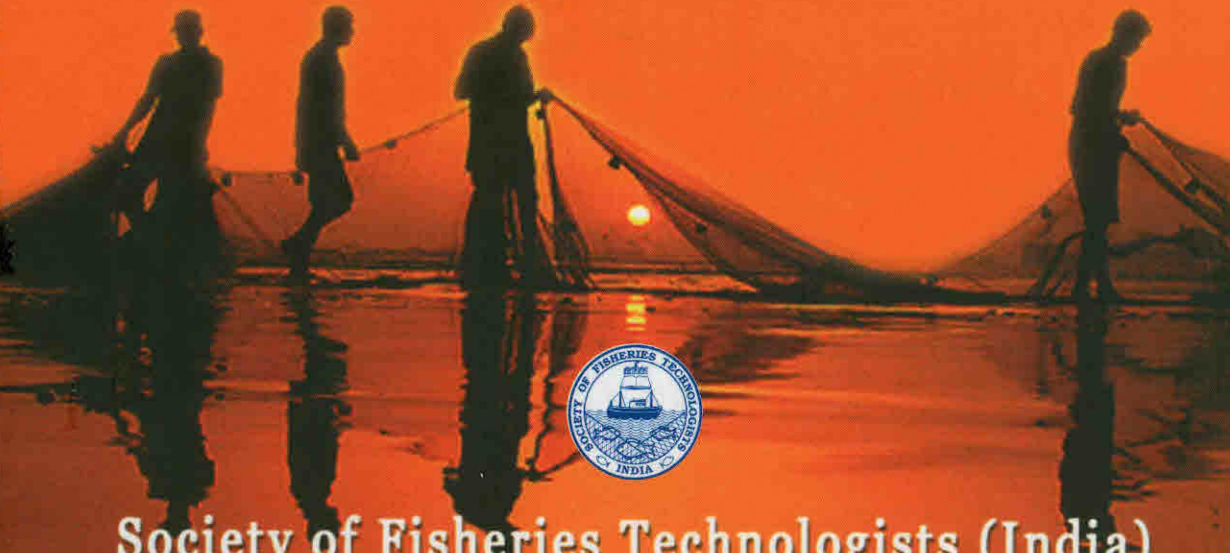
Coastal Fishery Resources of India

Conservation and Sustainable Utilisation



Society of Fisheries Technologists (India)

Cochin ◆ India

Coastal Fishery Resources of India: Conservation and Sustainable Utilisation

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)

MoES

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
Phone : 91 (0)484-2666845
Fax : 91 (0)484-2668212
Telegram : FISHTECH / MATSYAOUDYOGIKI
E-mail : cift@ciftmail.org
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

Coastal Fishery Resources of India
Conservation and Sustainable Utilisation

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

Heat Penetration Characteristics of Seafood Cocktail Soup Processed at Different Temperatures in Retortable Pouches

C.N. Ravishankar[1]*, K. Sihabudheen[2], Santhi Joseph[2] Sanam Basheer[2], C.O. Mohan[3], J. Bindu[1] and T.K. Srinivasa Gopal[1]

[1] Central Institute of Fisheries Technology
P.O. Matsyapuri, CIFT Junction, Cochin - 682 029, Kerala, India

[2] Department of Food Science and Technology
School of Health Sciences, University of Calicut
Thenhipalam - 673 635, Kerala, India

[3] Veraval Research Centre of CIFT
Matsyabhavan, Bhidia Plot, Veraval - 362 269, Gujarat, India
**E-mail: cnrs2000@gmail.com*

Introduction

Value addition is one of the most important approaches to raise the profitability of fish processing industry and its having an utmost importance in fish processing industry in these days because of its high unit value and nutrition. All over the world the consumer tendency now is to take convenience food such as assembling meals rather than preparing from basic ingredients. Such change is due to change in food concept and increasing working people who has less time for preparation. In today's affluent society, people prefer to buy ready-to-cook, ready-to-serve or ready-to-eat convenience products than buying raw materials. Recent development in fish processing technology is oriented towards technology up gradation, diversification and quality assurance. These have lead among others to great demand for seafood or seafood based convenience products in ready-to-serve, ready-to-eat forms or ready-to-consume forms. Besides, export demand in international market for value added products are increasing. Among different value added products, canned or sterilized products have their own distinct place in the world food market.

