

CIFT LIBRARY



011957

# Coastal Fishery Resources of India

## Conservation and Sustainable Utilisation



**Society of Fisheries Technologists (India)**

**Cochin ♦ India**

# Coastal Fishery Resources of India

## Conservation and Sustainable Utilisation

Reference

639.2 ME

### Editors

B. Meenakumari  
M.R. Boopendranath  
Leela Edwin  
T.V. Sankar  
Nikita Gopal  
George Ninan



**Society of Fisheries Technologists (India)**  
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, India

2010

CIFT LIBRARY



011957

## **Coastal Fishery Resources of India: Conservation and Sustainable Utilisation**

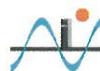
*Proceedings of the National Seminar on Conservation and Sustainability of Coastal Living Resources of India, 1-3 December 2009, Cochin*

*Organised by*

Society of Fisheries Technologists (India), Cochin  
and  
Centre for Ocean and Environmental Studies, New Delhi

*In association with*

Ministry of Earth Sciences (New Delhi)  
Central Marine Fisheries Research Institute (Cochin)  
National Institute of Oceanography (Goa) and  
Central Institute of Fisheries Technology (Cochin)



**@ 2010, Society of Fisheries Technologists (India), Cochin**

All rights reserved. No part of this publication may be reproduced in any form or by any means, without the prior written permission of the publishers.

**ISBN: 978-81-901038-7-9**

*Published by*

Society of Fisheries Technologists (India)  
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, India

URL : [www.fishtech.org](http://www.fishtech.org)

Telegram : FISHTECH / MATSYAODYOGIKI

Phone : 91 (0)484-2666845

E-mail : [cift@ciftmail.org](mailto:cift@ciftmail.org)

Fax : 91 (0)484-2668212

[enk\\_ciftaris@sancharnet.in](mailto:enk_ciftaris@sancharnet.in)

*Citation:*

Rao, G.S. (2010) Current status and prospects of fishery resources of the Indian continental shelf, In: Coastal Fishery Resources of India: Conservation and Sustainable Utilisation (Meenakumari, B., Boopendranath, M.R., Edwin, L., Sankar, T.V., Gopal, N. and Ninan, G., Eds.), p. 1-13, Society of Fisheries Technologists (India), Cochin

Cover design: Vineethkumar, P., CIFT, Cochin

Printed at PAICO, Cochin - 682 035, India

# Development of Ready to Eat Tuna Sausage in Synthetic Casings

T.K. Srinivasa Gopal<sup>1\*</sup>, Sanam Basheer<sup>2</sup>, R. Yathavamoorthi<sup>1</sup>  
J. Bindu<sup>1</sup>, C.O. Mohan<sup>3</sup> and C.N. Ravishankar<sup>1</sup>

<sup>1</sup> Central Institute of Fisheries Technology  
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, Kerala, India

<sup>2</sup> Department of Food Science and Technology  
School of Health Sciences, University of Calicut  
Thenhipalam - 673 635, Kerala, India

<sup>3</sup> Veraval Research Centre of CIFT, Matsyabhavan, Bhidia Plot,  
Veraval - 362 269, Gujarat, India

\*E-mail: tksgopal@gmail.com

## Introduction

The world fish consumption scenario is undergoing rapid changes and there has been emergence of new seafood product forms in the market, over the past few decades. Value addition and diversification to match the changing life style of the population is the need of the day. A large number of value added products both for export and internal markets from shrimp, lobsters, squids, cuttlefishes, bivalves and certain species of fish and minced meat from low priced fishes have been developed. Minced fish is an important ingredient in the production of a variety of seafood products in many countries for its several advantages such as better yield, ease in incorporation with stabilizers, flexibility in product preparation and suitability in blending (Abraham *et al.*, 1991). Several products including fermented pastes, sauces, sausages, patties, sticks and balls can be manufactured from the mince.

