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DEVELOPMENT OF CANNED FISH IN TOMATO SAUCE
ENRICHED WITH FISH OIL :

III. Optimization of Canning Process and Safety
Assessment of the Product

PENGEMBANGAN PRODUK IKAN KALENG BERMEDIUM SAUS TOMAT
YANG DIPERKAYA DENGAN MINYAK IKAN

III. Optimasi Proses Pengalengan dan Pengujian Keamanan Produk

Hari Eko Irianto, Carmen C. Fernandez*) and G.J. Shaw **)

ABSTRACT : Screening experiment on the important factors in the processing of canned fish enriched with fish oil performed in the previous experiment indicated that sterilization time and salt level in the tomato sauce were required for further experiment.

Optimization of those two factors has been carried out in this experiment. The results showed that the sensory properties of the canned fish product were not pronouncedly affected by sterilization time and salt level in tomato sauce. However, the sterilization time significantly influenced the acceptability of fish flesh texture and bone softness. Meanwhile, the sterilization time also significantly affected the peroxide value of the tomato sauce, in which the longer sterilization time the lower peroxide value. Fish canned in 2.5% salt - tomato sauce had a significantly higher salt content than fish canned in 1.5% salt level - tomato sauce.

The experiment recommended to sterilize canned fish enriched with fish oil at 121.1°C for 50 minutes and the salt level in tomato sauce was 1.5%. Safety assessment test indicated that the product processed using those recommended conditions was found safe.

ABSTRAK : Penelitian sebelumnya yang dilakukan untuk menyeleksi faktor-faktor penting pada pengolahan ikan kaleng yang diperkaya dengan minyak ikan didapatkan bahwa lama proses sterilisasi dan jumlah garam yang ditambahkan pada saus tomat perlu diteliti lebih lanjut untuk memperoleh kondisi yang optimal.

Penelitian optimasi kedua faktor tersebut telah dilakukan di dalam kegiatan ini. Hasil penelitian menunjukkan bahwa lama sterilisasi dan jumlah garam yang ditambahkan pada saus tomat tidak berpengaruh nyata terhadap karakteristik daging ikan dan saus tomat. Tetapi lama sterilisasi mempengaruhi penerimaan panelis terhadap tekstur daging dan kelunakan tulang. Selain itu lama sterilisasi juga berpengaruh terhadap nilai peroksida saus tomat, yaitu semakin lama sterilisasi, semakin rendah peroksidanya. Ikan yang dikalengkan dengan menggunakan saus tomat yang ditambah 2,5% garam mempunyai kadar garam yang lebih tinggi dibandingkan dengan ikan yang dikalengkan di dalam saus tomat yang ditambah 1,5% garam.

Penelitian ini menyarankan untuk mensterilkan ikan kaleng yang diperkaya dengan minyak ikan pada temperatur 121,1°C selama 50 menit dan jumlah garam yang ditambahkan pada saus tomat adalah 1,5%. Hasil pengujian keamanan konsumsi menunjukkan bahwa produk ikan kaleng yang diolah dengan kondisi yang disarankan di atas adalah aman.

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INTRODUCTION

Screening experiment conducted by using Plackett and Burman experimental design of canned fish with disguised fish oil (Irianto *et al.*, 1993b). The experiment indicated that sterilization time needed a further experiment for optimization. Meanwhile, the sensory analysis showed the tomato sauce was too salty, so the salt level in the sauce was required to be optimized as well.

Before releasing the product to the market, the product has to undergo safety test, especially in terms of microbiological aspects. The canned fish must free from any viable spoilage and pathogenic microorganisms.

Regarding to the above problem, this experiment was set up with the aim to determine optimum sterilization time and salt level in tomato sauce as well as to investigate the product safety.

MATERIALS AND METHODS

1. Materials

Fish used as raw material in this experiment was New Zealand sardine/pilchard (*Sardinops neopilchardus*) supplied by Star Fish Supply Ltd, Napier, New Zealand. The length, thick and individual weight of fish were 17.5 ± 0.5 cm, 1.8 ± 0.1 cm and 44.2 ± 4.9 g respectively. While the proximate composition of fish was 71.8% moisture, 22.2% protein, 2.4% fat and 3.1% ash.

The cans and tomato sauce materials are the same as used in the previous experiment (Irianto *et al.*, 1993b).

