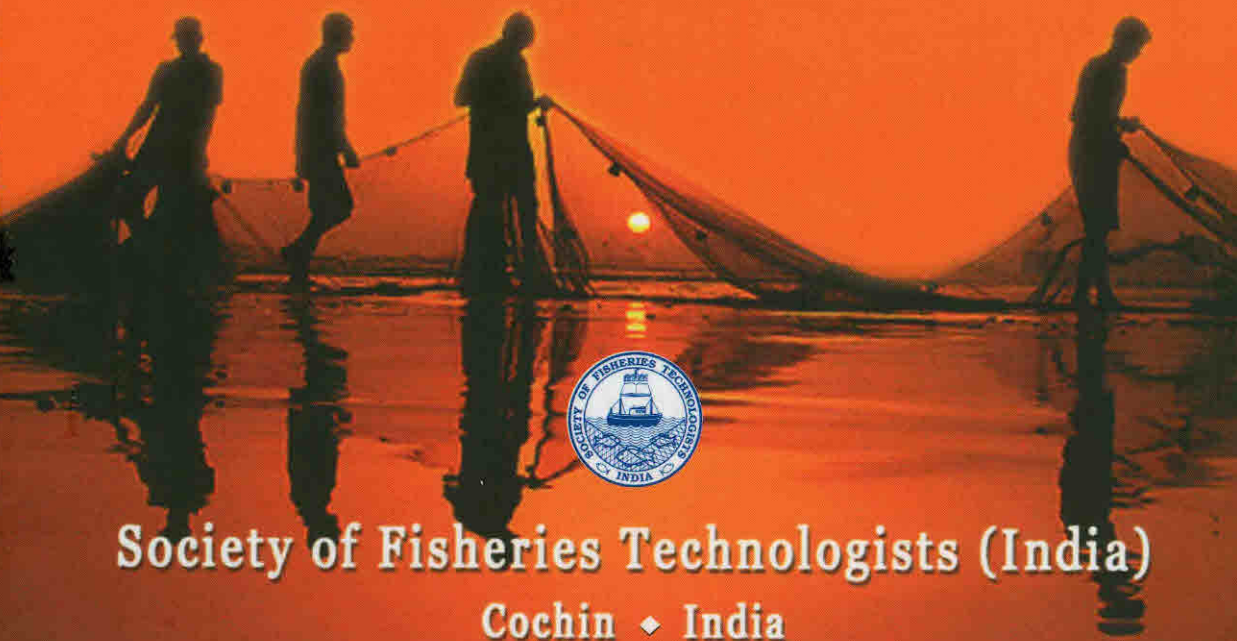


Coastal Fishery Resources of India

• Conservation and Sustainable Utilisation



Society of Fisheries Technologists (India)

Cochin ♦ India

Coastal Fishery Resources of India: Conservation and Sustainable Utilisation

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faster in tuna packed with broccoli resulting in higher lethality and it lost the textural properties considerably. The heat penetration was very slow in tuna without vegetables which resulted in least lethality compared to other products. The tuna with baby corn and green peas exhibited intermediate lethality. The thermal processing with baby corn and green peas improved the textural and sensory quality of tuna.

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Development of Ready-to-Serve Yellowfin Tuna and Vegetable in Tin-free Steel Cans

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Introduction

The increasing working woman population all over the World has resulted in the increasing demand for the ready to eat products. This is clearly reflected in the flooding of various ready to eat food products in the food market. Among the various food products, ready to eat fishery products assumes a greater importance due to their potential health benefits. Among the various fish species, the consumption, tunas have attracted great attention than any other forms of fishes due to their high global economic value and their prevalence in international trade for canning and sashimi. Yellowfin tuna (*Thunnus albacares*) forms an important large pelagic fish that prevail in the tropics and subtropics which contribute around 22% of the world's tuna catch (Al-Abdessalaam, 1995). They are commercially important in many countries and there is high demand from international markets. Like other fish and shellfishes, tuna is also highly perishable protein sources for human consumption. Researches are constantly hunting for better methods to preserve or extend the shelf life and safety of various aquatic food products. Thermal processing has proven as one of the most effective means of preserving food (Karel *et al.*, 1975) and canned tuna has very good market demand world wide. For canning, tuna chunks or loins are cut into different sizes based on the container size and packed with or without smoking in various filling medium like brine, oil, sauce, broth etc. In all the cases tuna alone is packed with the filling medium. Tuna canned along with different vegetables will be in great demand as it provides both protein rich food as well as fiber rich processed vegetables together. Various vegetables like green peas, baby corn and broccoli are having very good market demand due to their health benefits.