Sausage is one of the prominent value added product which has been gaining wide popularity in the recent years. The fish sausage can be defined as the *surimi* mixed with salt, spices, seasonings, starch and fat, ground well to get a fine pasty mass and stuffed in natural or synthetic casings, sealed and cooked (Gopakumar, 1997). Sausages packed in natural casings or intestines of animals are eaten along with the casings. A sausage in natural or synthetic casings needs cold store facilities during its storage and transportation which adds to the cost. Apart from this, shelf life is also limited for the sausages packed in natural casings. Hence,

there is a need to develop convenient ready to serve sausages, which can be stored at ambient storage conditions. To achieve this, thermal processing can be adopted. As natural casings cannot be heat sterilized, synthetic casings which can withstand heat sterilization temperatures are normally used for this purpose. One such synthetic casing made of krehalon or poly-vinylidene dichloride (PVDC) are commonly employed for this purpose. But this synthetic material suffers from the disadvantage of limited shelf life. Previous reports indicate that the polypropylene and cellulose material are suitable materials for sausages (Ravishankar *et al.*, 2002). Fish sausages in polypropylene casings, processed at high temperatures can be stored at ambient conditions ( $28\pm^{\circ}\text{C}$ ) for more than 6 months (Ravishankar *et al.*, 2002). Sausages are normally prepared using white meat fishes, which gives characteristic properties of sausage. However, many of the world fisheries are facing a crisis as majority of the fish stocks are exploited to their maximum level. Hence there is a need to find alternative fish species for sausage production. In recent past, there is an increased catch of tuna all over the world. Further, the taste of tuna is highly cherished in many parts of the world. It is expected that the sausages developed from tuna species will be greatly appreciated by consumers. However, the sausages developed from tuna alone may not give the required properties of sausage. Hence the present work was undertaken to develop ready to serve tuna and Japanese threadfin bream sausages in polypropylene casing in retortable pouches and high impact poly propylene (HIPP) trays and to asses the quality changes during ambient storage conditions.

## Materials and Methods

Fresh skipjack tuna (*Katsuwonus pelamis*) of size 45-50 cm weighing about 1.5-2 kg and Japanese threadfin bream (*Nemipterus japonicus*) of 10-12 cm weighing about 100 g each were purchased from the local fish market of Cochin. Fishes were washed thoroughly with clean water and iced in insulated boxes and brought to the lab within an hour and processed immediately. Fishes were dressed, washed in potable chilled water ( $0-2^{\circ}\text{C}$ ) and drained. Heading, gutting and washing was done manually. The fishes were then fed to a drum type meat-bone separator and the fish mince devoid of the bones and skin were collected in a tray and kept in chilled condition. The minced meat was washed in chilled potable water ( $0-2^{\circ}\text{C}$ ) with occasional stirring for 5 minutes. The washed mince was drained and dewatered by pressing in very fine mesh sieve. Raw washed mince was mixed first with salt, followed by other ingredients as listed in Table 1. The mixture was then mixed well in a silent cutter

(Alexander Werk Type 2N 20/82). The resultant mass thus obtained was stuffed into polypropylene casing using a stuffer (Stadler make). Initially, for standardization, tuna mince alone (100%) and in combination with Japanese threadfin bream mince (50%) was used for sausage preparation. Based on the properties of final sausage product, one combination was used for the further studies. The stuffed sausage was then tied and one batch was placed in see through retortable pouches (100 g each) and vacuum packed. The other batch was placed in high impact polypropylene (HIPP) trays and to this about 50 ml of brine solution (5%) was added and sealed. The packs were loaded to an over pressure autoclave and thermal processed at 115°C to an  $F_0$  of 7 minutes. They were then cooled in chilled water, wiped dry and stored in ambient temperature conditions.