The conventional heat processing often affects the quality of food particularly appearance, flavour and nutritive value. One of the major achievements in this effort to overcome this problem is development of a High Temperature Short Time (HTST) processing. The basic approach in this technique is to achieve more rapid heating of foods at higher processing temperature which reduces the heating time and hence maintains better quality. Heat penetration of various food materials in sealed container is influenced by various factors like container material, size of container, thickness of wall, properties of food, heating time and temperature. Over the years, various containers have been evolved for the food canning purpose which include glass, metal containers (tin, aluminium, tin-free-steel), flexible retort pouches. Various researchers have proven technical and commercial feasibilities of using retort pouches for thermal processing (Hu *et al.*, 1955; Goldfarb, 1970; Ravishankar *et al.,* 2002; Bindu *et al.,* 2004; Mohan *et al.*, 2006). A reduction of 35% and 56% process time was reported for 197 and 775g pack of prawn kuruma processed in retortable pouches compared to aluminium cans. Improved colour and shelf life for pouched products also reported by various workers (Chia *et al.*, 1983; Gopal *et al.*, 2001). Due to faster rate of heat penetration and shorter process time, retort pouches are gaining popularity all over the world. If HTST process is applied to retort pouched products, there will be further reduction in process time and better nutrient retention (Richard *et al.*, 1973; Busta, 1967; Pfeifer and Vojnovich 1952; Townsend *et al.,* 1938).

Soup is a savoury liquid food made by combining ingredients such as meat, vegetable and beans in stock or hot water until the flavour is extracted, forming broth. Soup serves two purposes. First as an appetizer, taken at the beginning of meal to stimulate the appetite and aid the flow of digestive juices in stomach, and secondly as an actual part of meal, when it contains sufficient nutritive material to permit to be considered as a part of meal instead of merely an addition. At present soup is either prepared fresh or made from soup powder. Both these methods are laborious and time consuming. Hence there is a need for developing a ready to serve soup, which can be stored at ambient condition for longer period. Shrimp, squid and crab have very good commercial acceptability and are commercially important both in domestic and international markets. Soup prepared from these seafood sources are expected to create a very good demand worldwide. There is no report on the studies concerning the development of ready-to-drink seafood soup. Hence, the present work was undertaken with an objective of optimizing the processing condition and to study the effect of process temperatures on the quality of ready-to-serve seafood cocktail soup stored at ambient temperature (28±2°C) in flexible retortable pouches.

Materials and methods

Retort pouch with three layer configuration of 12.5μ polyester / 12.5μ aluminium foil / 85μ cast poly propylene with size of 20×12 cm (M/s. Klass Engineering Pvt. Ltd., Bangalore, India) was used in this study. The Indian white shrimp (*Fenneropenaeus indicus*), squid (*Uroteuthis duvauceli)* and crab (*Portunus sanguinolentus*) from local landing centres were brought to the laboratory in iced condition. The shrimp was washed with chilled water, beheaded, peeled and de-veined manually. Head, tentacle and internal organs of the squid were carefully removed without breaking the ink sac. They were then washed with water and the squid tube was cut into small rings. The crab was first washed with chilled water and the carapace was removed. Hepatopancreas, entrails, gills, legs and gut were removed and washed. It is then subjected to steam cooking for 5-8 min. Then meat was picked using stainless steel knives. All the other ingredients like salt, butter, onion, ginger, corn flour and white pepper powder were procured from the local super market.

Standardized recipe, using the ingredients listed in Table 1 was used to prepare seafood cocktail soup. The shrimp, squid and crab meat were pre-cooked in distilled water containing 5% salt. It was drained and the stock solution was kept separately. Half of the cooked meat was ground into paste. Onion and ginger pastes were fried with butter in a vessel and the stock solution was added to this followed by meat paste and stirred well. Pepper and salt were added followed by the addition of corn flour. It was then blended and stirred well to attain the required consistency. While packing in pouches the remaining blanched meat pieces were added.

Table 1: Ingredients used in seafood cocktail soup

Ingredients	Quantity
Squid rings	500 g
Shrimp meat	500 g
Crab meat	500 g
Butter	200g
Onion paste	200 g
Ginger paste	100 g
Corn flour	60 g
White pepper powder	40 g
Water	5 litres
Salt	To taste

Filling into the pouches were done manually. About 100±5 ml soups was filled to the pouches. Utmost care was taken to maintain the sealing area free from contamination. Air removal and sealing was done in a vacuum sealing machine and the pouches were double sealed by hot bar sealing. For each batch of processing, three pouches where fixed with thermocouple glands, tips were immobilized in geometric centre of soups inside the pouches. The pouches where processed at different temperature like 110, 121.1 and 130°C for a lethality of 6 mins in an overpressure autoclave. Cooling process was started when the lethality of 5.5min was achieved to attain a final lethality of 6 min. Immediately after thermal processing, they were cooled by pumping cool water and the pouches were allowed to cool inside the autoclave. After cooling, the autoclave door was opened and pouches were taken out and washed thoroughly in soap water and wiped water completely and stored at ambient temperature.

