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Heat Penetration Characteristics and Shelf life Studies of Seer Fish Moilee Packed in Retort Pouch

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Flexible retort pouch is an ideal alternative to metal containers for heat-processed foods. This paper reports a study on fish moilee processed in retort pouch and its shelf life evaluation for 19 months. Seer fish (*Scomberomorus guttatus*) was processed by frying. About 90g fried fish and 140g of moilee medium were packed in retort pouch of 12.5μ polyester/12.5μ aluminium foil/80μ cast polypropylene having size 17x15.5 cm. Air inside the pouch was exhausted by steam injection, heat-sealed and heat processed at 121.1°C to an Fo 8.15 and total process time (B) of 48.3 min. The product remained sterile throughout the storage period. Shelf life studies showed that samples stored at ambient temperature (27±1°C) were acceptable and had good sensory attributes up to 18 months whereas samples stored at 37°C were acceptable only up to 10 months.

Key words: Retort pouch, seer fish moilee, heat penetration, storage characteristics

Value addition and diversification to satisfy the ever changing and diverse demands from the importing countries as well as urban consumers at home are some of the major challenges faced by the Indian fish processing industry. Value addition is of utmost importance in the fish processing industry these days because of the increased potential for realization of high unit value of such products. With the growing demand for convenience, the need for off the shelf, ready- to- cook and ready- to- eat packaged food is constantly on the rise. In developing such products, the industry has also to pay attention the use of safe packaging material and the use of recyclable and environment friendly biodegradable materials.

Earlier attempts of popularizing ready to serve curry products could not be met with success because of the limitations imposed by the metal containers. Metal containers available in India also are not suitable for this purpose because of the poor mechanical strength and high incidence of leakage through the seams. It has been reported that retort pouch having three-layer configuration of polyester/aluminium foil/ cast polypropylene can perform the packaging function equally well as metal cans and is free from disadvantages like poor barrier properties, pin holing, poor seal strength etc (Vijayan *et al*, 1998; Gopal *et al*, 1998).

We have earlier reported studies on standardisation of ready-to-serve curry products in retort pouch including mackerel curry (Srinivasa Gopal *et al*, 1998), rohu curry (Sonaji *et al*, 2002) and seer fish curry (Srinivasa Gopal *et al*, 2002).

Fish moilee is a popular fish product in Kerala prepared mainly out of fishes like seer, pearl spot etc. Seer fish is one of the highly cherished food fishes of India and

constitute nearly 1.2% of the annual fish landings. This paper deals with the heat penetration characteristics of seer fish moilee and its shelf life evaluation at ambient temperature (27±1°C) and at 37°C.

Materials and methods

Retort pouch with three-layer configuration of 12.5µ-polyester/12.5µ aluminium foil/80µ cast polypropylene with a size of 17x15.5 cm was used. Various physical parameters of the pouch were studied. The tensile strength and elongation at break was determined as per IS: 2508 (1984). Heat seal strength was determined by Duxbury *et al* (1970) and bond strength by ASTM (1972). The total thickness of the laminate was 420 gauge. The suitability of retort pouches for food contact application as indicated by water extractives were determined by the methods of FDA (1983).

Seer fish (*Scomberomorus guttatus*) from local landings was brought to the laboratory in iced condition. The fish were beheaded, gutted and cut into steaks. The steaks were then washed in potable water and drained well. The washed fish steaks were smeared with a mixture of turmeric and salt and set aside for about half an hour and then fried in refined ground nut oil at 180°C for 3 min. The ingredients used for the preparation of fish moilee are given in table 1.

For the preparation of moilee medium, chopped onion, ginger and green chillies were fried in refined groundnut oil. Cinnamon, clove, pepper and cardamom were added to onion-ginger-green chilly mixture and fried gently. Milk was extracted twice from grated coconut and the milk extracted second time was added to the above mixture and boiled. To this mixture sliced tomato was added followed by the addition of milk extracted first and boiled again.

Table 1. Ingredients used in fish moilee

Ingredients	Quantity
Dressed fish	1000 g
Onion	500 g
Ginger	15 g
Green chillies	35 g
Cinnamon	0.75 g
Clove	0.75 g
Cardamom	0.75 g
Pepper	0.75 g
Tomato	200 g
Turmeric powder	20 g
Salt	20 g
Coconut	1 no.
Water	750 ml

An amount of 90 g of fried fish and 140 g of moilee medium were filled manually in each pouch. Air from the filled pouch was exhausted by steam flushing (Madhwaraj *et al*, 1992) and sealed immediately using an impulse heat-sealing machine. Adequate pouches were fixed with thermocouple glands, tips of which were introduced into the centre of fish piece. Retort temperature was maintained at 121.1°C and heat processing was done in an over pressure autoclave (John Fraser & Sons Ltd, U.K, Model No. 5682). The time temperature data was measured using an Ellab CTF 9008 data recorder (Ellab Instruments, Denmark).

