also recognize the same phenomena in the canned tuna meat in cottonseed oil. They suggested the thermal decomposition of proteins at higher temperatures as the reason of the changes.

From these results, we concluded that the reasonable F_0-value of the canned SOCO to lower the changes in TBA and NH_2-N was 5.92 min.

Quality changes of the canned SOCO sterilized at 105℃ and 115℃ : The quality stability is an absolute prerequisite of the low acidic canned foods. Above data showed that 5.92 min was a rational F_0-value for the canned SOCOs with respect to the microbiological safety and quality stability, and these results agreed well with those of Heiss and Eichner (1984) and Han et al. (1995). To investigate the quality stability in more detail, the canned SOCOs were sterilized at 105 ℃ and 115℃ with $F_0=5.50 \pm 0.1$ min and 6.50 ± 0.1 min and the quality changes of the products stored at 18~50℃ for 4 months were determined.

As shown in Fig. 3 and 4, the changing tendencies of each value were almost same as those of the canned SOCOs sterilized at 110℃. And no remarkable

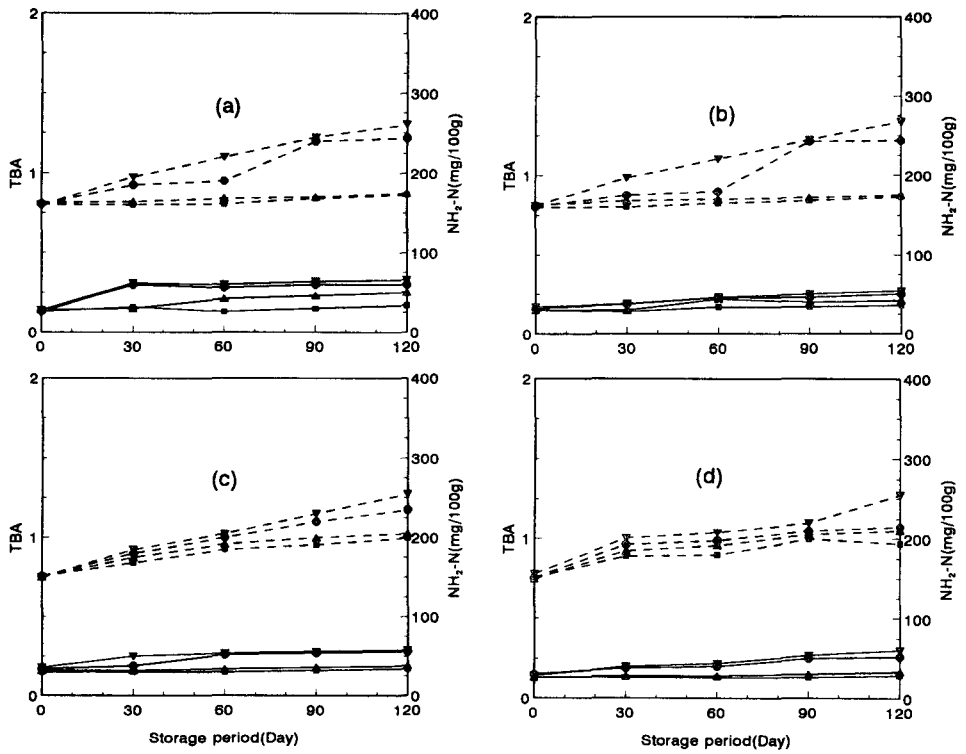

Fig 4. Changes of TBA (—) and NH_2-N content (···) of the canned SOCO sterilized at 105℃ and 115℃.
(a) $F_0=5.5 \pm 0.1$ min at 105℃, (b) $F_0=6.5 \pm 0.1$ min at 105℃,
(c) $F_0=5.5 \pm 0.1$ min at 115℃, (d) $F_0=6.5 \pm 0.1$ min at 115℃.
■ : 18℃, ▲ : 25℃, ● : 37℃, ▼ : 50℃.

Table 2. Changes of viable cell count in the canned SOCO during storage

F_0-values (min)	Storage Temp.(℃)	Storage days				
		0	30	60	90	120
3.09	5	-	-	-	>30	137
	25	-	-	>30	142	220
	50	-	130	320	440	1,800
5.92	5	-	-	-	-	-
	25	-	-	-	-	-
	50	-	-	-	-	-

differences in changes of each value were observed between the products sterilized with $F_0=5.5 \pm 0.1$ min and 6.5 ± 0.1 min.

In previous paper, we suggested 6.0 min as a reasonable F_0-value with respect to the microbiological safety of the canned SOCOs, as shown in Table 2. From this and above data, we could conclude again that 6.0 min was a rational F_0-value criterion for commercial sterilization of the canned SOCOs to insure the microbiological safety and quality stability.

Conclusion

Quality changes of the canned SOCOs were investigated to determine an optimal F_0-value to guarantee the microbiological safety and quality stability during long-term storage. The canned SOCOs were sterilized at the temperature range of 105℃~115℃ with various F_0-values and stored at the range of 5℃~50℃. No remarkable quality changes in pH, content of NH_2-N, AV and TBA value of the canned SOCOs sterilized at 110 ℃ with $F_0 \geq 5.92$ min were recognized at all storage temperatures. Same tendency was also recognized in the products sterilized at 105℃ and 115℃ with $F_0=5.5 \pm 0.1$ min and 6.5 ± 0.1 min, while those of the products with $F_0<5.92$ min at 110℃ changed markedly. Hence, it was considered that the rational F_0-value for the canned SOCO was 6.0 min.

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훈제 굴 통조림의 저장중의 품질변화

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훈제 굴 통조림의 가열살균기준 설정을 위하여 105℃~115℃의 온도범위에서 F_0-값을 달리하여 살균한 제품을 5℃~50℃의 서로 다른 온도에 저장하면서 품질의 안전성을 검토하였다. 110℃에서 F_0-값 5.92분 이상으로 살균한 제품은 6개월 동안의 저장에도 pH, 아미노질소의 양, 산가, 그리고 TBA-값에 거의 변화가 없었다. 온도 105℃ 및 115℃에서 F_0-값 5.50 ± 0.1분 및 6.50 ± 0.1분으로 살균하여 4개월 저장한 제품에서도 같은 결과를 확인하였다. 그러나 온도 110℃에서 F_0-값 5.92분 미만으로 열처리한 제품에서는 품질변화가 심하게 일어남이 확인되었다. 따라서 훈제 굴 통조림의 가열살균기준으로서는 F_0-값 6.0분이 적당한 것으로 판단되었다.