The heat penetration data were plotted on an inverted semi log paper (3 cycles) with temperature deficit (Retort temperature–Core temperature) on vertical log scale against time on the linear horizontal scale as described in NCA manual(1968). Lag factor for heating (j_h), slope of heating curve (f_h), time in minute for sterilization at retort temperature (U) and final temperature deficit were determined. Cooling curve was plotted as described by Ramaswamy and Singh, (1997) and lag factor for cooling (j_c) was determined. The process time was calculated by mathematical method described by Ball, (1957). Total process time T_B is determined by adding the effective heating period during come up time i.e. 58% of come up time to Ball's process time. Pouches processed at three temperature were tested for commercial sterility according to IS 2168 (BIS, 1971).

Proximate composition which includes moisture, crude protein, ash and crude fat was determined by the method of AOAC, (2006). The colour of filtered and homogenized samples was measured using Hunter lab MiniScan® XE Plus spectrocolorimeter (Model No: Mini Scan-XE plus, Hunter associate laboratory, Virgina, USA). Filtered and homogenized samples were loaded inside the sample holder for determination of the CIE Lab L^*, a^*, b^* values which corresponds to lightness, redness and yellowness. 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, gray when zero and greenness when negative. b^* measures yellowness when positive, gray with zero and blueness when negative.

pH was measured by using digital pH meter (Cyber Scan, Model No 510) according to APHA (1998). In the case of raw material, the muscle was homogenized with distilled water at 1:2 ratio (muscle to water) before analyzing the pH. In the case of soup, it was filtered and the filtrate was used to measure pH. Viscosity was measured by using Brookfield viscometer (Model DV-E), with spindle number L_2 at RPM 60. Volatile bases like total volatile base nitrogen (TVB-N) and tri-methylamine 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 AOAC (1975) whereas fat oxidation was measured as peroxide value (PV) by AOCS (1989) and thio-barbiutiric acid (TBA) by spectrophotometric method (Tarladgis *et al.*, 1960). Sensory analysis was carried out by trained 7 panelists using a nine point hedonic scale based on appearance, colour, odour, flavour, taste and viscosity as described by Peryam and Pilgrims (1957). The overall impression was scored as overall acceptability. A sensory score of 4 was taken as the limit of acceptability.

Storage studies were carried out at ambient temperature 28±2°C. The products were analyzed periodically for every 15 days for changes in various parameters as mentioned above.

Results and Discussion

Heat penetration characteristics of a product gives an idea of final product quality and safety. The come up time, which is the time required for the retort to attain the set retort temperature should be as low as possible. In the present study, it was in the range of 4-5 min. In general, the F_0 recommended for fish products ranges from 5-10 (Frott and Leweis, 1994). In this study, an F_0 value of 6 min was used. Heat penetration characteristics of soups at the three temperatures clearly indicate that the heating rate was very fast at 130°C as compared to other temperatures (Fig. 1-3). Time required to attain 1 log cycle reduction (f_h values) were 9.5, 6.5 and 4.5 for 110°C, 121.1°C and 130°C respectively, which indicates that at 110°C, it was twice the time as that of 130°C (Table 2). Decrease in f_h value for 130°C was due to increase in sterilization value. The soup at 130°C had a very little heating lag factor (j_h) and cooling (j_c) lag factor, which indicates both heating and cooling was faster at 130^0 C. The Ball's process time was only 6.6 min for the soup processed at 130°C compared to 13.5 and 85.5 min for 121.1 and 110°C respectively. The total process time for 110°C, 121.1°C and 131°C was 87.89, 16.39 and 9.5 min respectively. This clearly indicates that the pouches containing equal pack weight of 100 ml soup can be processed to F_0 value of 6 min within 10 minutes at 130°C which is 9.2 and 1.7 times lesser than at 110 and 121.1°C, respectively.