**Table 1: Recipe used in the study for the preparation of fish Sausage**

<b>Materials</b>	<b>% weight to fish mince</b>
<b>Fish mince</b>	70% of tuna and Japanese threadfin bream in 50:50 ratio
<b>Salt</b>	2
<b>Sugar</b>	1.5
<b>Polyphosphates</b>	0.2
<b>Corn flour</b>	9
<b>Fat</b>	5
<b>Water</b>	11
<b>Spices (oleoresins)</b>	
Ginger	5 drops
Turmeric	5 drops
Garlic	5 drops
<b>Colour</b>	
Paprika	5 drops

Samples were analyzed at regular intervals (0, 28 and 36 days) to determine their quality changes at ambient temperature storage conditions. Three pouches and trays each were drawn randomly at each sampling days. Volatile bases like total volatile base nitrogen (TVB-N) and trimethylamine nitrogen (TMA-N) were analysed as per Conway's micro-diffusion method (Conway, 1950). Fat hydrolysis was measured in terms of free fatty acid (FFA) value by the method of AOCS (1989), whereas

fat oxidation was measured as peroxide value (PV) by AOCS (1989) and thio-barbituric acid (TBA) by spectrophotometric method (Tarladgis *et al.*, 1960). pH was measured by homogenizing the sample with distilled water at 1:2 ratio (sausage to water) by using digital pH meter (Cyber Scan, Model No 510) according to IS: 2168 (BIS, 1971). The colour values as CIE Lab L\*, a\*, b of the samples was measured using Hunter lab MiniScan® XE Plus spectrophotometer (Model No: Mini Scan-XE plus, Hunter associate laboratory, Virginia, USA). L\* is a measure of the lightness of a sample, and range from 0 (black) to 100 (white). The chromacity dimension (a\* and b\*) give understandable designation of colour as follows, a\* measures redness when positive and greenness when negative. b\* measures yellowness when positive and blueness when negative. Instrumental texture parameters like hardness, chewiness, springiness, cohesiveness, gumminess and stiffness were measured using Food Texture Analyser (Lloyd Instruments, UK). In the instrumental method, texture profiling involves compressing the test samples at least twice and quantifying the mechanical parameters from the recorded force-deformation curves. Various parameters like hardness (force necessary to create a given deformation in the food) cohesiveness (refers to the extent to which a material can be deformed before it ruptures), springiness (rate at which a deformed material goes back to its undefined condition after the deforming force is removed), adhesiveness (work necessary to overcome the attractive force between the surface of the food and the surface of the other materials with which the food comes in contact), chewiness (energy required to masticate a solid food to a state ready for swallowing), which is a product of hardness, cohesiveness and springiness (Szczeniak, 2002) were measured. For expressible water content estimation, a slice of sausage (0.3 mm thick, about 1g in weight) was placed between two filter papers and was pressed by oil pressure equipment under a fixed pressure (10 kg.cm<sup>-2</sup>) for 20 seconds. For folding test, a 5 mm thick slice was slowly folded into half and further half and it was examined for any signs of structural failure (cracks). It was made sure that the sample was folded completely in half. It was kept in the folded state for 5 seconds, and then change in shape was evaluated by 5-stage merit marks as in Table 2. Sensory analysis was carried out by trained 7 panelists using a nine point hedonic scale based on appearance, colour, odour, flavour and taste as described by Peryam and Pilgrims (1957) in which a score of 9 was taken as extreme liking and least score being dislike extremely with a score of less than 4 as the limit of acceptability as given in Table 3. The overall impression was scored as overall acceptability. The sterility of the sample was estimated by incubating

thermal processed samples at 37°C for 15 days and at 55°C for 5 days. It was then inoculated into thioglycollate broth with paraffin oil poured on top to make it anaerobic. Incubation was again done for 2-3 days at 37°C and the tubes were checked for turbidity to detect the growth of any microorganism by comparing with a control tube.

