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Standardization of Process Parameters for Ready-to-Eat Crab Koftha in Indigenous Polymer-Coated Tin-Free Steel Cans

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Abstract

Koftha is a traditional North Indian food consisting of whole cooked potatoes in spicy gravy. Fried crab balls with koftha medium was packed in indigenous polymer-coated easy open-end tin-free steel cans of 307 ×109 size and processed at 121.1°C to three different F_0 values of 5, 6 and 7 with cook values of 61, 75 and 78 min respectively. The fried and processed crab balls were evaluated by sensory analysis, instrumental texture and colour analysis. Even though the processed cans for all three F_0 values were found to be commercially sterile, the product processed to F_0 6 was found to be ideal with regard to all sensory attributes. The one way analysis of variance of all the instrumental textural characteristics *viz.*, hardness 1, hardness 2, cohesiveness, springiness, gumminess and chewiness of different thermal process treatments were found to be significant at 5% level of significance. The treatment means comparisons for instrumental textural characteristics of different thermal process treatments were performed using Tukey's Test and the values were maximum for fried crab balls and minimum for crab balls processed to F_0 6 except for gumminess which was minimum for F_0 7. Considering the sensory and instrumental textural characteristics, F_0 6 was identified as the optimum process for crab koftha.

Keywords: Crab koftha, polymer-coated tin-free steel cans, heat penetration, texture profile analysis, colour analysis

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Introduction

Ready-to-eat or convenience foods are designed to save time in the kitchen and for convenience as they require minimum preparation. Typically, they need to be just warmed and are packed assuming a long shelf life with little loss of flavour and nutrients over time. Ready-to-eat foods traditionally processed in rigid containers like tin and aluminum cans (Vijayan & Balachandran, 1986; Mohan, 2004), had disadvantages like higher cost of container, metallic flavour and discolouration of the product. The higher cost of the container resulted in the collapse of canning industry in India (Sreenath et al., 2007). An innovation in this direction is the indigenous polymer-coated easy open-end tin-free steel (TFS) cans. The suitability of TFS for packing various products like fruits, vegetables and milk powder has been described by Mc Farlane (1970) and Naresh et al. (1980). The unique features of the TFS cans like EOEs (Easy Open Ends), universal lacquer and comparatively lower price make it an ideal container for thermal processing of fish and fish products (Sreenath et al., 2007).

The physical properties of indigenous polymer-coated TFS cans such as the air pressure test, tests for food contact applications, test for seam integrity and the double seam integrity parameters such as percentage overlap, body plate thickness and endplate thickness were conducted by Sreenath et al. (2008). The results indicated that the indigenous polymer-coated EOE TFS cans are suitable for the thermal processing of fish and fish products.

Crab is an important seafood commodity, relished by many communities throughout the world. In India, crab is preferred along the southern coast in traditional fried and curry recipes. Crab items are being exported to a number of countries contributing 1% by quantity and 1.9% by value to the total export of marine products from India during the year 2006-2007 (MPEDA, 2008). Even though the method of canning crab has been described by many (Edwards & Early, 1978; Villanueva & Acevedo 1976; Gopakumar, 1988; Howgate, 1984), little information is available on the standardization of process parameters for ready-to-eat crab products. The present work was an attempt to develop a ready-to-eat convenience product from crab meat in indigenous polymer-coated TFS cans and to standardize various process parameters.

Table 1. Ingredients for crab balls

Cooked crab meat	1000 g
Cooked potatoes	2000 g
Egg (beaten)	4 numbers
Butter	40 g
Pepper	20 g
Corn starch	250 g
Salt	To taste

Materials and Methods

Indigenous polymer-coated easy open-end (EOE) TFS cans (2-piece can of 307 × 109 size of 169.8 g capacity) supplied by M/s Amtech Packs, Mysore, India were used for the study. The cans were made of electrochemically chromium-coated steel (ECCS) plate with clear polyethylene terephthalate (PET) coating on either side which acts as a universal lacquer thereby offering both acid and sulphur resistance.

