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Heat Penetration in Fish Curry in Retort Pouch

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Mackerel in curry packed in retort pouch was heat-processed in an over pressure autoclave. 210-220 g curry was packed in each pouch (15.5 x 17 cm) fitted with a thermocouple. Time temperature data were collected during heat processing using a data recorder cum F_0 and cook value integrator. The heat penetration parameters were calculated. The heating curve obtained was logarithmic in nature. Though fish curry in pouch heat-processed to F_0 8.43 and 6.56 were bacteriologically safe, the former is desirable in view of better sensory characteristics, particularly texture.

Key words: Heat penetration, fish curry, retort pouch, process time

Value addition and diversification of processed seafoods is an important need in fish processing. Preference for ready to cook or ready to serve type products is on the increase. One such product is fish curry. Vijayan and Balachandran (1986) reported processing fish curry in metal cans. Srinivasa Gopal *et. al.* (1995) studied preservation of formulated fish curry in frozen form. Frozen curry though organoleptically superior, requires a cold chain in processing, distribution and retailing. Metal cans affect the quality because of a metallic taste developing in the product as also due to the long exposure to high temperature during processing. Retortable pouch is an ideal alternate to metal cans because of the lower heat processing needs and the consequent less heat induced damage to the food. However, there are no data available on the heat penetration characteristics of fish curry in retort pouch, which is an essential need in developing the process. This paper reports the heat penetration profile in fish curry processed in retort pouch and makes an assessment of the process needs.

Materials and Methods

Fresh mackerel (*Rastrelliger kanagurta*) procured from the local market were dressed, cleaned, and cut into 3 cm long pieces, washed and drained. The recipe of the curry is given in Table 1. Onion and tomato were chopped and ground separately in a mixer. The onion slurry was heated in oil till the colour became light brown. At this stage ground tomato was added and heating continued for 10 min. Curry powder, turmeric powder and chilli powder were added to green chilly and ginger fried separately in oil and heated under a low flame. The fried ingredients were added to the boiling onion-tomato slurry and heating continued. Potable water was added to adjust the consistency of the curry. 120g fish was packed in each pouch (15.5 x 17 cm) made of three layer configuration of 12 μ plain polyester/15 μ aluminium

Table 1. Recipe for fish curry

Ingredients	Weight, g
Dressed fish	1000
Onion	420
Tomato	278
Green chillies	14
Ginger	14
Turmeric	3
Masala mix	16.8
Chilli powder	5.6
Water	616
Oil	140
Salt	20

foil /75 μ cast polypropylene laminate containing 90 g curry medium. Steam flush water seal technique was used for removal of headspace air in the pouch (Madhwaraj *et. al.,* 1992) and sealed immediately using an impulse heat-sealing machine. Adequate pouches were fixed with thermocouples, the tips of which were introduced into the fish meat. The filled and sealed packs were laid flat on the trays in an over pressure autoclave (John Fraser & Sons Ltd., UK, Model No C 5682). The thermocouple outputs were measured using an Ellab CTF 84 data recorder and a note book computer connected to each other.

The retort temperature (RT) was maintained at 121°C. The filled pouches were processed to F_0 (time in minutes at 121°C) 8.43 and 6.56. Pressure was maintained at 172 kpa throughout the process, using steam-air mixture while heating and, air and water while cooling. Rapid cooling was accomplished by recirculating cooling water. The pouches were removed from the retort when the core temperature (T_c) reached around 40°C. The recorded data was analysed using a desktop computer. Heat penetration data were plotted on a log paper with temperature deficit (RT-TC) against time. Lag factor for heating (J_h), slope of the heating curve (f_h), time in minutes for sterilisation at retort temperature (U) and lag factor for cooling (J_c) were determined. The process time (B) was calculated by mathematical method (Stumbo, 1973). Actual process time is determined by adding process time (B) and the effective