Heat penetration data were plotted on a semi log paper with temperature deficit i.e. Retort temperature – Core temperature (RT-CT) on log scale against time. Lag factor for heating (J_h), slope of heating curve (f_h), time in min for sterilization at retort temperature

(U), lag factor for cooling (J_c), final temperature deficit (g) and cook value (C_g) were determined. The process time (B) was calculated by mathematical method (Stumbo, 1973). Total process time was determined by adding process time (B) and the effective heating period during come up time i.e. 58% of come up time of the product. The come up time should be as short as possible (Anon, 1968). The F value is used as a basis for comparing heat sterilisation procedures. It represents the total time-temperature combination received by a food and is quoted with suffixes indicating the retort temperature and the Z value of the target microorganisms Fo value is used to describe the processes that operate at 121°C, which are based on a microorganism with a Z value of 10°C. This value is used in canning industry when food processing times are being calculated. Among the three different Fo values (6.54, 8.15 and 9.5) tried, the product with an Fo value of 8.15 min was found to give better sensory attributes and hence that particular Fo value was chosen for large scale production and storage studies. Sterility of the product was tested as per IS: 2168 (1971).

Storage studies were carried out at ambient temperature and at 37°C. The product was analysed periodically every month for changes in TBA, pH and sensory characteristics. Four replicate samples were analysed and vertical bars in the figures represent standard deviations. TBA value of the fish pieces was determined spectrophotometrically (Tarladgis *et al*, 1960). pH was determined according to APHA (1998) using a digital pH meter after making the fish muscle into a homogenate with water. Sensory analysis was carried out by a 7 member trained sensory panel using a ten point hedonic scale (Vijayan, 1984). Sensory evaluation of fish curry was carried out based on the score sheet given in Appendix A. The characteristics covered under the taste panel were flavour, overall acceptability and texture. Under texture the characteristics such as toughness, fibrosity and succulence were studied. The evaluations of the panel members were converted to equivalent numerical scores for statistical analysis. A sensory score of 4 was taken as the limit of acceptability.

Texture profile analysis of fish pieces in seer fish moilee samples was done using the food texture analyzer of Lloyd Instruments, Hampshire, U.K. Model LRX plus, equipped with a load cell of 50N, with software Nexygen. Parameters like hardness1 and hardness 2 (peak of the two curves), cohesiveness (area of curve 2/area of curve 1) and chewiness (gumminess x springiness) were done using a cylindrical probe of 50mm

Table 2. Physical properties of retort pouch

Parameters	Description
Tensile strength	
(Machine direction)	451 kg/cm^2
(Cross direction)	425 kg/cm^2
Elongation at break	
(Machine direction)	20%
(Cross direction)	20%
Heat seal strength	
(Machine direction)	70.25N/25mm width
(Cross direction)	60.75N/25mm width
Bursting strength	21 psig
Bond strength of inner layer	184 g/10mm width
Bond strength of the outer layer	110 g/10mm width
Overall migration residue (mg/dm^3)	0.95

diameter at a test speed of 12mm/min and the samples were compressed by 40%. Penetration was done using a puncture probe of 5mm diameter at the same test speed.

A method for speeding up the time required to determine the shelf life of a product is necessary, and therefore accelerated shelf life studies has been developed for that reason. The basic assumption underlying accelerated shelf life testing is that the principles of chemical kinetics could be applied to quantify the effects which extrinsic factors such as temperature, humidity, gas atmosphere and light have on the rate of deteriorative reactions. For a given extent of deterioration and reaction order, the rate constant is inversely proportional to the time to reach some degree of quality loss. Thus by taking the ratio of the shelf life between any two temperatures 10°C apart, the Q_{10} of the reaction can be found (Robertson, 1993). Q_{10} can be calculated using the equation,

$$Q_{10}=k_T + 10/k_T = \theta_{sT} / \theta_{sT+10}$$

Where, θ_{sT} is the shelf life at temperature T°C and θ_{sT+10} is the shelf life at temperature (T+10°C). In this experiment the accelerated shelf life studies were carried out by keeping the samples at ambient temperature and at 37°C.

Results and Discussion

The physical properties of the pouch were studied and the results are given in Table 2. The results indicate that the pouch meet the requirements as a container for heat processed foods.

