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# Development of Ready to Serve Rice and Sardine Curry in High Impact Polypropylene Containers

**J. Bindu*, C.K. Kamalakanth, C.N. Ravishankar and T.K. Srinivasa Gopal**
*Central Institute of Fisheries Technology, P.O. Matsyapuri, Cochin - 682 029, India*

## Abstract

Rice with fish curry is a staple food of people inhabiting the coastal belt of India. Sardine (*Sardinella longiceps*) is the most commonly available fish in the south-west part of India. Sardine curry and semi cooked par boiled rice were vacuum packed separately in high impact polypropylene (HIPP) thermoformed containers in a tray packing machine and top sealed with clear polyester/cast polypropylene film. The containers were then twin packed in indigenous three layered see- through laminated retortable polyester pouches coated with silicon dioxide / nylon / cast polypropylene and processed in a still over pressure retort at 121.1°C. The Fo value of fish curry was 8.12 min and rice was 16.11 min. Changes in biochemical parameters like FFA and TBA and sensory parameters during storage were studied at monthly intervals for the fish curry. The processed products were found to be sterile and remained in good condition for a period of four months as twin pack at ambient storage (28 ± 2°C) with regard to all sensory attributes.

**Keywords**: Par boiled rice, sardine curry, thermal processing, HIPP containers, Fo value, ready to serve

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* *E-mail: bindujaganath@gmail.com*

## Introduction

Different types of ready to eat thermal processed products from fish, meat and vegetable sources are available in the market. Since thermal processed products have long-term shelf stability, it is still considered as one of the most widely used methods for food preservation. Thermal processing is commonly done in cans, retort pouches and in recent times in thermoformed containers. A number of ready to serve fish products like seer fish moilee (Manju et al., 2004), ready to eat mussels ( Bindu et al., 2004 ), prawn kuruma (Mohan et al., 2006), grey clams (Bindu et al., 2007), and etroplus curry (Pandey et al., 2007) have been processed in retort pouches.

Semi-rigid plastic containers are thermoformed containers that are economical and offer convenience to the user. The containers are thin in profile and three dimensional in shape with a filling volume. The heat setting fixes the shapes and can also facilitate sealing of the filled containers. High impact polypropylene (HIPP) containers can withstand high processing temperatures without losing their shape and properties and has higher heat penetration rate due to the thin material.

A wide variety of ethnic and local delicacies from fish and other food products are available in the market. These products have a limited shelf life and are usually consumed the very day it is prepared. Sardine is the most commonly available fish species and is consumed in different forms all along the coastal belt of Kerala and southern parts of India. Since rice and fish curry are high moisture foods, they have limited storage life at ordinary temperatures. Hence in this study, an attempt was made to develop a ready to eat rice and fish curry product as twin packs in thermoformed containers made of HIPP, so as to obtain a sterile product with an extended shelf life for storing at ambient temperatures (28 ± 2°C).

## Materials and Methods

Indigenously manufactured high impact polypropylene (HIPP) trays (size 12.5 cm x 8.5 cm x 2.5 cm l x b x h, with 270 ± 5 cc volume) manufactured by Kalyx Plastopack, (Pappinesseri, Kannur, India)

were used in the study. The top sealing film for the trays was a two layered laminate made of polyester/ cast polypropylene. The physical properties and suitability for food contact application of the tray and film were ascertained by determining overall migration residue (IS.9845:1981; USFDA, 1983), heat seal strength (ASTM, 1973), tensile strength and elongation at break (IS 2508: 1984), oxygen permeability (gas and steam permeability, AtsFaar, Societa' Per Azioni, Milano, Italia) (ASTM, 1982) and water vapour transmission rate (ASTM E 96-80, 1987). The sterility for the finished product was determined as per IS 2168: 1971.

Fresh sardines landed at the Cochin fisheries harbour within 4 h of catching were used for the study. They were transported to the laboratory in iced conditions. The fish was, descaled beheaded, gutted, and washed for preparation of the curry. The cleaned fish was blanched in 3% brine solution at 20°C and curry was prepared as per recipe standardized (Vijayan et al., 1998). The rice required for the preparation was purchased from the local market at Thevara, Cochin and was washed with potable water and drained. Since the capacity of the tray was 220 ml. Trials were carried out to find the optimum amount of rice to be put into the tray and it was standardized as 120 g rice and 120 ml water, for thermal processing inside the retort.