Maize (*Zea mays* L) is the third most important cereal crop next to rice and wheat and has the highest production potential among the cereals. For diversification and value addition of maize as well as growth of food processing industries, an interesting recent development is of growing maize for vegetable purpose, which is known as 'baby corn'. It is a small young corn ear harvested at the stage of silk emergence. Baby corn ears in light yellow colour with regular row arrangement, 10-12 cm long and a diameter of 1.0-1.5 cm are preferred in the market. De-husked young ear is used as salad, vegetable, soup, pickles, etc. (Tiwari and Verma, 1999). Corn is a good source of vitamin B₁, B₅, C, E, folic acid, magnesium and phosphorus. It is also a good source of complex carbohydrate, fiber, and healthful essential fatty acids. It is considered to be low in protein, due to the minimal content of the amino acids lysine and tryptophan. The various flavonoids and carotenes contained in corn, are responsible for the different colors of its different varieties. Yellow corn, which is commonly cultivated in India is high in the carotenoid and lutein. The lutein in yellow corn and yellow corn food products can protect against heart disease and macular degeneration. Macular degeneration is a condition of the eye which is typically seen in older age. Green peas (*Pisum sativum*) are a good source of protein, B, C and K vitamins, magnesium, phosphorus, manganese, iron, potassium, fiber, carotenes and antioxidants. Broccoli (*Brassica oleracea* var. *italica*) is a plant of the Cabbage family, Brassicaceae (formerly Cruciferae). It is classified as the Italica Cultivar Group of the species *Brassica oleracea*. Broccoli possesses abundant fleshy flower heads, usually green in color, arranged in a tree-like fashion on branches sprouting from a thick, edible stalk. The large mass of flower heads is surrounded by leaves. Broccoli is low in calories and is one of the most nutrient-dense foods. It is an excellent source of potassium, phosphorus, magnesium, vitamins A, C, K, B₆, E, folic acid, and fiber. Broccoli also contains the carotenoid lutein, glucosinolates, and phytochemicals that have tremendous anticancer effects. The addition of these vegetables into canned tuna products will be advantageous for obtaining increased health benefits. However the addition of vegetables may alter the heat penetration characteristics and sensory properties of the food material. Hence the present study was undertaken to investigate the effect of vegetable incorporation like baby corn, green peas and broccoli with tuna on the heat penetration characteristics and sensory quality changes during thermal processing in TFS cans.

Materials and Methods

Fresh yellowfin tuna (*Thunnus albacares*) of 10 to 12 kg each were purchased from a local fish landing centre in Cochin, Kerala, Southern

India and transported in ice (1:1 ratio fish to ice) to the laboratory. Up on arrival to the laboratory, they were de-iced and washed with chilled potable water. Fishes were beheaded, gutted and cleaned properly to remove all unwanted material. They were then pre-cooked under steam in a laboratory scale over pressure autoclave (Model No. 5682; John Fraser and Sons Ltd, Newcastle-upon-Tyne, UK) for 45 min. Fishes were immersed in chilled potable water for cooling immediately after pre-cooking and transferred to chill room (1-2°C) and stored overnight. On next day they were taken out of chill room and de-skinned manually. Fishes were cut into two pieces along the back bone and red meat was separated manually and only light meat was used for the study. It was cut into 3.0 cm thick pieces and kept ready for packing into TFS cans.

Vegetables preparation

Fresh milky baby corn (*Zea mays* L.) of 10-12 cm length with 2-3 cm dia were procured from local market for the study. The outer green leafy cover was removed and only inner pulp was used completely. It was cut into round pieces of 2-3 mm thick. The fresh green pea (*Pisum sativum*) procured from local market was used after washing thoroughly. The broccoli (*Brassica oleracea* var. *Italica*) with bright green colour was chosen for the study. It was washed thoroughly with potable water and cut into small size (2-3 cm). Baby corn and green peas were given a separate hot blanching treatment in boiling salt solution (6%) (90°C) for 4-5 min whereas broccoli was hot blanched (90°C) only for 3-4 min. They were drained and cooled under air and kept ready for packing.