Table 2. Heat penetration characteristics in fish curry

Retort temperature, °C	121
J_h	76
f_h	18.0
F_o	8.43
U	10.61
f_h/ U	1.7
J_c	1.30
B	34.95
Actual Processing time, min	38.43

heating period for the product i.e. 58% of the come up time. The suitability of retort pouches for food contact application as indicated by water extractives was determined by the method of FDA (1983). Internal burst strength for seal integrity was determined by the method described by Duxbury *et. al.* (1970) using an internal burst testing apparatus. Heat seal strength was determined as per ASTM (1973). Process resistance of pouch laminate was assessed by autoclaving crumpled and uncrumpled pouches at 121°C for 30 min and examining for delamination (Gopakumar, 1993). Sterility of the pouch was tested as per IS: 2168 (1971). The organoleptic properties were assessed by a trained taste panel (ASTM 1968).

Results and Discussion

The F_0 recommended for fish and fish products ranges from 5-20 (Frott and Lewis, 1994). F_0 for herring in tomato sauce sold in U.K. is 6-8 (Brennan *et. al.*, 1990). Fish curry in pouch was heat processed for F_0 of 8.43 and 6.56. Though both samples were sterile, curry processed to F_0 8.43 had better texture. Heat penetration characteristics of curry processed to F_0 8.43 are shown in Table 2. The come up time to attain 121°C was 6 min. The come up time should be kept as short as possible (Anon, 1968). Actual process time was 38.43 min, which included 58% of the come up time, which gave an F_0 8.43. The f_h value of 18 min was indicative of mixed convection and conduction heating. Core temperature, retort temperature and F_0 of the process are shown in Fig. 1. There was sudden decrease in retort temperature

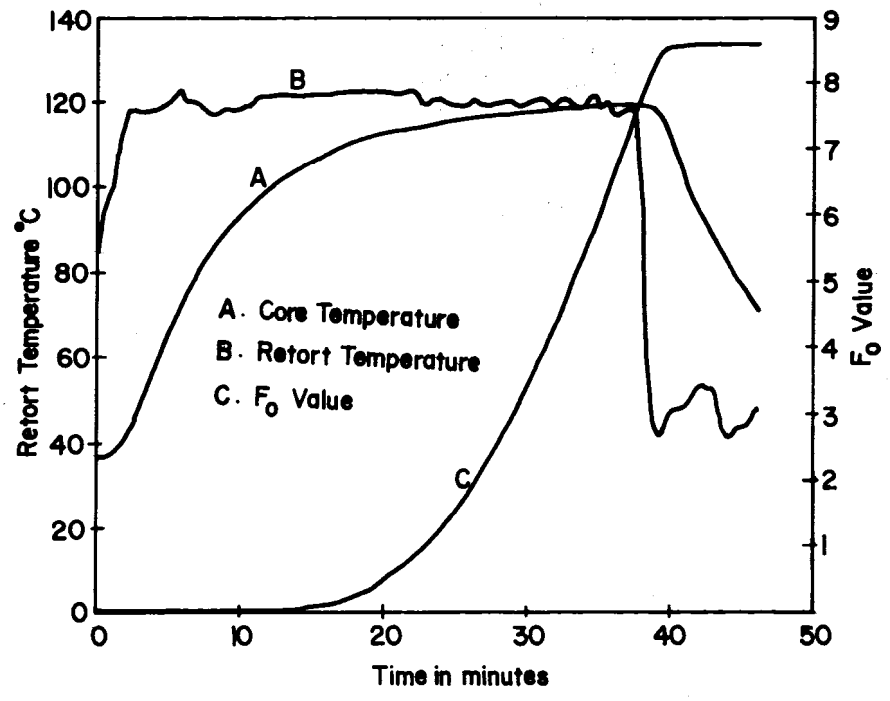

Fig. 1. Heat penetration and F_0 value in fish curry

when steam was cut off and cold water was circulated. This is necessary because the product should be cooled as quickly as possible to avoid over cooking and to prevent growth of thermophiles. The heat penetration characteristics with reference to cook value (C_g) is shown in Fig. 2. The cook value is aimed at the optimal degree