2. Methodology

2.1. Experimental design

All conditions were maintained constant except for two factors :

- a. Sterilization time : 40, 50 and 60 minutes
- b. Salt level in tomato sauce : 1.5 and 2.5%

A factorial design was used, yielding 10 samples units. Since the experiment was run in two replication, a 20 sample total was tested. Results were analysed using a factorial complete randomized design. The T - test was used to differentiate the average significant levels within the treatments.

One of the best treatments was chosen for safety assessment experiment. In this experiment, the product was processed at pilot plant scale.

2.2. Canned fish processing

Canned fish was processed using the same method as explained by Irianto *et al.*, (1993b). Pre - cooking was performed for 20 minutes and the cans were vacuum sealed. The products were sterilized at 121.10°C for specified time as previously mentioned.

2.3. Analysis

Canned fish product obtained were analysed organoleptically, chemically and physically. Optimum processing condition was determined by evaluating the results of sensory test. The sensory evaluation methods employed was scored descriptive and preference methods, and the sensory form used is shown in Appendix 1.

Chemical analysis covered moisture content (Irianto, 1992), salt content (AOAC, 1984), pH (Irianto, 1992), and peroxide value (Pearson, 1973). Physical analysis was carried out for colour using Hunter Lab Colourquest Spectrophotometer Model CQ 1200 k with 2.33 software.

2.4. Safety assessment

Product safety was assessed by using sterility and incubation tests as well as by measuring overlap of double seam.

2.4.1. Sterility

Total plate count (TPC) analysis was used to determine the sterility of the product. The analysis was carried out by spreading 0.1 ml of diluted sample (10:1) on the surface of nutrient agar plates. The plates were incubated aerobically at 30^o and 55^oC. The dilution was prepared by weighing a portion of the fish flesh (25 g) and placing the portion in 225 ml 0.1% peptone water. The samples were obtained from two canned fish products.

2.4.2. Incubation test

The canned fish products were incubated at 30^o and 50^oC (5 cans at each temperature) for 14 days. Every seven days the cans were observed for swelling and one was opened for detection of undesirable odour.

2.4.3. Overlap of double seam

The overlap was measured using a method described by Warne and Sumner (1984).

RESULTS AND DISCUSSIONS

1. Product Acceptability

Tables 1 and 2 exhibit the results of sensory evaluation for fish and tomato sauce. variables of sterilization did not significantly affect the sensory properties of tomato sauce. Both variables also did not show any pronounced effect on sourness, saltiness, spiciness and fishiness of the fish.

Sterilization apparently affected the acceptability of fish flesh texture and bone softness. The texture of fish sterilized for 40 and 50 minutes was more acceptable than the texture of fish sterilized for 60 minutes. Bone softness of fish sterilized for 50 and 60 minutes was more acceptable than the bone softness of fish sterilized for 40 minutes. By considering both texture and bone softness acceptability, the sterilization time of 50 minutes was regarded as the optimal sterilization time for canned fish with fish oil disguised in it. Generally, both flesh texture and bone softness are the

Table 1. Sensory changes in fish during optimization experiment

Attributes		Salt in tomato sauce (%)	Sterilization time (minutes)		
			40	50	60
Fish texture	Tender - not tender	2.5 1.5	6.6 6.9	6.9 6.8	6.4 6.3
	acceptability	2.5 1.5	7.0 7.0	7.2 7.2	6.7 6.8
Bone softness	soft - not soft	2.5 1.5	5.4 4.8	6.1 6.4	6.5 6.3
	acceptability	2.5 1.5	5.7 5.5	6.5 6.8	6.9 6.9
Sourness	sour - not sour	2.5 1.5	5.4 5.0	5.1 5.4	5.7 5.3
	acceptability	2.5 1.5	6.5 6.4	6.7 6.8	6.7 6.2
Saltiness	salty - not salty	2.5 1.5	5.6 5.2	5.9 6.0	5.9 5.3
	acceptability	1.5	6.6	6.0	6.5
Spiciness	spicy - not spicy	2.5 1.5	6.4 6.1	6.3 6.2	6.1 6.1
	acceptability	1.5	6.4	6.9	6.8
Fishiness	Fishy - not fishy	2.5 1.5	5.2 5.3	4.7 5.3	5.3 5.2
	Acceptability	2.5 1.5	6.5 6.7	7.0 6.6	6.5 6.5

most important factors in determining the acceptability of canned fish as indicated by the results of consumer survey conducted by Irianto *et al.*, (1993a). However the optimization experiment did not reveal any significant effect on sensory properties and acceptability of the tomato sauce due to sterilization and salt level.