Thermal processing of tuna with vegetables

A total of 75 TFS cans were divided into five batches of 15 cans each for packing tuna and vegetables for canning. One batch was used to pack yellowfin tuna alone without any vegetable. In this batch, about 150±5g was packed in each can. Other four batches were used to pack tuna along with different vegetables. About 110±5 g of fish was packed along with 40g of blanched baby corn, broccoli and green peas separately in three batches. In fifth batch, 110±5 g of fish was packed with 40g of mixed vegetables consisting of all the three vegetables (around 12-13g each). To this 30-35 ml of hot brine (2% sodium chloride solution) was added to all the cans. In all the batches, the cans were fixed with thermocouple glands (model no. GkJ 13009 C042, Ellab Co. Rødovre, Denmark), and the thermocouple probe (model no. SSA 12040 G700 TS, Ellab Co. Rødovre, Denmark) was inserted through it. The tip of the

thermocouple glands was inserted into the fish pieces to record the products core temperature. The cans were exhausted in steam for 10 min to remove the residual air, and immediately double seamed. The sealed cans were loaded inside the retort (Model no. 5682, John Fraser & Sons Ltd., Newcastle upon Tyne, U.K.) separately for each batch and thermal processed for about 35 min when retort temperature attained 121.1°C. The temperature data was acquired for every minute using Ellab data recorder (model TM 9608, Ellab Co. Rødovre, Denmark). The lethality (F_0 value) accumulated during the entire processing (heating and cooling) was calculated from the temperature history inside by numerical integration (Ball and Olson, 1957). After thermal processing, the cans were cooled by pumping water into the retort and as the temperature reduce to around 40°C, the cans were removed from the retort and immersed in chilled water and washed thoroughly with soap solution. They were drained and kept at ambient temperature for 2 weeks for conditioning. After conditioning, samples were taken for various analysis.

Sensory analysis

Eight semi-trained persons consisting of scientists and researchers evaluated the sensory quality of the thermal processed tuna and vegetable product. Three cans from each batch were used for the analysis. The sensory attributes evaluated were appearance, firmness, texture and taste using a 9 point hedonic scale. The overall impression of the product on the assessor was scored in overall acceptability. The sample, including the vegetables, was served after heating in a microwave oven for 3 min on a coded plate. Water was provided to restore taste sensitivity. Panelists were asked to assign a score of 1 to 9 as prescribed by Meilgaard *et al.* (1999). A score above 6.0 was considered as the margin for acceptance. Apart from the score, the panelists were also asked to conduct a descriptive analysis of the product based on their previous experience.

Sterility test

Cans processed in different batches were tested for commercial sterility (IS 2168, 1971). About four cans were selected at random from each batch. Two cans from each batch were incubated at 55°C for 4 days and another two were incubated at 37°C for 14 days. The incubated cans were opened under aseptic conditions and the samples were transferred to sterile thioglycollate broth (HiMedia, Mumbai, India) tubes. Then a layer of sterile liquid paraffin wax was applied in each tube to create anaerobic conditions. The tubes were then incubated at 37°C for 48 h and observed

for turbidity development, which indicates the survival of microorganisms. Tubes which did not show any turbidity were incubated again for another 48 h at 37°C to confirm the sterility.

Statistical data analysis

The results are expressed as mean \pm standard deviation. Significant ($P < 0.05$) differences between different batches of the thermal processed products were evaluated by analysis of variance (ANOVA) using the software SPSS version 10.00 (SPSS, 2000). Mean separations were determined by Duncan's multiple range test.

Results and Discussion

Tuna packed with and without different vegetables in brine medium were maintained in the over pressure autoclave for about 35 ± 1 min when the retort temperature reached 121.1°C. Various process parameters obtained by plotting the time temperature data on a semi-logarithmic paper are given in Table. 1.

Table 1: Thermal processing parameters for yellowfin tuna packed with and without vegetables in brine medium in TFS cans

Process parameters	Tuna without vegetables	Tuna and peas	Tuna and baby corn	Tuna and broccoli	Tuna and mixed vegetables
Heating lag factor (J_h)	1.43	1.45	1.43	1.53	1.36
Cooling lag factor (J_c)	1.01	1.14	1.07	1.01	1.15
Heating rate index (f_h) (min)	19	16	16	13.5	19.3
Sterilisation value (g)	1.13	0.48	0.45	0.22	0.97
Lethality (F_0) (min)	9.97	13.63	13.89	16.02	11.52