Table 2: Heat penetration parameters

Parameters	110°C	121.1°C	130°C
j_h	0.71	0.64	0.31
J_c	0.59	0.64	0.36
f_h, min	9.5	6.5	4.5
U	79.22	6.66	1.04
f_h/U	0.12	0.98	4.30
g	2.3×10^{-8}	0.49	4.89
B, min	85.57	13.49	6.60
CUT, min	4	5	5
T_B, min	87.89	16.39	9.5

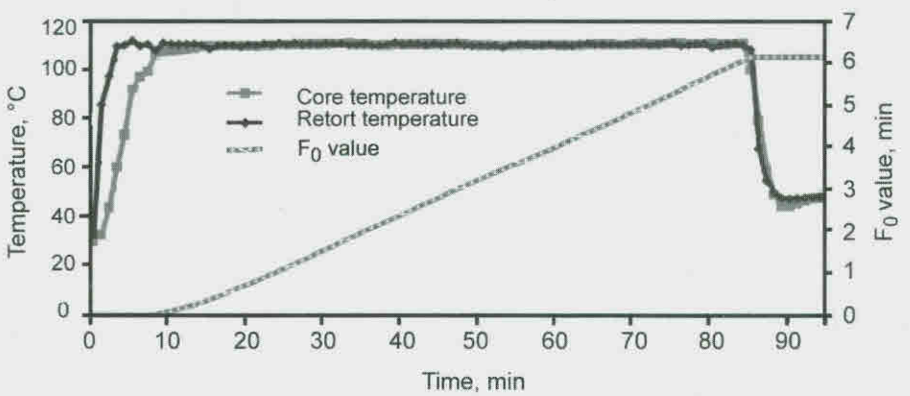


Fig. 1: Heat penetration characteristics of soup at 110°C

The edible portion of the seafood sample used had water content in the range of 78-84.7% in which shrimp has the lowest water content (Table 3). Crude protein content was observed to vary from 13.6-17.8% with shrimp having higher protein content. Both squid and crab had similar water, crude protein and ash content. The crude fat content was higher in squid compared to other two samples. The major changes up on soup preparation in the proximate composition is the increased water and crude

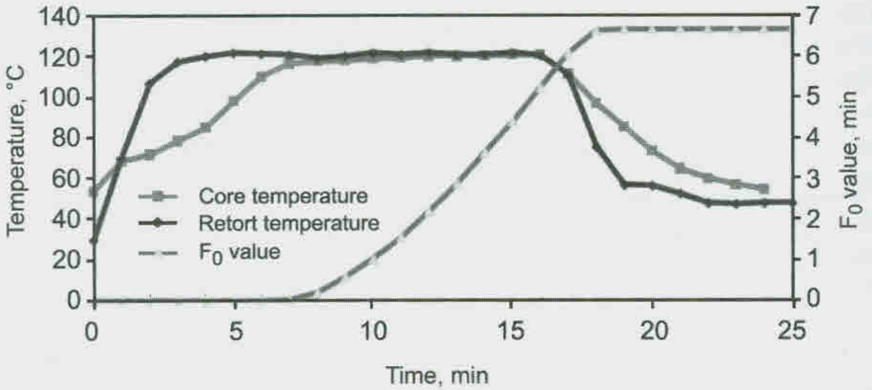


Fig. 2: Heat penetration characteristics of soup at 121.1°C

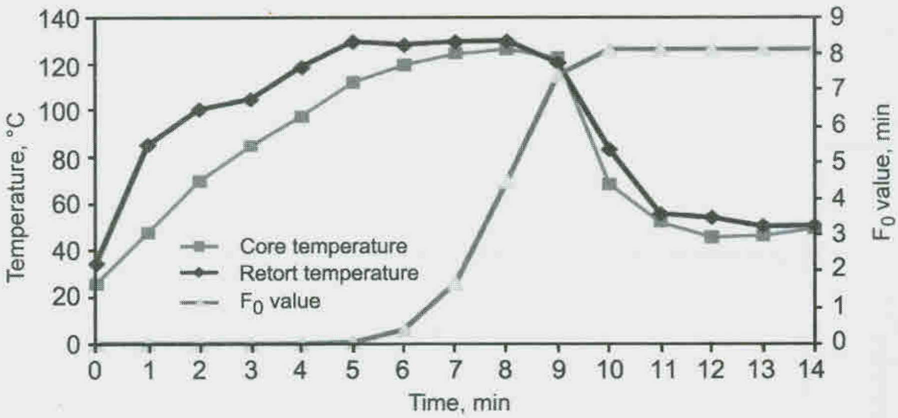


Fig. 3: Heat penetration characteristics of soup at 130°C

fat content and decreased crude protein and ash content. The soup prepared from these raw materials had very high water content due to the extraction of water from these raw materials and the addition of large quantity of water in preparation of soup. The crude fat content increased as butter was used in the preparation of soup. A decrease in crude protein and ash content was observed for the raw soup. A slight variation in the proximate composition was observed for the thermal processed soup. There was slightly higher decrease in the water content, crude fat and protein content for the soup processed at 110°C compared to soup processed at 121.1 and 130°C. There was not much variations in the content of ash for the soup processed at different temperatures. Least decrease in protein and water content was observed for the soup processed at 130°C, indicating its efficiency in maintaining the higher protein content.