**Table 2: Scoring pattern used for folding test**

Property	Mark
No crack occurs even if folded in four	5
No crack occurs if folded in two, but crack occurs if folded in four	4
No crack occur if folded in two, but splits if folded in four	3
Cracks if folded in two	2
Splits into two if folded in two	1

**Table 3: Nine point hedonic scale used for sensory analysis**

Quality grade description	Score
Like extremely	09
Like very much	08
Like moderately	07
Like slightly	06
Neither like nor dislike	05
Dislike slightly	04
Dislike moderately	03
Dislike very much	02
Dislike extremely	01

## Results and Discussion

A novel tuna based sausage was developed in combination of Japanese threadfin bream mince. For this, initially, two different combinations namely 100 and 50% of tuna washed mince was mixed with 0 and 50% of Japanese threadfin bream mince along with other ingredients. The stuffed sausage was subjected to sensory analysis. The

sausage which had only tuna mince did not give appreciable product based on sensory analysis. The sausage with 50% combination of tuna and Japanese threadfin bream mince was selected for the further studies.

A comparative study of the thermal processed tuna and Japanese threadfin bream sausage in retortable pouches and HIPP trays indicated that heating and cooling rate was faster for trays compared to pouches (Table 4). This could be attributed to the addition of 5% salt solution in the tray which has increased the heating rate. This resulted in slightly less process time (66.2 min) for trays compared to pouches (67.1 min). The sterility tests conducted at two different temperatures for pouch and tray samples showed that both the samples were sterile indicating that the lethality ( $F_0$  7 min) given was sufficient to achieve a safe sausage products.

**Table 4: Heat penetration characteristics of tuna sausage in retortable pouches and HIPP trays**

Parameter	Pouch	Tray
Heating Rate Index ( $f_h$ ), min	48	40
Heating lag factor ( $J_h$ )	0.35	0.52
$F_0$ value, min	7.26	6.79
Temperature deficit, (g)	1.44	1.47
Cooling lag factor ( $J_c$ )	0.90	1.11
Process time (B), min	64.6	64.1
Total process time (T), min	67.12	66.20

The textural property of sausage is one of the important properties which influence the consumer acceptability. Most of the instrumental textural parameters of the sausages processed in trays and retortable pouches were almost followed the similar trend (Table 5). The hardness (1 and 2), which is the maximum force at which deformation occurs at first (hardness 1) and second compression (hardness 2) did not change much between the tray and pouch samples. However, the hardness 2 was slightly higher for tray samples compared to pouch samples. The other textural properties like springiness, chewiness, cohesiveness and stiffness did not show much variation between the two samples.

The folding test, which was conducted to assess the gel strength of sausages manually, indicated that both sausage samples processed in

**Table 5: Changes in instrumental textural properties of tuna sausages thermal processed in retortable pouches and HIPP trays**

Textural parameters	Pouch			Tray		
	0 day	28 <sup>th</sup> day	36 <sup>th</sup> day	0 day	28 <sup>th</sup> day	36 <sup>th</sup> day
Hardness I, kgf	1.63	1.14	1.95	1.56	1.18	2.11
Hardness II, kgf	1.06	1.13	1.43	1.21	1.13	1.84
Cohesiveness	0.36	0.48	1.24	0.38	0.48	0.44
Gumminess, kgf	0.58	0.68	0.81	0.60	0.70	0.93
Adhesiveness, kgf.mm	1.66x 10 <sup>-3</sup>	- 0.03	6.33x 10 <sup>-3</sup>	8.0x 10 <sup>-3</sup>	-6.0x 10 <sup>-3</sup>	1.8x 10 <sup>-3</sup>
Springiness, mm	9.09	6.65	6.28	8.93	9.69	6.04
Chewiness, kg f.mm	5.33	4.61	4.52	5.33	6.80	6.87
Stiffness, kgf.m <sup>-1</sup>	0.19	0.30	0.30	0.20	0.35	0.41

pouch and tray had least score of one. This score remained unchanged throughout the storage period for both the samples. This least score could be due to low gel strength, which resulted due to high temperature processing. Proteins form less strong gels as the heating rate and temperature increases. During rapid heating, there is insufficient time for proteins to denature and properly align before aggregation and gelation resulting in gels that are more coarse and weak. Faster heating rates would allow less time at temperature above the denaturation temperature of the proteins for aggregation to occur. Expressible water content of the samples packed in tray was observed higher (1.8%) compared to pouch samples (1.5%) which decreased with the storage period for both the samples (Table 6).