The come up time (CUT), which is the time taken to reach the required retort temperature, should be as short as possible. In the present study, a CUT of 4 minute was observed for different products. All the products showed a similar lag which resulted in a heating lag factor (J_h) of over 1.36. Tuna processed without any vegetables and with peas and baby corn showed a similar heating lag factor (1.43-1.45). Tuna processed with broccoli exhibited highest heating lag factor (1.53) whereas tuna with mixed

vegetables showed lowest lag factor (1.36). The cooling lag factor (J_c) for different products were lower than the heating lag factor (J_h). Tuna processed with broccoli which showed the highest heating lag factor exhibited the lowest cooling lag factor value. This indicates that both heating and cooling rate is faster in this product followed by tuna without vegetables, tuna with peas and baby corn. The lowest heating lag factor and highest cooling lag factor was exhibited by Tuna with mixed vegetables. Similar results were reported for prawn kuruma packed in aluminium cans (Mohan *et al.* 2008) and squid masala in TFS cans (Sreenath *et al.* 2007). Heating rate index (f_h) was faster in tuna with broccoli compared to all the other products. This could be due to the soft nature of the broccoli compared to other vegetables. However the ' f_h ' value obtained for all the products in this study were lower than squid masala (Sreenath *et al.* 2007) and prawn curry in TFS cans (Sreenath *et al.* 2008) and prawn kuruma in aluminium cans (Mohan *et al.* 2008). This could be due to the brine medium used in the present study in which the heating rate will be faster compared to thicker curry, masala and kuruma mediums. The ' g ' value was least for tuna processed with broccoli and highest for tuna without any vegetables pack. Fig. 1 illustrates the typical heating and cooling behavior and Fig. 2 shows the accumulated lethality (F_0) of thermal processed tuna without vegetables, with peas, baby corn, broccoli and mixed vegetables respectively.

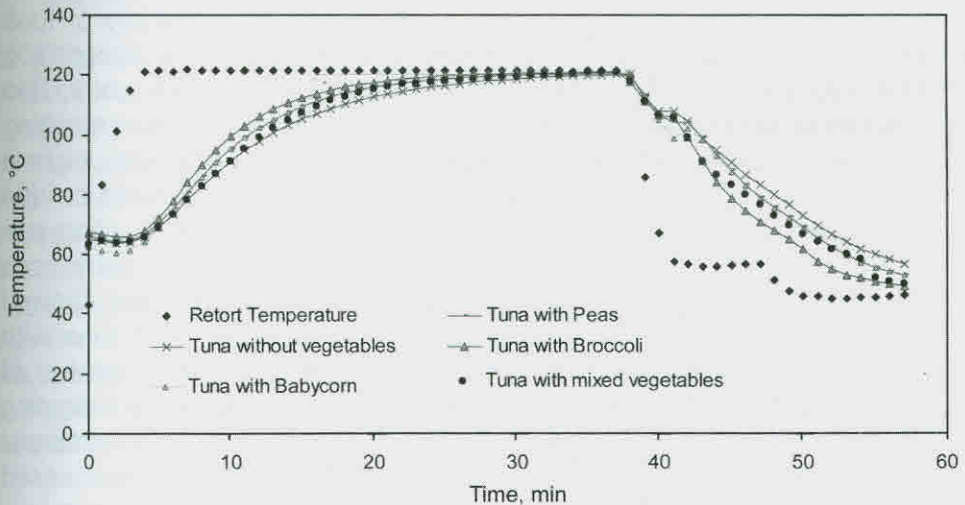


Fig. 1: Profiles of report (RT) and internal product core temperature for tuna with and without vegetables over time in brine medium packed in tin-free steel (TFS) cans

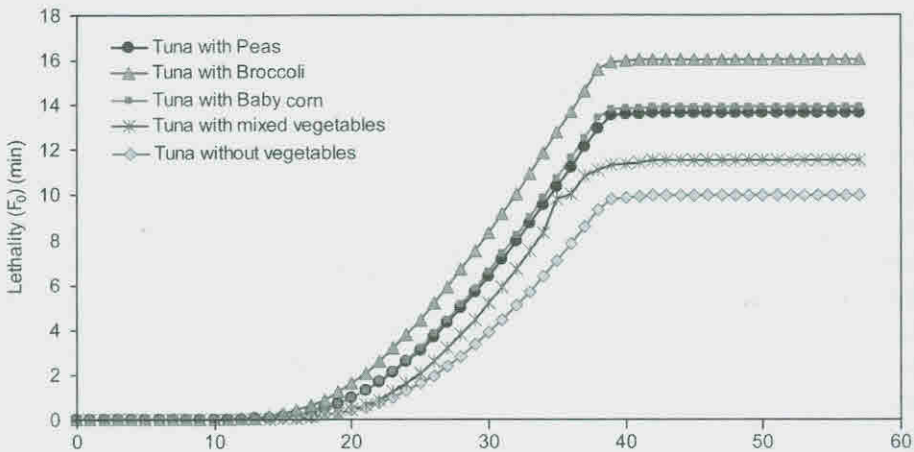


Fig. 2: Profile of accumulated lethality F_0 over tie for tuna with and without different vegetables in brine medium packed in tin-free steel (TFS) cans