About 50 kg of crab (*Portunus pelagicus* Linnaeus, 1766) was procured in live condition from Fort Cochin fish landing centre and transported to the laboratory under chilled condition. The crabs were washed in potable water to remove adhering dirt and boiled for 10 min at 95-100°C. The semi-cooked crabs were cooled to room temperature and the meat was separated from the shell with the help of stainless steel knife. The crab meat was macerated with the ingredients (Table 1) in a mechanical homogeniser (Tecator 1094 Homogenizer, Sweden) and hand-rolled into small balls of about 30 mm diameter. The balls were deep fried in sunflower oil for 3 min at 170-180°C and kept aside. The ingredients used for the preparation of crab koftha gravy are given in Table 2. Small onion, green chilly and ginger were washed well and chopped. Oil was heated in a pan and the chopped items were fried until light brown in colour. Turmeric, chilly and meat masala powder were added and heated for about 30 sec. Milk extracted from grated coconut was added along with water and cooked for 10 min at 100°C.

General bacteriological quality of the crab balls and koftha gravy was assessed for raw, cooked and thermal processed samples for total aerobic plate count (TAPC) (AOAC, 1990).

About 60 g of fried crab balls and 100 g of koftha gravy were packed in each polymer-coated easy open-end TFS cans (169.8 g capacity), maintaining a head space of 6 mm. The cans were fixed with thermocouple glands (Ellab model No: GKJ 13009 C042) and were exhausted and double seamed. The sealed cans were divided into three batches and were loaded inside the retort (John Fraser & Sons Ltd, UK. Model No: 5682) separately and processed at 121.1°C to F_0 values of 5, 6 and 7. The cans were cooled using water to a core temperature of 40°C. The thermocouple output was recorded using Ellab data recorder (Ellab, Model TM 9608, Denmark).

The data generated were analysed and heat penetration curve was plotted on a semi log graph paper with temperature deficit against time. The lag factor of heating (J_h), lag factor of cooling (J_c), slope of heating curve (f_h) and U (time in minutes for sterilization at retort temperature) values were determined. Using these parameters, the process time (B) for crab koftha processed to three F_0 values was calculated according to the mathematical method of Stumbo (1973). The total process time was calculated by adding 58% of come up time (CUT) to B. Cans processed to different F_0 values were tested for commercial sterility as per IS: 2168 (1971) using thioglucolate broth.

Texture Profile Analysis (TPA) of fried crab balls and crab balls processed to three F_0 values was performed using the food texture analyser (Lloyds Instruments, UK; model LRX Plus) and Lloyd Instruments NEXYGEN data analysis and applications software. The test was conducted at a speed of 12 mm s^{-1} using a 50 N load cell with a 50 mm diameter cylindrical probe. The samples were subjected to a double compression of 40% with a trigger force of 0.5 kg, during which various textural parameters like hardness 1, hardness 2, cohesiveness, gumminess, springiness and chewiness were determined.

Colour measurements were done using a Hunter lab Colourimeter Model No D/8-S (Miniscan XE Plus)

Table 2. Ingredients for koftha gravy

Small onion	250 g
Green chilly	10 g
Ginger	20 g
Curry leaves	2–3 g
Turmeric powder	5 g
Chilly powder	10 g
Meat masala	7 g
Salt	to taste
Grated coconut	250 g
Water	500 ml

with geometry of diffuse /8° (sphere 8 mm view) and an illuminant of D65/10 deg. Crab balls were blended and the colour was measured and expressed as the mean of measurements of the homogenized ball. In the Hunter scale, L* measures lightness and varies from 100 for perfect white to zero for black, a* measures redness when positive, gray when zero, and greenness when negative, and b* measures yellowness when positive, gray when zero, and blueness when negative.

The sensory characteristics of the products were analysed by ten trained panelists using a 10-point hedonic scale (Vijayan, 1984). A score of 4 was taken as limit of acceptability. Based on the results of organoleptic evaluation and instrumental sensory analysis, the optimum F_0 value for crab koftha in TFS cans was standardised.

Statistical analysis was carried out with SAS 9.2 Software. One way analysis of variance was performed to see the effect of thermal processed treatments at different F_0 values. Tukey's test was used to compare the treatment means.

Results and Discussion

The Total Aerobic Plate Count (TAPC) of crab balls and koftha gravy before thermal processing indicated that the crab balls before frying had a TAPC of $1.76 \times 10^6 \pm 0.99$ cfu g^{-1}. The koftha gravy before subjected to thermal processing had a TAPC of $1.42 \times 10^6 \pm 0.71$ cfu g^{-1}. The bacteriological analysis conducted revealed that the microbiological acceptability of the condiments and crab balls were within acceptable limits. The sterility test conducted proved that processed cans of all the three batches were commercially sterile. The thioglycollate broth tubes inoculated with the samples did not develop any turbidity even after 96 h of incubation at 37°C, indicating that the thermal processing was sufficient to bring about commercial sterility.