The proximate composition of the fresh seer fish sample is given in Table 3.

Table 3. Proximate composition of fresh seer fish

Parameters	Composition (%)
Moisture	74.28
Crude fat	06.63
Crude protein	16.04
Ash	01.29

The Fo recommended for fish products ranges from 5-10 (Frott and Lewis, 1994). Srinivasa Gopal *et al.*, (1998) reported that a F_o 8.43 was sufficient to attain good texture in case of mackerel curry. Thermal processing of fish moilee was done to Fo value of 8.15 min. The total process time was 48.3 min, which included 58% of the come up time. Upon sterility test the product was found to be sterile. Thermal processing data of seer fish moilee is presented in Table 4. Core temperature, retort temperature and Fo of the process are shown in fig. 1.

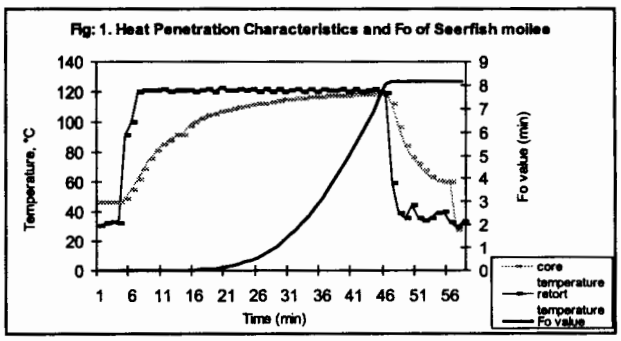

Fig. 1. Heat Penetration Characteristics and Fo of Seerfish moilee

Cook value is aimed at obtaining an optimal tenderness in a finished product. Heat penetration characteristics and cook value of the product is shown in fig. 2.

The product had very good appearance and the bones were soft with a cook value of 89.79 min.

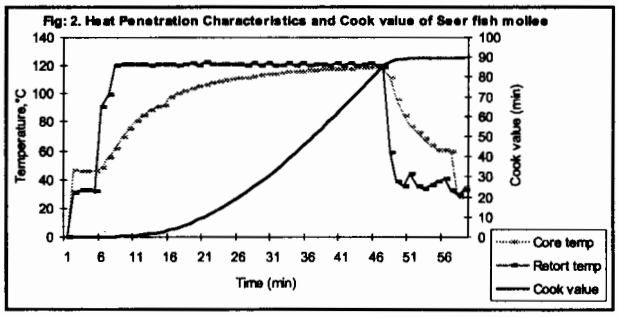

Fig. 2. Heat Penetration Characteristics and Cook value of Seerfish moilee

Changes in chemical parameters such as TBA value, which is a measure of oxidative rancidity for the product during storage at ambient temperature and at 37°C, are presented in Fig. 3. Results of chemical analysis indicate that TBA values decreases in case of both the products stored at ambient temperature and at 37°C, as also observed by Aubourg *et al.*, (1997) and Medina *et al.*, (1999). This decrease may be due to the fact that the secondary oxidation products may be lost from the muscle into the aqueous curry medium and TBA being a reactive substance can react with other reactive compounds like amino groups, which can cause its reduction (Pokorny, 1981; Maruf *et al.*, 1990 and Aubourg *et al.*, 1995).

Table 4. Thermal processing data of seer fish moilee

Parameters	Values
Fo	8.15 min
f_h	44 min
J_h	0.42
Jc	0.98
U	8.15
g	3.17
C_g	89.79 min
B	44.44 min
Total process time	48.3 min

Appendix A

Sensory evaluation

Assessor

Date

Please score the sample by placing a cross at the relevant point along the scales.

Sample number	
Excellent	10
Very good	9
Good	8
Moderately good	7
Neither good nor bad	6
Slightly rancid, bitter or other off-flavours	5
Moderately rancid, bitter or other off-flavours	4
Strong rancid, bitter or other off-flavours	3
Very strong rancid, bitter or other off-flavours	2
Extremely rancid, totally unacceptable	1

Please score the following characteristics by placing a cross and sample number on the appropriate place on each of the following scales.