Table 3: Proximate composition of raw seafood materials and processed seafood soup

Raw material and soup	Moisture, %	Crude fat, %	Ash, %	Crude protein, %
Shrimp	78.18±0.13	0.29±.08	1.26±0.03	17.83±0.02
Squid	84.69±0.92	0.65±0.12	0.28±0.13	13.74±1.13
Crab	84.14±0.2	0.25±0.05	0.25±0.12	13.62±0.40
Raw soup	93.1±0.65	0.99±0.12	0.03±.01	5.8±0.10
Soup processed at 110°C	91.7±0.51	0.81±0.09	0.034±0.01	4.84±0.06
Soup processed at 121.1°C	92.04±0.08	1.39±0.13	0.036±0.01	4.83±0.01
Soup processed at 130°C	92.47±0.7	1.19±0.08	0.035±0.00	5.51±0.60

Mean±SD; n=3

Total volatile base-nitrogen in fish muscle and fishery products includes NPN (Non Protein Nitrogen) fractions, which include ammonia, monomethyl amine, dimethyl amine and trimethyl amine. Both trimethylamine (TMA) and total volatile base nitrogen (TVB-N) represent the microbial spoilage of fishery product. These are of minor significant in muscle of living organism but most important in assessing the quality as they are found in common pattern of spoilage. Initially, the TVB-N and TMA-N content of the species used in the study was in the range of 4.2 – 9.3 and 1.6 – 5.6 mg N_2 $100g^{-1}$ respectively (Table 4), which were well below the maximum acceptable limit of 30-35 and 10-15 mg N_2 $100g^{-1}$ respectively. This clearly indicates the freshness of the raw materials used in the study. Up on preparation of seafood soup, both TMA-N and TVB-N values increased to 10.6 and 17.7 mg N_2 $100g^{-1}$ respectively (Table 5), which could be attributed to the heat induced increase. Thermal processing again reduced the content of TMA-N and TVB-N values. Relatively higher reduction was observed for the soup processed at 130°C followed by 121.1 and 110°C and the increase in the values of TMA-N and TVB-N was not observed in any of the samples indicating that the lethality given was sufficient to destroy all the bacteria responsible for the formation of TMA and TVB-N.

Fat oxidation and hydrolysis products measured as PV, TBA and FFA value are given in Table 4 and 5. Peroxide value, which gives an indication of primary oxidation could not be detected in both raw material as well as processed product (data not shown). This could be due the highly

Table 4: Biochemical quality parameters of Seafood material used in the study

Biochemical parameters	Shrimp	Squid	Crab
TVB-N, mg N_2.100g^{-1}	9.32±1.30	4.20±1.6	7.73±2.10
TMA, mg N_2.100g^{-1}	5.61±0.93	1.68±1.34	5.15±1.30
FFA, as % oleic acid	13.34±0.10	5.05±0.05	16.51±0.03
TBA, mg malonaldehyde kg^{-1}	0.09±0.01	0.069±0.08	0.06±0.39

Mean± SD: n=3

Table 5: Changes in biochemical quality of seafood soup thermal processed at different temperatures in retortable pouches