The cans were processed to F_0 values of 5, 6 and 7. The recommended F_0 value for various fish and fish products is 5-20 (Frott & Lewis, 1994). The heat penetration data of crab koftha in indigenous polymer-coated TFS cans processed to F_0 5, 6 and 7 are presented in Table 3 and the heat penetration curves with respect to F_0 and cook value are diagrammatically represented in Figs 1-6. It is recommended that the Cum Up Time (CUT) should be as short as possible (Anon, 1968). It is evident from the figures that the CUT was in the range of 6-8 min. The g value which is the final temperature deficit decreased with the increase in F_0 values. The U values were considered to be 5, 6 and 7 for F_0 5, 6 and 7 as the processing was carried out at 121.1°C. The process time (B) taken to reach F_0 5, 6 and 7 were 17.6, 26.9 and 27.1 min. The cook value increased with F_0 value and was 61, 75 and 78 min, respectively. The total process time was 21.6, 29.8 and 31.7 min, which was found out by adding 58% of CUT to B.

The thermal processing experiment conducted, clearly indicates that the indigenous polymer-coated easy open-end tin-free steel cans are suitable for

Table 3. Heat penetration data of crab koftha in indigenous polymer-coated TFS cans processed to F_0 5, 6 and 7

Parameters	F_0 5	F_0 6	F_0 7
J_h	0.85	0.98	0.87
J_c	1.86	1.15	0.681
f_h	18.5 min	25.5 min	18.5 min
U	5 min	6 min	7 min
f_h/U	3.59	4	2.45
g	4.99	4.42	2.26
B	17.6 min	26.9 min	27.1 min
Total process time	21.6 min	29.8 min	31.76 min
C_g	61 min	75 min	78 min

J_h -lag factor of heating; J_c - lag factor of cooling; f_h - slope of heating curve; U - number of minutes for sterilisation at the retort temperature; g - final temperature deficit; C_g - cook value; B - Ball's process time.

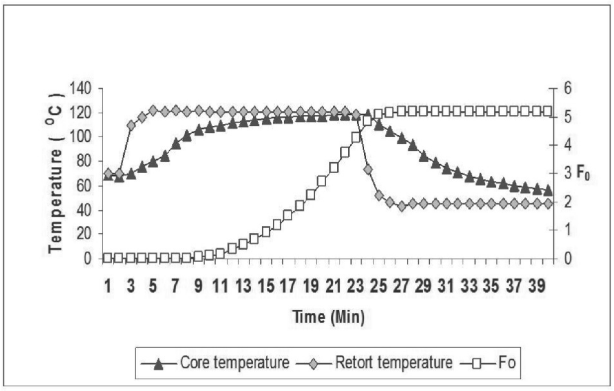

Fig. 1. Heat penetration characteristics with respect to F_0 of crab koftha processed to F_0 5 in TFS can

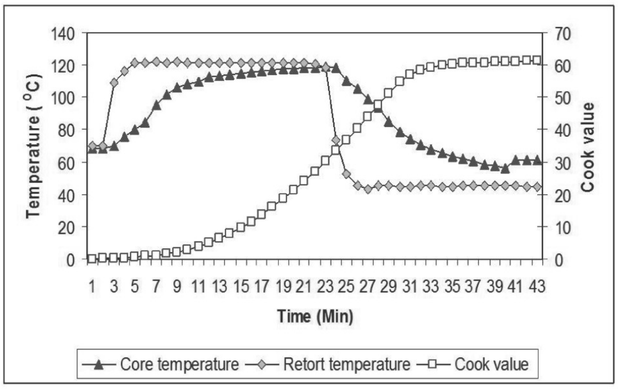

Fig. 2. Heat penetration characteristics with respect to cook value of crab koftha processed to F_0 5 in TFS can

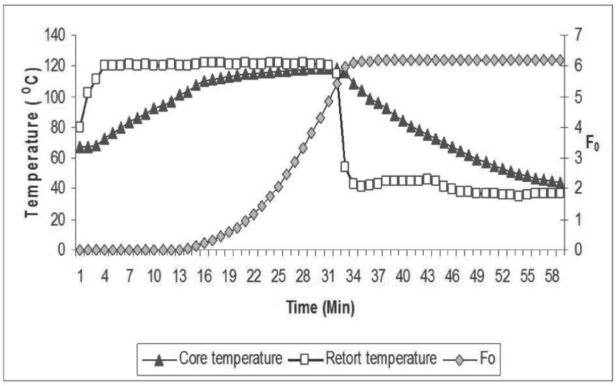

Fig. 3. Heat penetration characteristics with respect to F_0 of crab koftha processed to F_0 6 in TFS can