The raw sausage samples had instrumental colour values of 66.6, 1.24 and 19.58 for L\*, a\* and b\* respectively (Table 6). Thermal processing of sausage in both trays and pouches increased the lightness to 68.7 and 68.5 respectively and a\* to 3.9 and 3.1 respectively, whereas the b\* was decreased to 17.2 and 17.04 for tray and pouch samples. The increase in a\* indicated the increased redness of the sample whereas the decreased b\* indicated the reduced yellowness of the samples. During the further storage period, much variation was not observed for both the samples. The brown discolouration of the processed sausages could be due to the non-enzymatic or Maillard browning. The ribose sugar released from RNA combines with the amino acid to form brown colour. Changes

in the salmon colour pigments upon heating have been studied by Naughton *et al.* (1956). Labuza (1972) reported that due to the lower water activity of the fish muscle, browning takes place more rapidly in the muscles.

**Table 6: Changes in instrumental colour and expressible water of tuna sausages thermal processed in retortable pouches and HIPP trays**

Quality parameter	Raw sausage	Pouch			Tray		
		0 day	28 <sup>th</sup> day	36 <sup>th</sup> day	0 day	28 <sup>th</sup> day	36 <sup>th</sup> day
L*	66.61	68.47	68.89	68.07	68.68	68.31	68.75
a*	1.24	3.10	3.66	3.02	3.87	3.61	3.84
b*	19.58	17.04	17.63	17.52	17.18	17.96	17.48
Expressible water, %	ND	1.51	1.48	1.40	1.82	1.63	1.02

ND = not detected

The primary lipid oxidation product which is estimated as peroxide value was not observed in both the samples after thermal processing and during the subsequent storage periods. This could be attributed to the sensitiveness of these primary oxidation products to high thermal processing temperature which breakdown to further compounds. TBA is a measure of malonaldehyde production which is a secondary product of lipid oxidation and is widely used as an indicator of degree of lipid oxidation (Connell, 1990). The TBA value was 0.38 mg.malonaldehyde kg<sup>-1</sup> sample for the raw sausage, which increased to 0.63 and 0.68 mg.malonaldehyde kg<sup>-1</sup> in pouch and trays samples respectively after thermal processing (Table 7). During the subsequent storage period, TBA value showed a decreasing trend in both the samples. The decrease was more in pouch samples which reached 0.41 mg malonaldehyde kg<sup>-1</sup> by the end of storage study compared to tray samples which was 0.59 mg.malonaldehyde kg<sup>-1</sup>. The initial increase in the TBA value could be due to the heating effects on fat and the further breakdown of intermediary lipid oxidation products in to stable aldehydes. An increase in TBA value was also reported by Aubourg *et al.*, (1997) on heat processing. However the TBA value of both the samples remained less than 1 mg malonaldehyde kg<sup>-1</sup>. A decreasing trend observed during the storage period for both the samples is similar to the results reported by Aubourg

*et al* (1997) and Medina *et al.* (1999). This could be due to the reaction of these oxidation products with the other reactive compounds like amino groups, which can cause its reduction (Pokorny, 1981; Maruf *et al.*, 1990; Aubourg *et al.*, 1995). The variation in the lipid hydrolysis product as measured by FFA in both the samples followed a similar manner and the values did not change much. The presence of FFA is due to the oxidation and hydrolysis of lipids and is undesirable since the fatty acid may be converted to odourless volatiles. Both the samples showed a slight increase in the FFA content (5.18-5.2% oleic acid) after thermal processing from an initial value of 4.1% oleic acid (Table 7), which is similar to the reports by Aubourg. *et al.* (1990; 1997). The slight increase could be attributed to an increased lipid hydrolysis at elevated temperature.