Composition (%)	Process temperature	Raw soup	Storage days		
			0	30	45
pH	110ºC	6.77±0.03	6.92±0.03	6.85±0.011	6.86±0.21
	121.1ºC	6.77±0.03	6.94±0.02	6.95±0.31	6.81±0.07
	130ºC	6.77±0.03	6.97±0.1	6.96±0.04	6.96±0.021
FFA, as % oleic acid	110ºC	3.91±2.08	5.6±0.54	4.93±1.13	4.87±0.44
	121.1ºC	3.91±2.08	6.54±0.81	5.74±0.47	5.65±0.43
	130ºC	3.91±2.08	7.34±0.09	6.38±0.54	5.8±01.1
TBA, mg malonaldehyde kg^{-1}	110ºC	0.22±1.2	0.055±0.9	0.062±1.02	0.113±.02
	121.1ºC	0.22±1.2	0.047±0.89	0.039±1.11	0.113±.04
	130ºC	0.22±1.2	0.039±0.99	0.063±0.98	0.199±1.03
TVB-N, mg N_2.100g^{-1}	110°C	17.72±1.8	9.45±1.3	9.02±0.98	8.72±1.2
	121.1°C	17.72±1.8	9.05±1.8	6.97±1.9	6.31±1.4
	130°C	17.72±1.8	7.72±1.1	7.63±1.05	4.17±1.6
TMA-N, mg N_2 100g^{-1}	110°C	10.64±2.1	6.66±2	6.24±0.88	6.1±0.32
	121.1°C	10.64±2.1	6.33±1.40	5.14±1.12	5.8±1.1
	130°C	10.64±2.1	4.73±1.67	4.6±0.88	2.08±1.8

Mean ± SD; n=3

unstable nature of primary oxidation products, which breakdown further into various other compounds. Similar results are reported for fish paste (Thankamma *et al.*, 1998) and Shrimp kuruma (Mohan *et al.*, 2006) thermal processed in retortable pouches. TBA value gives an indication of aldehyde products which are stable fat oxidation products. Initially, TBA value for crab, squid and shrimp was 0.06, 0.069 and 0.094 mg Malonaldehyde kg^{-1} which indicates the good raw material quality. During the preparation of soup, the TBA value rose to 0.22 mg Malonaldehyde kg^{-1}, which could be attributed to the addition of butter and heating of the contents. Up on thermal processing, TBA value reduced to 0.04 – 0.05, in which greater reduction was observed for the soup processed at 130°C and least reduction was noticed for 110°C. It could be due to the loss of secondary oxidation products during thermal processing or reaction with other compounds like amino group (Pokorny, 1981; Maruf *et al.*, 1990; Aubourg *et al.*, 1995). During the storage at ambient temperature, it showed a slight increasing trend. However, in none of the samples, the value crossed 0.2 mg.malonaldehyde kg^{-1} during the storage period of 45 days. FFA content indicates the degree of lipid hydrolysis. The value of FFA as % oleic acid in the raw materials ranged from 5-16, with least observed for squid and highest for crabs. Up on preparation of soup, it got reduced to 3.9, which could be attributed to the heat induced effects. However, during thermal processing and its values increased to 5.6-7.3 % oleic acid and during the subsequent storage period it further followed a decreasing trend.

pH value can be used objectively to assess the quality of seafood products. The pH of the raw soup was 6.77 which increased to 6.9 up on thermal processing in all the different temperature (Table 5). During the storage period, pH was stable in the soup processed at 130°C where as the soup processed at 110°C showed a slight decreasing value. Initially, the viscosity of the raw soup was very high (996 cP), which decreased to 780 – 860 cP up on thermal processing at different temperatures (Table 6). This decrease could be due to the dissolution of added starch molecules at higher temperature as reported by Martin *et al.*, (1978) for thermally processed soy beverages. The least decrease in viscosity was observed for the soup processed at 130°C, followed by 110 and 121.1°C, which indicates that thermal processing at higher temperature gives better soup product. At 110°C, although it has taken very long time for processing compared to 121.1°C, it maintained higher viscosity. This could be due to the gelatinization of starch based products up on heat exposure to longer periods. During the storage for one month, the viscosity increased slightly in all the samples and decreased during further storage.

Changes in instrumental colour (CIE L*, a* and b*) is given in Table 6. The L* value of raw soup was 91.6 which decreased in all the samples up on thermal processing at different temperatures. The maximum decrease in lightness was observed for the soup samples processed at

Table 6: Changes in viscosity and instrumental colour of seafood soup thermal processed at different temperatures in retortable pouches

Parameter	Process temperature	Raw soup	Storage days		
			0	30	45
Viscosity, cP	110ºC	996.45±2.2	829.58±1.7	880.64±1.2	546.7±2.1
	121.1ºC	996.45±2.2	780.34±0.34	785.33±1.2	867.7±0.48
	130ºC	996.45±2.2	860.68±.09	870.57±1.3	571.86±0.55
L*	110ºC	91.67±0 .01	51.80±.06	52.47±0.03	52.55±0.13
	121.1ºC	91.67±0 .01	53.37±.32	54.72±0.02	53.78±1.3
	130ºC	91.67±0 .01	57.68±1.7	55.19±1.2	55.61±0.5
a*	110ºC	-1.72±0.01	-0.63±0.22	-0.65±.05	-0.83±1.2
	121.1ºC	-1.72±0.01	-0.432±0.04	-1.02±.05	-0.124±0.8
	130ºC	-1.72±0.01	-0.96±0.39	-0.99±0.12	-1.054±0.01
b*	110°C	9.65±0.04	5.32±0.76	5.634±0.34	4.18±0.32
	121.1°C	9.65±0.04	5.36±0.41	5.13±0.09	4.99±0.56
	130°C	9.65±0.04	5.47±0.53	5.04±0.07	4.83±0.22