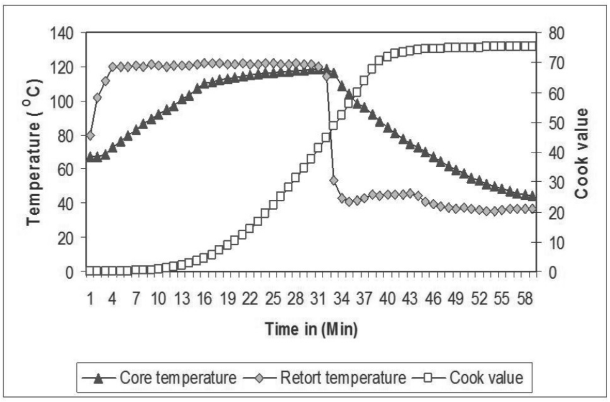

Fig. 4. Heat penetration characteristics with respect to cook value of crab koftha processed to F_0 6 in TFS can

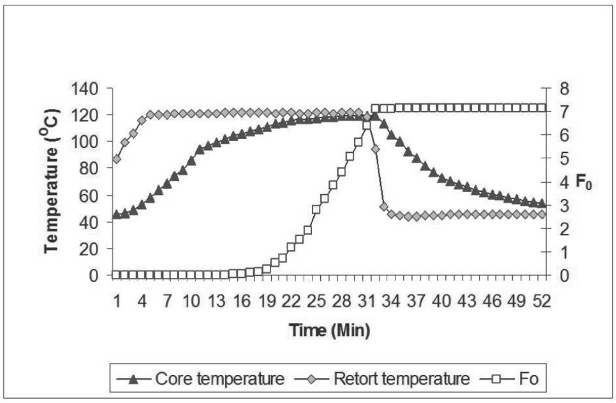

Fig. 5. Heat penetration characteristics with respect to F_0 of crab koftha processed to F_0 7 in TFS can

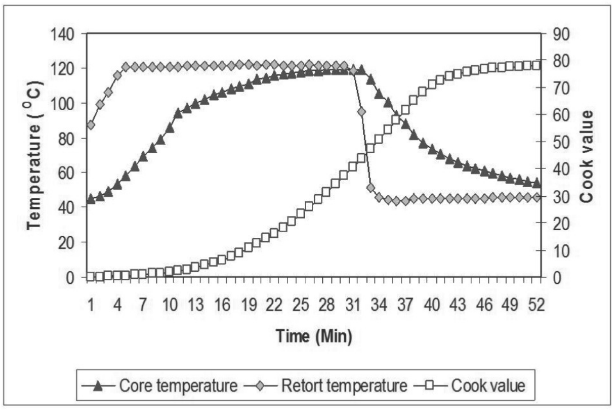

Fig. 6. Heat penetration characteristics with respect to cook value of crab koftha processed to F_0 7 in TFS can

commercial processing of ready to eat crab koftha and similar food preparations. Mallick (2006) reported that thermal processed rohu curry in TFS cans was acceptable even after one year of storage with respect to sensory and biochemical parameters. Investigations carried out by Mahadeviah & Gowaramma (1996) showed that the organoleptic quality of mackerel in brine was quite acceptable when packed in TFS cans up to 12 months of storage at 37°C. Hottenroth (1972) found that chromium

Table 4. Instrumental textural characteristics of different treatments of crab balls

Treatment	Instrumental textural characteristics					
	Hardness 1	Hardness 2	Cohesiveness	Springiness	Gumminess	Chewiness
cb fried	$15.108^{A} \pm 1.169$	$12.278^{A} \pm 0.215$	$0.097^{A} \pm 0.006$	$1.887^{A} \pm 0.269$	$1.464^{A} \pm 0.026$	$2.765^{A} \pm 0.442$
cb F_o 7	$11.36^{AB} \pm 1.503$	$10.352^{B} \pm 0.415$	$0.086^{A} \pm 0.013$	$1.619^{A} \pm 0.500$	$0.669^{B} \pm 0.378$	$1.674^{BC} \pm 0.246$
cb F_o 5	$10.252^{B} \pm 2.538$	$5.673^{D} \pm 0.803$	$0.015^{B} \pm 0.004$	$0.837^{B} \pm 0.017$	$1.292^{A} \pm 0.200$	$2.387^{AB} \pm 0.372$
cb F_o 6	$9.712^{B} \pm 0.965$	$7.698^{C} \pm 0.606$	$0.096^{A} \pm 0.010$	$1.372^{AB} \pm 0.024$	$0.938^{AB} \pm 0.194$	$1.284^{C} \pm 0.243$

Results are Mean ± Standard deviation of five observations. Treatment means with common letters are homogenous.