**Table 7: Changes in biochemical quality parameters of tuna sausages thermal processed in retortable pouches and HIPP trays**

Quality parameters	Raw sausage	Pouch			Tray		
		0 day	28 <sup>th</sup> day	36 <sup>th</sup> day	0 day	28 <sup>th</sup> day	36 <sup>th</sup> day
TBA, mg malonaldehyde kg <sup>-1</sup>	0.38	0.63	0.55	0.41	0.68	0.61	0.59
FFA (as % oleic acid)	4.10	5.18	5.14	5.54	5.20	5.36	5.39
PV, milli Eq O <sub>2</sub> kg <sup>-1</sup>	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TVB-N, mg N <sub>2</sub> 100 g <sup>-1</sup>	6.5	7.8	ND	ND	7.2	ND	ND
TMA-N, mg N <sub>2</sub> 100 g <sup>-1</sup>	4.2	5.39	ND	ND	5.48	ND	ND

ND = not detected

The TVBN refers to the total volatile base nitrogen and comprises all the volatile basic compounds mainly TMA, NH<sub>3</sub>, DMA and other volatile basic nitrogenous compounds associated with seafood spoilage (Gill, 1990). TVBN relates to the organoleptic score of the fish (Civera *et al.*, 1993). The raw sausage had TVBN value of 6.5 mg% which increased to 7.2 and 7.8 mg% for the samples processed in tray and pouch respectively (Table 7). This increase in the TVBN content after thermal processing could be due to the thermal degradation at higher temperature. The increase in Total volatile bases and loss of TMAO following heat processing was reported by Gallardo *et al.* (1990) during canning of albacore.

*et al* (1997) and Medina *et al.* (1999). This could be due to the reaction of these oxidation products with the other reactive compounds like amino groups, which can cause its reduction (Pokorny, 1981; Maruf *et al.*, 1990; Aubourg *et al.*, 1995). The variation in the lipid hydrolysis product as measured by FFA in both the samples followed a similar manner and the values did not change much. The presence of FFA is due to the oxidation and hydrolysis of lipids and is undesirable since the fatty acid may be converted to odourless volatiles. Both the samples showed a slight increase in the FFA content (5.18-5.2% oleic acid) after thermal processing from an initial value of 4.1% oleic acid (Table 7), which is similar to the reports by Aubourg *et al.* (1990; 1997). The slight increase could be attributed to an increased lipid hydrolysis at elevated temperature.

**Table 7: Changes in biochemical quality parameters of tuna sausages thermal processed in retortable pouches and HIPP trays**

Quality parameters	Raw sausage	Pouch			Tray		
		0 day	28 <sup>th</sup> day	36 <sup>th</sup> day	0 day	28 <sup>th</sup> day	36 <sup>th</sup> day
TBA, mg malonaldehyde kg <sup>-1</sup>	0.38	0.63	0.55	0.41	0.68	0.61	0.59
FFA (as % oleic acid)	4.10	5.18	5.14	5.54	5.20	5.36	5.39
PV, milli Eq O <sub>2</sub> kg <sup>-1</sup>	Nil	Nil	Nil	Nil	Nil	Nil	Nil
TVB-N, mg N <sub>2</sub> 100 g <sup>-1</sup>	6.5	7.8	ND	ND	7.2	ND	ND
TMA-N, mg N <sub>2</sub> 100 g <sup>-1</sup>	4.2	5.39	ND	ND	5.48	ND	ND

ND = not detected

The TVBN refers to the total volatile base nitrogen and comprises all the volatile basic compounds mainly TMA, NH<sub>3</sub>, DMA and other volatile basic nitrogenous compounds associated with seafood spoilage (Gill, 1990). TVBN relates to the organoleptic score of the fish (Civera *et al.*, 1993). The raw sausage had TVBN value of 6.5 mg% which increased to 7.2 and 7.8 mg% for the samples processed in tray and pouch respectively (Table 7). This increase in the TVBN content after thermal processing could be due to the thermal degradation at higher temperature. The increase in Total volatile bases and loss of TMAO following heat processing was reported by Gallardo *et al.* (1990) during canning of albacore.