Mean ± SD; n=3

110°C followed by 121.1 and 130°C. This drastic decrease in the lightness of the soup could be attributed to the heat induced changes, which causes the oxidation of various pigments. However, during the subsequent storage period, the changes in the lightness value were relatively very less. The a* value for the raw soup was -1.7 indicating slight greenish colour of the soup. Up on thermal processing, it reduced to -0.43 to -0.96, in which processing at 130°C showed a least change. During the storage, the soups processed at 110 and 130°C showed an increasing trend where as the soup processed at 121.1°C exhibited a varying trend. b* value of the raw soup was 9.6 indicating the yellowness nature of soup. It reduced to 5.3 - 5.4 up on thermal processing and it followed a decreasing trend with the increasing storage period in all the soup samples.

The soup processed in all the three different temperature had good sensory acceptability. However, the soup processed at 130°C was rated better for all the sensory attributes compared to 121.1 and 110°C (Table 7). The soup processed at 110°C had least preference, particularly the appearance, flavour and viscosity was rated very low compared to soup processed at other temperatures. The sensory viscosity of the soup processed at 130°C increased compared to raw soup whereas for the soup processed at other temperatures it reduced slightly. Most of the sensory attributes particularly appearance, colour, flavour and viscosity was maintained in the storage duration as well for the product processed at 130°C, whereas for the soup processed at 121.1 and 110°C these attributes showed a slight decreasing trend with the storage period. The overall acceptability indicates that the soup processed at all the three different temperatures were in acceptable condition till 45 days of storage.

Table 7: Changes in sensory quality of seafood soup thermal processed at different temperatures in retortable pouches

Sensory attributes	Raw soup	110°C			121.1°C			130°C		
		0 d	30 d	45 d	0 d	30 d	45 d	0 d	30 d	45 d
Appearance	8.8	7	6.8	6.5	8	7.8	7.3	8.3	8.2	8
Colour	8.6	7.5	7.4	7.1	8.1	7.9	7.4	8.5	8.3	8.1
Odour	8.7	7.8	7.8	7.5	7.6	8.1	7.9	8.7	8.4	8.6
Flavour	8.7	7.2	7	7	8	7.2	7.1	8	8.8	7.9
Viscosity	8	7.6	7.7	7.4	8	7.9	7.6	8.6	8.5	8.6
Taste	8.8	7.5	7.4	7.3	8.3	7.9	7.6	8.5	8.6	8.1
Overall acceptability	8.8	8.2	8.1	7.9	8.3	8.2	7.9	8.5	8.5	8.2

Mean ±SD; n=7

Conclusion

The present study indicates that the ready to serve pleasant seafood cocktail soup can be produced in retortable pouches. The process time for the thermal processing of seafood soup to a lethality of 6 min was only 9.5 min at 130°C compared to 16.4 and 87.9 min at 121.1 and 110°C, which resulted in drastic reduction of process time. This reduction in process time was advantageous for maintaining better quality of the soup. Thermal processing of soup resulted in increased water and fat content and reduced protein content. The TBA value was least for the soup processed at 130°C compared to soup processed at 121.1 and 110°C. The decrease in viscosity and lightness of the soup was higher for the soup processed at 110 and least for the soup processed at 130°C. Sensorily, the soup processed at 130°C was appreciated better followed by 121.1 and 110°C.

Authors would like to thank Director, CIFT, Cochin for providing facilities to conduct this study and permitting to publish this work.

References

AOAC (1975) Official Methods of Analysis, 12th edn., Association of Official Analytical Chemists, AOAC International, Washington, DC, USA

AOAC (2006) Official Methods of Analysis, Association of Official Analytical Chemists International, Maryland, USA

AOCS (1989) Official Methods and Recommended Practices of American Oil Chemists Society, 5th edn., AOAC International, Washington, DC, USA

APHA (1998) Standard Methods for the Examination of Water and Waste Water, 20th edn., Washington, DC, USA

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, Z Lebensm Unters Forsch 200: 252-255

Ball, C.O. and Ulson, F.C.W. (1957) Sterilization in food technology, McGraw Hill Book Co., New York: 654 p.