Both rice and sardine curry were vacuum packed separately in HIPP thermoformed containers using a vacuum sealing machine. In each tray, 120 g rice, 120 ml water and 150 g sardine curry was packed. The curry had three to four pieces of sardine weighing 90 g and remaining portion was gravy. The trays were then top sealed with polyester/cast polypropylene laminate film in a vacuum packing machine. The twin containers were then packed in indigenous three layered see through retortable pouches consisting of polyester coated with silicon dioxide/ nylon /cast polypropylene film and heat processed in an over pressure autoclave at 121.1°C to a Fo value of 8.12 min. For heat penetration studies, both the trays were fixed with two different thermocouple glands through which thermocouples were inserted. In the case of fish curry, the tip of the thermocouples was inserted into the fish pieces whereas for tray packed with rice and water it was fixed at the geometric centre, for recording the core temperature during heat processing in the still over pressure retort (Model No 5682: John Fraser & Sons Ltd, Newcastle-upon-Tyne, U.K.). The thermocouple outputs during heat processing was collected using an Eval (Ellab A/S, Roedovre, Denmark) data recorder cum Fo and cook value integrator and heat penetration characteristics were determined. The retort temperature (RT) was maintained at 121.1°C and air pressure was maintained at 28 psig throughout the heating and cooling period. The trays were rapidly cooled by pumping water into the retort. Fo of 7, 8 and 9 min was carried out and an optimum of 8 was observed. The lag factor for heating (Jh), slope of the heating curve (fh), time in min for sterilization (U) and lag factor for cooling (Jc) were calculated by plotting temperature deficit (RT-Tc) against time on semi log paper. The process time (B) was calculated by mathematical method (Stumbo, 1973). The total process time was calculated by adding 42% of the come up time (CUT) to B. The processed product was tested for sterility by using thioglycollate broth medium as per the method described in IS: 2168 (1971).

Samples were analysed in triplicates for free fatty acid (FFA) expressed as oleic acid by the method of AOCS (1989) and thiobarbituric acid value (TBA) was estimated spectrophotometrically according to Tarladgis et al. (1960) using the fish pieces for all the tests. Sensory analysis of rice and sardine curry was carried out by the method described by Meilgaard et al. (1999). The panelists were asked to score for appearance, colour, texture, flavor, taste and odour for the samples. A score of above 4 was considered as the margin of acceptance. Scores were given separately for rice and sardine curry.

## Results and Discussion

The physico-chemical properties of the HIPP trays, cast polypropylene top sealing film and the outer layer of see through retortable pouches are given in Table 1. The different physical properties tested showed that the packaging materials were suitable for thermal processing and food contact applications. Plastic films and tray had high tensile strength in both machine and cross direction, which is satisfactory for withstanding the rigors of heat processing in an over pressure autoclave. The overall migration residue when determined with water extractives at 121°C for 2 h and heptane extraction at 66°C for 2 h was found to be well below the limits specified for food contact application. The trays with see through retortable pouch materials had low barrier properties towards water vapour and oxygen.

Table 1. Physico-chemical properties of the different packaging materials

| Properties | HIPP trays | PEST silicon dioxide/ Nylon/ CPP | PEST/CPP |
|---|---|---|---|
| Thickness (μm) | 880±1.18 | 101 ± 0.01 | 131 ± 0.01 |
| Tensile strength MD (kg $cm^{-2}$) | 283 | 717 ± 0.01 | 316 ± 0.01 |
| Tensile strength CD (kg $cm^{-2}$) | 262 | 592 ± 0.01 | 292 ± 0.01 |
| Heat seal strength MD (kg $cm^{-2}$) | NA | 538 ± 0.03 | 303 ± 0.01 |
| Heat seal strength CD (kg $cm^{-2}$) | NA | 412 ± 0.01 | 286 ± 0.02 |
| Elongation at break (%) | 80 ± 2.18 | 78 ± 0.01 | 53 ± 0.02 |
| WVTR (g $m^{-2}$ 24 $h^{-1}$ at $37^0$C and 92% RH) | 0.89 ± 0.07 | 0.86 ± 0.02 | 1.99 ± 0.01 |
| OTR (cc $m^{-2}$ 24 $h^{-1}$ at 1 atm. pressure) | 13.2 ± 0.37 | 2.0 ± 0.01 | 55 ± 0.01 |
| Food contact application (overall migration test) | | | |
| a. Water extractives (mg $L^{-1}$) | 6.3 ± 1.03 | 3.2 ± 0.01 | 6.8 ± 0.01 |
| b. n-heptane | 8.41 ± 0.95 | 1.65 ± 0.02 | 1.98 ± 0.01 |

* Each value is represented as the average ± standard deviation of at least 10 determinants.
Where PEST- Polyester, CPP-Cast Polypropylene, MD-Machine Direction, CD- Cross Direction

The recommended Fo value for fish and fish products ranges from 5- 20 (Frott & Lewis, 1994). Preliminary trials indicated that processing at Fo of 8.12 min for sardine curry gave a product with good sensory properties. For the twin pack of sardine curry and rice, the heat penetration characteristics are represented in Table 2 and the Fo value in Fig. 1 and 2. The come up time for the retort to attain 121.1°C was 1.74 min (Table 2). The Fo value for the rice was 16.11 min. Heat penetration was slower for sardine curry which was in a semisolid gravy form compared to rice where heat penetration was much quicker. Moreover, here the thermocouple was inserted into the fish pieces. The fh value for sardine curry was 30 min and the process time (B) was 36.75 min. The fh value for rice was 18 min and the process time (B) was 36.30 min as rice and sardine curry is packed together. The total process time to reach the respective Fo values were 38.04 min for rice and 38.49 min for sardine curry. Sterility test was conducted and it was found to be sterile.