1) Succulence
Very succulent Juicy — 10 9 8 7 6 5 4 3 2 1 — Very dry

2) Toughness
Very tender — 10 9 8 7 6 5 4 3 2 1 — Very tough

3) Fibrosity
Not fibrous — 10 9 8 7 6 5 4 3 2 1 — Fibrous

4) Overall Acceptability
Like extremely — 10 9 8 7 6 5 4 3 2 1 — Dislike extremely

Decrease is found to be more in case of incubated samples than in case of samples stored at ambient temperature. FFA values are also found to decrease gradually during

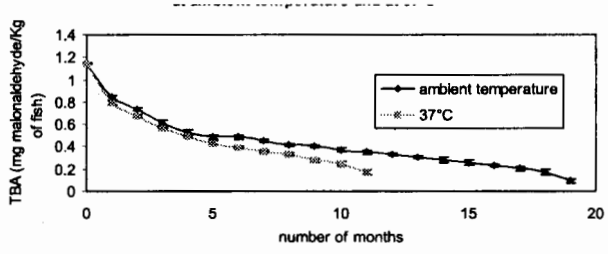

Fig. 3. Changes in TBA values of fish pieces in seer fish moilee samples stored at ambient temperature and at 37°C

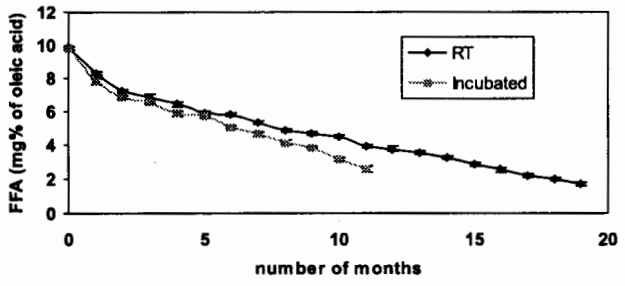

Fig. 4. Changes in FFA values of seer fish moilee samples stored at ambient temperature and at 37°C

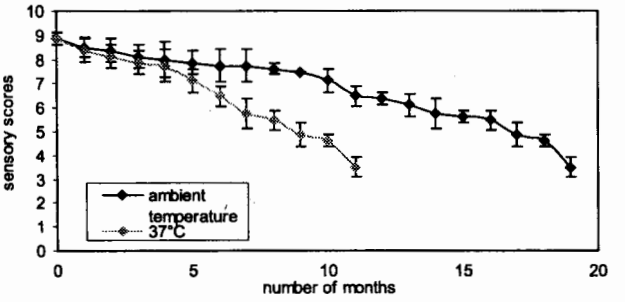

Fig. 5. Changes in sensory scores of seer fish moilee samples stored at ambient temperature and at 37°C

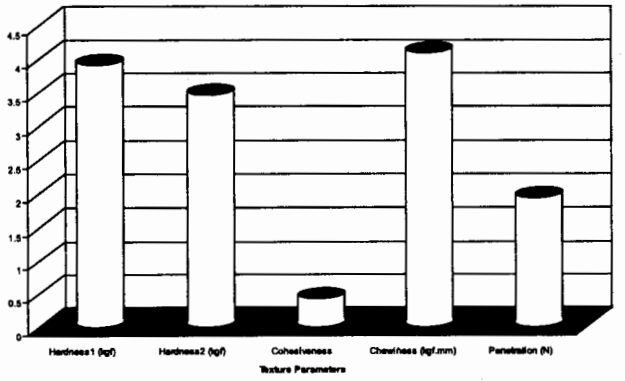

Fig. 6. Texture profile analysis of fish pieces in seer fish moilee samples

storage as observed by Koizumi *et al.*, (1986). As with TBA here also decrease is found to be more in the case of samples stored at ambient temperature than that of samples stored at 37°C. Changes in sensory scores of the samples during storage at ambient and at 37°C are presented in fig. 5. pH of the product stored at ambient temperature and at 37°C remained more or less the same during storage period. Based on sensory scores samples stored at ambient temperature were found to be acceptable up to 18 months whereas the samples stored at 37°C were acceptable only up to 10 months. Q_{10} values of the product found to be 1.8. By knowing the Q_{10} values it is easy to predict the shelf life at any temperature.

Texture profile analysis of fish pieces in seer fish moilee samples is shown in fig. 6. Fish pieces on testing had hardness1 of 3.982 kgf, Hardness 2 of 3.455 kgf, cohesiveness of 0.382, chewiness of 4.09 kgf.mm and penetration of 1.922 N.

The results shows that the indigenous retortable pouches of 12.5μ polyester/12.5μ aluminium foil/80μ cast polypropylene are suitable for packing fish moilee with a shelf life of 18 months at ambient temperature and 10 months at 37°C. The above packaging material does not impart any undesirable flavour to the fish moilee. The physical properties of the pouch, bacteriological and sensory characteristics of the product were satisfactory. The processing of the product to a Fo value of 8.15 min was found to be ideal to get desired texture, sensory characteristics and storage stability of the product.

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