Bindu, J., Gopal, T.K.S. and Nair, T.S.V. (2004) Relay to eat mussel meat processed in retort pouches for retail and export market, Packag. Technol. Sci. 17: 113-117

Busta, F.F. (1967). Thermal inactivation characteristics of bacterial spores at ultra high temperatures. Appl. Microbiol. 15: p 640.

Chia, S.S., Baker, R.C. and Hotchlaiss, J.H. (1983). Quality comparison of thermo processed fishery products in cans and retortable pouches. J. Food Sci., 48: pp 1521-1525, 1531.

Conway, E.J. (1950) Microdiffusion Analysis of Volumetric Error, Crosby, Cockwood and Sons Ltd., London

Frott, R., and Leweis, A.S. (1994) Canning of meat and fish products (Frott, R. and Leweis , A.S., Eds.), p. 200–202, Chapman and Hall, UK

Goldfarb, P.L. (1970). Pouch for low acid foods. J. Mod. Pack.. 43(12), pp 71-76.

Gopal, T.K.S. and Ravishankar, C.N. (2001) Packaging of value added fish products, Indian Food Ind. 20(3): 64-67

Hu, K.H., Nelson, A., Legault, R.R. and Steinberg, M.P. (1955) Feasibility of using plastic film packages for heat processed foods, Food Technol., 19(9): 236-240

BIS (1971) IS: 2168 Specification for pomfret canned in oil, Bureau of Indian Standards, New Delhi

Martin, R.E., Gray, R.J. and Pierson, M.D. (1978) Quality assessment of fresh fish and the role of naturally occurring microflora, Food Tech 32(5): 188-198

Maruf, F., Ledward, D., Neale, R. and Poulter, R. (1990) Commercial nutritional quality of Indonesian dried-salted mackerel (*Rastrelliger kanagurta*), Int. J. Food Sci. Tech. 25: 66-77

Mohan, C.O., Ravishankar, C.N., Bindu, J., Geethalakshmi, V. and Gopal T.K.S. (2006) Effect of thermal process time on quality of shrimp kuruma in retortable pouches and aluminium cans, J. Food Sci. 71(2): 496-500

NCA (1968) Laboratory Manual Food Canners and Processors, Vol. 1, National Canners Association, AVI Publishing Co., West Port, USA

Peryam, D.R. and Pilgrims, F.J. (1951) Hedonic scale method of measuring food preferences, Food Technol. 2: 9-14

Pfeifer, V.F. and Vojnovich, C. (1952) Continuous sterilization of media in biochemical processes, Ind. And Eng. Chem. 44: 1940-1946

Pokorney, J. (1981) Browning of lipid protein interactions, Prog. Food Nutr. Sci. 5: 421-428

Ramaswamy, R.P. and Singh, R.P. (1997) Sterilization process engineering (Rotsetein, E., Sing, R.P., and Valentas, K., Eds.), Chapter 2,Handbook of Food Engineering Practice, p. 1-69, Boca Raton, CRC Press, FL, USA

Ravishankar, C.N., Gopal, T.K.S., and Vijayan, P.K. (2002) Studies on heat processing and storage of seerfish curry in retort pouches, Packag. Technol. Sci. 15: 3-7

Richard, A.J., Leoyd, L.K. and Nicholas, A.M. (1973) High temperature short time processing of suspensions containing bacterial spore, J. Food Sci. 38: 168-172

Tarladgis, G.B., Watts, M.B. and Younathan, M.T. (1960) A distillation method for the quantitative determination of malonaldeyde in rancid foods, J. Am. Oil Chem. Soc. 37: 44-50

Thankamma, R., Gopal, T.K.S. and Iyer, T.S.G. (1998) Storage of heat processed fish paste in retort pouch, In: Advances and Priorities in Fisheries Technology (Balachandran et al., Eds). Society of fisheries technologists (India) p. 246-250, In: Advances and Priorities in Fishery Technology (Balachandran, K.K., Iyer, T.S.G., Madhavan, P., Joseph, J., Perigreen, P.A., Raghunath, M.R. and Varghese, M.D., Eds.), Society of Fisheries Technologists (India), Cochin

Townsend, C.T., Esty, J.R. and Baselt, F.C. (1938) Heat resistance studies on spores of putrefactive anaerobes in relation to determination of safe processes for canned foods, Food Res. 3: 323-346