Table 2. Sensory changes in tomato sauce and overall acceptability of the product during optimization experiment

Attributes		Salt in tomato sauce (%)	Sterilization time (minutes)		
			40	50	60
Sauce colour	Bright red - not bright red	2.5 1.5	6.1 5.9	5.6 6.3	6.0 5.7
	acceptability	2.5 1.5	6.7 6.7	6.5 6.8	6.6 6.5
Mouth feel	oily - not oily	2.5 1.5	5.7 6.2	5.7 5.9	6.1 6.0
	acceptability	2.5 1.5	6.2 6.3	6.5 6.5	5.9 5.9
Sourness	sour - not sour	2.5 1.5	4.9 4.9	5.1 5.5	5.6 4.8
	acceptability	2.5 1.5	6.4 6.2	6.4 6.5	6.3 6.5
Saltiness	salty - not salty	2.5 1.5	5.9 5.5	6.0 6.1	5.8 5.4
	acceptability	2.5 1.5	6.5 6.5	6.4 6.5	6.4 6.6
Spiciness	spicy - not spicy	2.5 1.5	6.3 6.4	6.3 6.5	6.0 6.4
	acceptability	2.5 1.5	6.8 6.7	6.6 6.8	6.5 6.9
Fishiness	Fishy - not fishy	2.5 1.5	4.9 5.3	5.4 5.1	5.4 5.4
	Acceptability	2.5 1.5	6.4 6.2	6.5 6.1	6.1 6.6
Overall acceptability of the canned fish product		2.5 1.5	6.5 6.2	6.8 6.7	6.5 6.8

Statistically, the overall acceptability of the canned fish product was not affected by sterilization time and the level of salt addition. However, the trend showed that the sterilization time of 50 minutes generally produced canned fish with a better overall acceptability than the other two sterilization time. Thus, all of the above explanations suggested to the use of 50 minute sterilization time for processing canned fish with fish oil disguised in it. Directorate General of Fishery (1984) recommended sterilization of canned sardine in tomato sauce at 117°C for 54 minutes. However, Irianto (1992) proved that temperature causes more damage to omega - 3 fatty acids in fish oil compared to 121.1°C.

2. Chemical Changes

The results of chemical analysis for fish flesh and medium are shown in Table 3.

Table 3. Chemical changes in fish and tomato during optimization experiment

Sample	Analysis	Salt in tomato sauce (%)	Sterilization time (minutes)		
			40	50	60
Fish	Moisture content (%)	2.5	67.41	67.52	67.00
		1.5	67.55	67.76	66.74
	Salt content (%)	2.5	1.80	1.90	1.86
		1.5	1.46	1.60	1.56
	pH	2.5	6.05	6.09	6.02
		1.5	6.07	5.98	5.95
Tomato sauce	pH	2.5	6.00	5.89	5.88
		1.5	5.98	5.90	5.90
	peroxide value (meq/kg)	2.5	37.12	29.67	29.36
		1.5	38.14	24.19	25.26

Analysis of variance shows that moisture content of fish and pH of both tomato sauce and fish were not significantly affected by sterilization time and salt level in tomato sauce. However, the salt content of fish was pronouncedly influenced by the salt level in tomato sauce. Fish canned in tomato sauce with 2.5% salt showed a higher salt content than the salt in tomato sauce with 1.5% salt. This means that the higher the salt in tomato sauce the higher opportunity for the salt to penetrate into the fish. The average salt content of fish canned in medium with 2.5% salt was 1.85% and the average salt content of fish canned in medium with 1.5% salt was 1.54%.

Sterilization time showed a significant influence on the peroxide value of tomato sauce, where tomato sauce from canned fish sterilized for 50 and 60 minutes had a lower peroxide value in

comparison with the tomato sauce from the canned fish sterilized for 40 minutes. Thus, the longer the sterilization time, the greater decomposition effects on hydroperoxides, consequently, the lower the peroxide value in the tomato sauce. As explained by Irianto (1992) that sterilization process had an unusual effect on tomato sauce, particularly the oil in the tomato sauce, and the changes occurring looked very complicated. High temperature may have accelerated all oxidation processes in the sauce. Hydrogen peroxide might undergo a destruction process through scission and dismutation reaction resulting in carbonyl compounds, hydroxy compounds, short chain fatty acids, dimers and polymers including compounds known as secondary products of oxidation. These processes may have induced the reduction of hydroperoxide value in the tomato sauce during sterilization.