On storage, the free fatty acid values were almost the same for the first two months but gradually increased after the third month (Fig. 3). Throughout the storage period, their values were very low (Fig. 3). This slow increase could be due to the fact

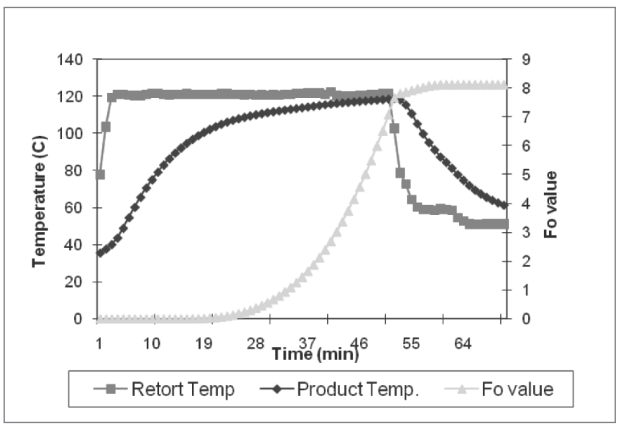


Fig. 1. Heat penetration characteristics and Fo value of sardine curry in HIPP trays

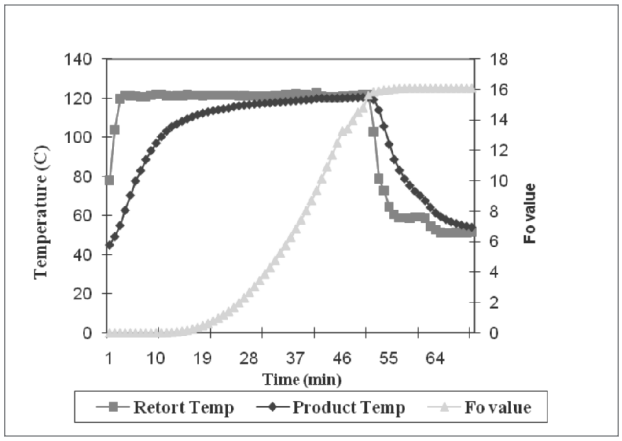


Fig. 2. Heat penetration characteristics and Fo value of rice in HIPP trays

Table 2. Heat Penetration characteristics

| Parameters | Rice | Sardine curry |
|---|---|---|
| Fo value (min) | 16.11 | 8.12 |
| Jh (lag factor - heating) | 0.89 | 0.77 |
| Jc (lag factor - cooling) | 0.90 | 0.99 |
| fh (min)( Heating rate index) | 18 | 30 |
| fh/u | 1.11 | 3.69 |
| g | 0.65 | 3.85 |
| B (min) Ball's process time | 36.30 | 36.75 |
| CUT (Come up time) (min) | 1.74 | 1.74 |
| Total process time (min) | 38.04 | 38.49 |

that during the cooking process of the sardine curry, the unsaturated lipids could have oxidized to highly reactive peroxides. These peroxides would have hydrolysed to form FFA during the storage period. A slight increase in the FFA content has been observed by Aubourg (1998) for canned tuna muscle after 1.5 years of storage. Mai et al. (1978) reported that canning process followed by storage produced an increase in the proportion of FFA in the muscle lipids.

TBA value, an index of secondary lipid oxidation, showed an increasing trend after the initial period of two months of storage (Fig. 4). The peroxides formed during storage may have decomposed to form compounds which include aldehydes such as malonaldehyde which are responsible for increasing TBA values. Medina et al. (1998) have observed an increase in the TBA value of canned tuna after 5 months of storage. Tanaka et al. (1985) and Aubourg