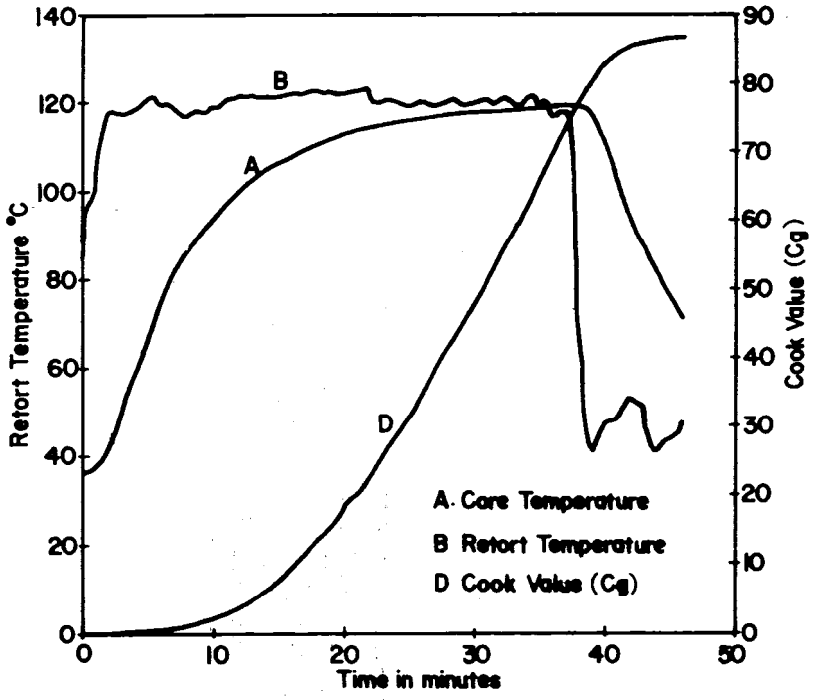

Fig. 2. Heat penetration and cook value in fish curry

of tenderness in a finished product. The product had very good appearance and the bone was soft with a cook value of 85 min. Generally recognised minimum process time for prevention of botulism in canned fishery products preserved by heat alone is 3 min at 121°C i.e., $F_0 = 3$. For highly heat resistant spore formers like *Clostridium thermosaccharolyticus* and *Bacillus stearothermophilus* the minimum thermal processing time should be 16 and 25min respectively at 121.1°C (Warne, 1988; Clucas and Ward, 1996). Processing to such high F_0 will adversely affect the texture of the product. Therefore while it is absolutely essential to ensure freedom from *C. botulinum* through adequate thermal processing, striving to achieve absolute sterility against highly heat resistant spore formers would lead to an unpalatable product. Hence it will be ideal to control the thermophilic spore formers by using raw materials and ingredients with low bacterial loads and adopting good manufacturing practices. Considering these, the process, which results in F_0 between 5 and 10 was chosen.

Physical properties of the packaging materials used are detailed in Table 3. Heat seal strength of the laminate was 82 N/25 mm width in cross direction and 98 N/ 25 mm width in machine direction. The minimum heat strength required for 25 mm

width is 75 N. The laminate possessed high bursting strength of more than 241 kpa which makes it suitable for processing under high pressure. The average water extractives were 0.3 mg/dm^2 when extracted with water at 121°C for 2 hours. The results indicate that the extractives are below the limits specified (IS: 9845, 1981; FDA, 1983) for food contact application.

Table 3. Physical properties of retort pouch

Parameters	Description
Thickness and details of laminate	12 μ plain polyester / 15 μ aluminium foil / 75 μ cast polypropylene
Process resistance	No delamination
Heat seal strength	Machine direction : 98N / 25 mm width Cross direction : 82 N / 25 mm width
Bursting strength	Greater than 241 kpa
Overall migration residue: Water extractives	0.3 mg / dm^2

Retortable pouch with 12 μ plain polyester/15 μ aluminium foil /75 μ cast polypropylene is found suitable for packing fish curry. As the process gives F_0 value above the prescribed limit for *C. botulinum* the product is bacteriologically sound for thermally processed seafoods. Being a product which contains bones also, the high process value softens the bones and yields desired texture.

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