TMA-N level in fish muscle has been used as an index of bacterial spoilage. TMA being a part of a bacterial action has a direct relation to bacterial growth and decomposition and hence has been suggested as spoilage indices by many workers (Laycock and Regier, 1971; Finne, 1992). The accumulation of TMA in spoiling fish is the result of bacterial degradation of choline as well as the reduction of TMAO to TMA and is responsible for the fishy odour (Hebard *et al.*, 1982). In the present study TMA values of the thermally processed sausage (5.4 and 5.48 mg% for pouch and tray samples, respectively) was found to be higher than that of the raw sausage (4.2 mg%) (Table 7). In the present study, this increase in TMA-N value could be mainly due to the thermal degradation of nitrogenous compounds and not due to the microbial action as the thermal processing resulted in sterile product as indicated by sterility test.

Sensory quality is the ultimate parameter for the acceptability of any product. In the present study there was no much variation in the sensory attributes studied (Table 8). Most of the parameters were rated higher for both products. However, sensory odour and taste was rated better for tray samples resulting slightly higher overall acceptability compared to pouch samples. This indicates that the thermal processing can be adopted for the production of tuna based sausages which can be stored at ambient storage conditions.

**Table 8: Sensory quality of thermally processed sausages in retortable pouches and HIPP trays**

Sensory attributes	Pouch		Tray	
	0 day	36 <sup>th</sup> day	0 day	36 <sup>th</sup> day
Appearance	8.5	8	8.5	8
Colour	8.3	8	8.3	8
Odour	7.5	7	8.0	7.5
Flavour	7.4	7	7.5	7
Firmness	8.8	8.5	8.8	8.5
Taste	7.8	7.5	8.0	7.8
Overall acceptability	8.1	7.5	8.3	8

## Conclusion

The studies indicated that skipjack tuna mince can be used for the preparation of thermal processed sausages in combination with Japanese

threadfin bream mince. The sausages processed in tray and a pouch to a lethality of 7 min was sufficient to produce safe product retaining most of the sensory properties. The heating rate was slightly faster in tray packs compared to retortable pouches. However, the process time for both the packaging materials did not differ much, which resulted in almost similar biochemical and physical quality changes.

Authors wish to thank Director, CIFT, Cochin for providing the facilities to carry out this work and for permission to publish this paper.

## References

- Abraham, T.J., Sugumar, G., Sukumar, D. and Jayachandran, P. (1992) Bacterial profile of fresh and spoiled fish mince from *Johnius dussumieri* at refrigerated storage, Fish. Tech. 29(1): 53-56
- AOCS (1989) Official methods and Recommended Practices of American Oil Chemists Society, 5<sup>th</sup> edn American Oil Chemists Society Champaign, USA
- Aubourg, S., Gallardo, J.M. and Medina, I. (1997) Changes in lipids during different sterilizing conditions in canning of albacore (*Thannus alalunga*) in oil, Int. J. of Food Sci. and Tech. 32(4): 427-431
- Aubourg, S., Medina, I. and Perez-Martin, R. (1995) A comparison between conventional and fluorescence detection methods of cooking-induced damage to tuna fish lipids, Zeitschrift für Lebensmitteluntersuchung und-Forschung A 200: 252-255
- Aubourg, S.P., Sotelo, C.G. and Gallardo, J.M. (1990) Changes in flesh lipids and fill oils of albacore (*Thannus alalunga*) during canning and storage, J. Agric. Food Chem. 38(3): 809-812
- BIS (1971) IS: 2168 Specification for Pomfret Canned in Oil, Indian Standard Institute, New Delhi, India
- Civera, T., Turi, R.M., Bisio, C., Parisi, E. and Fazio, G. (1993) Sensory and chemical assessment of marine teleosts - relationship between total volatile basic nitrogen, TMA and sensory characteristics, Sciences de, Aliments 13(1): 109-117
- Connell, J.J. (1990) Control of Fish Quality, 2<sup>nd</sup> edn., Fishing News (Books) Ltd., Farnham, Surrey, England: 222 p.
- Conway, E.J. (1950) Microdiffusion Analysis of Volumetric Error, Crosby, Lockwood, and Sons, Ltd., London
- Finne, G. (1992) Non-protein nitrogen compounds in fish and shellfish, In: Advances in Seafood Biochemistry (Flick, G.J. and Martin R.E., Ed.) Technical Publishing Co. Inc., Lancaster, Pennsylvania