3. Fish Flesh Colour

Hunter -L, -a and -b values of fish flesh varied due to various sterilization time as shown in Table 4. Sterilization time significantly affected the Hunter -L, -a and -b values of fish flesh. Fish sterilized for 50 and 60 minutes had a lower Hunter -L value than fish sterilized for 40 minutes. This indicated that the longer sterilization time resulted in a darker fish flesh colour. Fish sterilization time of 50 and 60 minutes resulted in a higher Hunter -a value than sterilization of 40 minutes. This informed that the longer sterilization of 40 minutes. This informed that the longer sterilization tended to give a reddish colour to the fish. The fish sterilized for 40 and 50 minutes showed a lower Hunter -b value compared to the fish sterilized for 60 minutes. This means that the longer sterilization time produced fish with yellowish colour. The Hunter -a and -b values could be affected by oxidation of the high myoglobin to metmyoglobin, a dark brown pigment, or by trimethylamine (TMAO) promoting the formation of the disulphite bond between denaturated myoglobin and cysteine producing a green pigment (Francis and Cydesdale, 1975; English *et al.*, 1988). Meanwhile, the salt level in tomato sauce did not pronouncendly affect the colour of fish.

Table 4. Hunter - L, -a and -b values changes in fish flesh during sterilization process

Hunter value	Salt in tomato sauce (%)	Sterilization time (minutes)		
		40	50	60
L	2.5	48.64	44.63	45.23
	1.5	46.52	44.38	44.52
a	2.5	2.33	3.38	3.65
	1.5	2.41	3.35	3.54
b	2.5	14.10	14.17	14.48
	1.5	13.62	13.87	14.55

4. Product Safety

The sterility test showed that no microorganisms grew on the nutrient agar plates during aerobic and anaerobic incubation at 30° and 50°C. The incubation test performed by incubating five cans each at 30° and 50°C for 14 days indicated that the can appearance was still in normal condition until the end of incubation period, and no undesirable changes, such as swelling were observed. Thus, sterility and incubation test results revealed that the canned fish product was safe for consumption. Therefore, the possibility of spoilage due to the microorganisms survive during the sterilization process was not considered, and the shelf life of the product depended on post processing contamination.

Contamination of can contents after processing can occur through leaks in the can. Such leaks are often the result of faulty seaming and excessive corrosion (Van den Broek, 1965). The measured overlap of double seam of the can was 62.6% which was higher than the minimum standard of 45% (Warne, 1988). Thus, this overlap was considered safe.

CONCLUSIONS

The optimization experiment recommended sterilizing the canned fish with disguised fish oil at 121.1°C for 50 minutes. The optimum level of salt in the tomato sauce was found to be 1.5%.

In term of the results of sterility and incubation tests as well as overlap measurement of double seam, the canned fish processed using those sterilization condition were guaranteed safe. However, a consumer acceptance test for this product was required to assess the consumer acceptance and market potential before product launching.

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Appendix 1. Sensory sheet for experiment on canning process optimization

FISH CANNING PROCESS OPTIMIZATION

Name :

Date :

Please indicate the score that best reflects your attitude about each sample in terms of product characteristics and acceptability

Score Product Characteristics

- 9 Extremely very
- 8 Very
- 7
- 6 Slightly
- 5 Not sure
- 4 Slightly not
- 3 Not
- 2 Very not
- 1 Extremely very not

Score Product Acceptability

- 9 Extremely very acceptable
- 8 Very acceptable
- 7 Acceptable
- 6 Slightly acceptable
- 5 Not sure
- 4 Slightly unacceptable
- 3 Unacceptable
- 2 Very unacceptable
- 1 Extremely very unacceptable

Note : means followed by description placed under evaluated characteristics

Attributs

Product characteristic/Product acceptability
SAMPLE CODES

.....

FISH

- 1. Flesh texture
(tender - not tender or tough)
- 2. Softness of bone
(soft - not soft)
- 3. Sourness
(sour - not sour)
- 4. Saltiness
(salty - not salty)
- 5. Overall spiciness
(spicy - not spicy)
- 6. Fishiness
(fishy - not fishy)

TOMATO SAUCE

- 1. Sauce colour
(bright red - not bright red or dark red)
- 2. Mouth feel of sauce
(oily - not oily)
- 3. Sourness
(sour - not sour)
- 4. Saltiness
(salty - not salty)
- 5. Overall spiciness
(spicy - not spicy)
- 6. Fishiness
(fishy - not fishy)

OVERALL ACCEPTABILITY

.....

COMMENTS :
.....
.....
.....

Thank you for your time