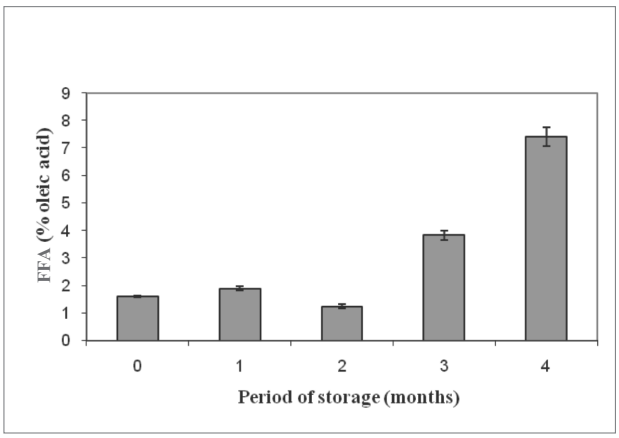


Fig. 3. Changes in FFA content of sardine curry during storage

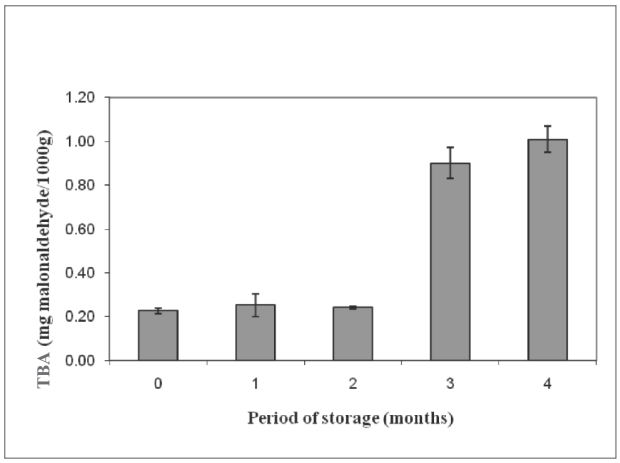


Fig. 4. Changes in TBA content of sardine curry during storage

Table 3. Changes in sensory scores of rice and sardine curry

| Parameter | Storage Period in Months | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Sardine curry | | | | | Rice | | | | |
| | 1 | 2 | 3 | 4 | 5 | 1 | 2 | 3 | 4 | 5 |
| Appearance | 8.5±0.1 | 7±0.2 | 6.6±0.2 | 5.5±0.1 | 3.2±0.2 | 8.6±0.1 | 7.5±0.1 | 6.7±0.1 | 5.2±0.1 | 3.8±0.1 |
| Colour | 8.5±0.1 | 7.2±0.1 | 5.5±0.2 | 4.2±0.2 | 3.1±0.1 | 8.7±0.1 | 7.4±0.1 | 6.5±0.3 | 4.7±0.2 | 3.8±0.1 |
| Odour | 8.5±0.1 | 8.5±0.1 | 8.2±0.2 | 7.5±0.2 | 5.9±0.01 | 8.5±0.2 | 7.6±0.1 | 7±0.1 | 6.9±0.1 | 5.8±0.1 |
| Flavour | 8.2 | 8±0.1 | 8±0.2 | 7.3±0.2 | 5.6±0.2 | 8.3±0.2 | 7.5±0.1 | 7±0.1 | 6.8±0.3 | 5±0.1 |
| Taste | 8.5 | 8±0.1 | 8±0.2 | 7.1±0.1 | 6.4±0.2 | 8.5±0.1 | 7.5±0.1 | 7±0.3 | 6.4±0.1 | 4±0.1 |
| Texture | 8.3 | 8±0.1 | 7.9±0.2 | 7.2±0.2 | 6.1±0.2 | 8.3±0.1 | 7.4±0.1 | 6.8±0.2 | 5.5±0.2 | 3.9±0.1 |
| Overall acceptance | 8.3 | 8.0 | 7.4 | 6.5 | 5.1 | 8.5 | 7.5 | 6.8 | 5.9 | 4.4 |

et al. (1995) have suggested a decrease in TBA value of canned fish meat in oil during storage which might be due to dilution of secondary oxidation products by the fill oils, or their extraction from the meat to the fill oils, or loss to the aqueous exudates from the meat. However in the present study sardine alone was taken for analysis and hence the values were found to increase. Another factor which may have added to the higher oxidation rate is the reaction between oxygen in the headspace of the tray and the high fat content of sardine meat. Even though the trays were vacuum packed, only 90% vacuumisation was possible because we found that at 100% there was a change in shape of the trays and it was not possible to uniformly heat seal the cover film on the top.

There was a gradual decrease in all the sensory parameters during storage, the changes in colour were more prominent for the fish curry. The rice had a firm texture initially which slightly hardened after three months of storage and resulted in rejection after four months of storage. Sardine curry was found organoleptically acceptable upto four months of storage.

The results showed that Fo value of 8.12 min and 16.11 min for sardine curry and rice respectively were found to be optimum for processing rice and fish curry as twin pack in HIPP trays. The product remained in good condition for a storage period of 4 months at ambient temperature. Such thermal processing technologies can be applied to produce and store different types of local delicacies in the ready to eat condition for longer duration at ambient temperatures. This innovative product of twin packs in HIPP thermoformed containers is the first of its kind for rice and fish curry.

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