These figures clearly indicate that the retort temperature was maintained uniformly in all the batches. The lethality obtained for different products were in the range of 9.9–16 min which is well within the recommended F_0 value (5–20 min) for various fish and fish products (Frott and Lewis, 1994). Since all the products were processed to equal time this difference in the lethality was observed for different products. Lowest lethality was observed for the tuna packs without any vegetables compared to tuna packed with vegetables. This could be due the quantity of tuna packed in the different packs. In tuna without vegetables cans, about 150g of tuna was packed compared to only 110g of tuna in other cans. This has slowed down the heat penetration into the core of the product resulting in the lower lethality. Among the tuna packed with vegetables, highest lethality (16 min) was observed for tuna with broccoli. This could be due to the soft nature of the broccoli which resulted in the faster heating rate resulting in highest lethality. Tuna packed with peas and baby corn exhibited similar lethality where as tuna with mixed vegetables showed lethality intermediate to the tuna without any vegetables and tuna with broccoli. Although these products exhibited different lethality values, all these processed products were found to be commercially sterile indicating that the thermal process time given was sufficient to achieve commercial sterility of the products. The sensory ratings of tuna thermal processed with and without vegetables are given in Fig. 3.

Sensory appearance of the tuna processed with vegetables was rated significantly higher compared to tuna without vegetables. Appearance and

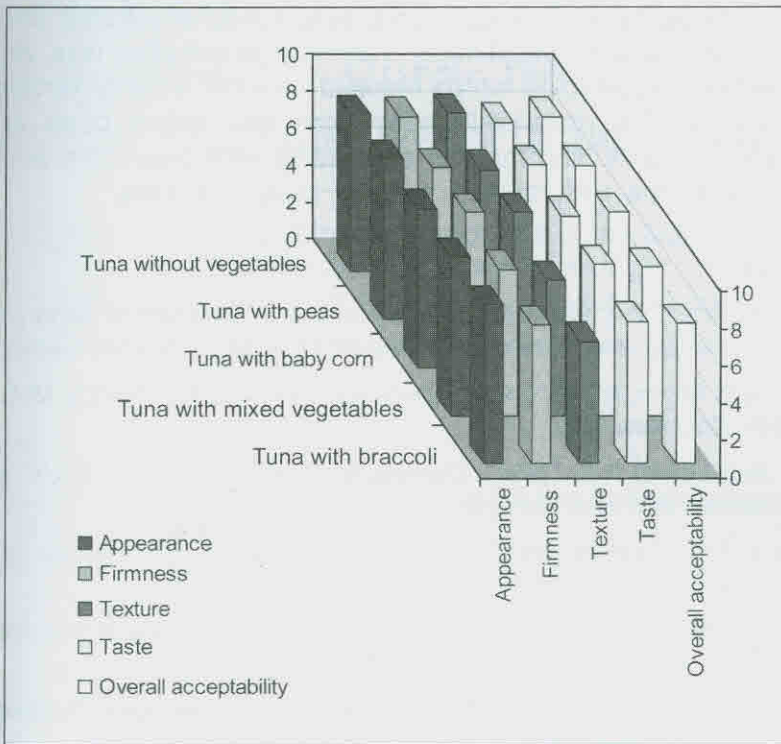


Fig. 3: Changes in sensory quality of thermal processed tuna with and without vegetables in brine medium in TFS cans

taste of the tuna with peas was rated as more desirable whereas firmness and texture of the tuna with baby corn was rated better. The panelists felt improved taste when tuna was consumed with green peas and baby corn compared to tuna alone. Although appearance of the tuna with broccoli was rated higher than tuna without vegetables, its texture, firmness and taste was rated significantly lower than all the other products. This could be mainly due to the soft nature of the broccoli which turned into paste upon pressing the processed product which resulted in poor rating. The overall acceptability was judged to be significantly higher for tuna with baby corn followed by tuna with peas and tuna without vegetables and mixed vegetables. For tuna processed with broccoli, the overall acceptability was rated least.

Conclusion

The present study indicated that the addition of different vegetables affected the heat penetration characteristics. The heat penetration was