Table 5. Colour analysis of crab koftha

Sample	L* values	a* values	b* values
Crab balls (Fried)	58.92 ± 0.11	2.1 ± 0.05	15.875 ± 0.32
F_0 5	58.850 ± 0.22	2.330 ± 0.17	25.410 ± 0.73
F_0 6	58.673 ± 0.80	2.733 ± 0.15	17.693 ± 0.48
F_0 7	57.383 ± 0.332	3.380 ± 0.11	24.020 ± 0.86

Results are Mean ± Standard deviation of five observations.

plated cans were suitable for packing slightly or moderately corrosive, low acidic fish products for over a period of one year.

The results of TPA of fried crab balls and crab balls processed to F_0 5, 6 and 7 in koftha gravy are shown in Table 4. The values for fried crab balls with respect to hardness 1 and 2 decreased after processing to different F_0 values. Maximum decrease was observed in samples processed to F_0 5. Cohesiveness, the ratio of the positive force during the second compression to that of first was maximum for the fried crab balls scoring a value of 0.12. These values decreased after processing to F_0 5, 6 and 7. The gumminess which is the product of hardness 1 and cohesiveness was also maximum in fried crab balls. After heat processing, the gumminess was maximum for samples processed to F_0 6 and minimum for F_0 5. The springiness and the chewiness values also showed the same trend.

In the case of gumminess, the trend was slightly different as after the initial drop, the gumminess increased in samples processed to F_0 6 and then slightly reduced to F_0 7 processed samples. The initial drop in the textural properties may be due to the absorption of the gravy by the fried crab balls and later increase due to gelatinization of starch added in the form of potato and corn flour, at high temperature during processing (Yang & Park, 1998). Lazos (1996) reported an increase in texture profile in fried fish balls with an increase in temperature. The results on octopus (Eugenios, 2004), squid (Sreenath et al., 2007) and oil sardine (Ali et al., 2005) indicated a reduction in values of texture properties with increase in processing time. The effect of thermal processing at different F_0 values was found significant at 5% level of significance for all the instrumental textural characteristics *viz.*, hardness1, hardness2, cohesiveness, springiness,

Table 6. Sensory characteristics of crab koftha in indigenous TFS cans

Parameter	F_0 5	F_0 6	F_0 7
Appearance	8.5	7.2	6.5
Colour	8.2	8.3	7.5
Odour	8.0	8.5	7.5
Flavour	8.2	8.5	7.5
Taste	7.9	8.2	8.0
Texture	7.0	8.0	7.5
Overall acceptability	7.9	8.03	7.5

gumminess and chewiness. The instrumental values were maximum for fried crab balls and minimum for fried crab balls processed at F_0 6.

The L* values showed a gradual decrease and a maximum value was for the fried crab balls and further decreased when crab balls processed in koftha gravy to F_0 5, 6 and 7 (Table 5). This indicated that, whiteness of the crab balls decreased as the thermal process time increased. Other than the L* values, a* and b* values showed an increasing trend as the crab balls were subjected to a prolonged process time indicating an increasing pattern in the yellowness. This observation was in agreement with the work on canned crab meat by Requena et al. (1998). While Kong et al. (2006) reported an increase of L* values with increasing processing time in fish muscle.

The sensory scores for processed crab koftha is given in Table 6. Crab koftha processed to F_0 7, although found to be commercially sterile, had slightly hard texture and discolouration compared to that processed to F_0 6, which had soft and firm texture and very good acceptability scores. On the other hand, crab koftha processed to F_0 5 had very soft texture while its overall acceptability score was considerably low. The crab koftha processed to F_0 6 was considered to be the most acceptable on the basis of the taste panel study conducted.

The study indicated the suitability of indigenous polymer-coated easy open-end tin-free steel cans for thermal processing of crab koftha. Considering the sensory and instrumental textural characteristics, F_0 6 was identified as the optimum process for crab koftha.

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