## Development of Ready to Eat Tuna Sausage in Synthetic Casings

- Gallardo, J.M., Perez-Martin, R.I., Franco, J.M., Aubourg, S. and Sotelo, C.G. (1990) Changes in volatile bases and trimethylamine oxide during the canning of albacore (*Thannus alalunga*), *Int. J. Food Sci. Technol.* 25: 78-81
- Gill, T.A. (1990) Objective Analysis of Seafood Quality, *Food Rev. Int.* 6(49): 681-714
- Gopakumar, K., (1997) Biochemical Composition of Indian Food Fishes, Central Institute of Fisheries Technology, Cochin: 44 p.
- Hebard, C.E., Flick, G.J. and Marlin, R.E. (1982) Occurrence and significance of TMAO and its derivation in fish and shellfish, In: *Chemistry and Biochemistry of Marine Food Products* (Martin, R.E., Plick, G.J., Hebard, C.E. and Ward, D.R., Eds.), p. 149-304, AVI Publishing Company, Westport, CT, USA
- Labuza, T.P. (1972) Nutrient losses during drying and storage of dehydrated foods, *CRC Crit. Rev. Food Technol.* 3: 217-240
- Laycock, R.A. and Regier, L.W. (1971) TMA producing bacteria on haddock, (*Melanogammus aeglefinus*) fillets during refrigerated storage, *J. Fish. Res. Board Can.* 28: 305-309
- Maruf, F., Ledward, D., Neale, R. and Poulter, R. (1990) Commercial nutritional quality of Indonesian dried-salted mackerel (*Rastrelliger Kanagurta*), *Int. Food Sci. Technol.* 25: 66-77
- Medina, I., Sacchi, R. and Aubourg, S. (1995) ABC-NMR study of lipid alterations during fish canning: effect of filling medium, *J. Sci. Food Agric.* 69(4): 445-450
- Naughton, J.J., Frodyma, M.M. and Seitlin, H. (1956) Nature of green or off-colour condition in pre-cooked yellowfin tuna, *US Fish. Wildlife. Serv. Spec. Sci. Rept. No. 197*: 7 p.
- Peryam, D.R. and Pilgrim, F.J. (1957) Hedonic scale method of measuring food preferences, *Food Technol.* 11(9): 9-14
- Pokorny, J. (1981) Browning of lipid-protein interaction, *Prog. Food Nutr. Sci.* 5: 421-428
- Ravishankar, C.N., Gopal, T.K.S. and Vijayan, P.K. (2002) Studies on heat processing and storage of seerfish curry in retort pouches, *Pack. Technol. Sci.* 15: 3-7
- Szczesniak, A.S. (2002) Texture is a sensory property, *Food Qual. Pref.* 13: 215-225
- Tarladgis, G.B., Watts, M.B. and Younathan, T.M., (1960) A distillation method for the quantitative determination of malonaldehyde in rancid foods, *J. AOCS* 37: 44-50