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DEVELOPMENT OF READY TO SERVE TILAPIA SANDWICH PASTE IN RETORTABLE POUCHES

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Abstract: A ready to serve sandwich paste was developed from the meat of tilapia (*Oreochromis mossambicus*) with peeled potato by thermal processing in retortable pouches at a temperature of 121.1°C with different F_0 values of 6,7,8 and 9. Based on the evaluation of samples for texture, colour, commercial sterility, biochemical and sensory analysis all the samples were found to be acceptable based on the quality. The samples processed at 121.1°C at F_0 value 8.08, Cook value 75.02 and total process time 32.23 min were found to be the best. Thermally processed ready to serve tilapia sandwich paste was developed and its keeping quality was studied at ambient temperature. During storage, there was no significant change in the contents of Moisture, Protein, Fat and Ash. The TBA values of tilapia sandwich paste slightly increased during storage. Tilapia sandwich paste processed at 121.1°C for F_0 value 8.08 was fit for consumption even after a period of 1 year storage in retort pouch.
Keywords: Tilapia, Sandwich paste, Thermal processing, retort pouch, Commercial sterility.

Introduction

Indian planners ensuring food security for the increasing population have accorded the utilization of aquatic resources for human consumption. Though marine fish production is stagnant since last 3-5 years, the production of fresh water fish has shown significant progress. Tilapia, one of the fish in the world has been the choice of many. This is due to the efficient conversion of feed, ability to breed easily, resistance to handling stress, and disease and palatability (Akande, 1989). Culture of tilapia in India is now being commercially practiced and is also grown wildly in natural water bodies. Globally bulk of the tilapia is being consumed in fresh, frozen (fillets) and smoked condition (Asiedu et al., 1991). Tilapias are less commonly utilized for canning in the Asia-Pacific region, but well accepted in the filleted form. The available research literature in India on thermal processing of Tilapia is

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very limited. Recently, market for processed foods has been growing at a greater rate due to the change in life style and food habits of the people. Since tilapia is an odorless lean variety of fish with white flesh, it could be an ideal choice as raw material for the development of ready to serve fish products like fish curry, sandwich, cutlets, burgers and sticks by using retort pouches for both domestic and international markets (Dhanapal et al., 2010).

Therefore, the present study was aimed at developing thermally processed sandwich paste from tilapia in retortable pouch and to study the keeping quality of the product at ambient temperature.

Materials and Methods

Tilapia Fish (*Oreochromis mossambicus*) harvested from the natural waters of Muthukur, Nellore District, Andhra Pradesh, India was iced in the ratio of 1:1 and transported to laboratory in chilled condition. Fish measuring around 18 to 26 cm (4-5 pieces/kg) were washed with chilled water. Meat was separated from dressed fish using rotary type deboner (M/s. Safe World, Malaysia). The deboned fish meat was later minced using a mincer (M/s. Sirman, Italy) to obtain uniform size meat particles. The fresh minced meat obtained from tilapia was used for the preparation of sandwich paste.

Ingredients used for the sandwich paste preparation are presented in the Table 1. The sandwich paste was prepared by the following method. The mince was boiled for 15 minutes and made into paste. Potato was boiled, peeled and were made into paste. Chopped ginger, garlic and green chilies were also ground into paste. Chilly powder and turmeric powder together were made into a paste by adding sufficient water. Cinnamon, cardamom, anise, pepper, bay leaf and cloves in equal proportion was made into powder and used as spice mix. Fish paste was added into the frying pan and fried with half of the oil and kept aside. Half broken mustard and cumin seed were added into the hot oil and fried for 1-2 min. Chopped ginger, garlic and green chilly paste was added and half fried. Chilli powder and turmeric powder paste along with spice mix and salt were also added and fried until characteristic odour of fried spices emerges. The fish paste and potato paste were added and frying continued in a low flame for a while with vigorous stirring till the characteristic smell emerged. Lemon juice extract and coriander leaves were added and mixed uniformly prior to filling in the pouch for the study.

Table 1: Ingredients for Sandwich paste

Ingredients	Quantity (%)
Fish mince	50.50
Peeled potato	13.85
Refined sunflower oil	11.50
Garlic	4.60
Ginger	1.25
Green chilli	1.85
Mustard	0.25
Cumin seeds	0.75
Salt	1.80
Spice mix	0.25
Turmeric powder	0.50
Red chilli powder	1.25
Coriander leaves	0.40
Water	9.25
Lemon juice extract	2.00

Standardization of Fish Sandwich Paste

Five different fish paste recipe were prepared to improve the taste and spreadability by altering the content of fish mince with potato mince. Based on the sensory analysis, instrumental texture and colour an ideal recipe of 55% fish & 15% potato for fish sandwich paste was selected. The ingredients used for the finally selected recipe for Sandwich paste is given in Table.1

Retort Pouch

Laminated flexible pouch (4-ply), consisting of 12 µ polyester (outer layer), 9 µ aluminium foil and 15 µ nylon layer (middle layer) and 70 µ polypropylene (inner cast) was used for packing the sandwich paste. Pouches (150×200 mm) were used for the present study were purchased from M/s. Pradeep Laminators Pvt. Ltd. Pune. Maharastra, India.

Overpressure Retort

The pilot scale overpressure retorting unit (Alpha Steritech, Bangalore, India) consisting of retort, receiver and the control system was used for thermal processing which ensures close simulation with commercial scale equipment and which produces a high degree of process reproducibility and accuracy.

Ellab CTF 9004 (ELLAB Co., Roedovre, Denmark) Precission Thermometer and F_0 value integrator (Version 5.0, Denmark) was used to record core temperature, retort temperature, F_0 value and cook value at a specific time interval of 60 seconds. Temperature range of the instrument is -100^0C to +350°C with resolution of 0.1°C. The F_0 constants were e programmed at T=121.1°C, Z=10°C and Cook value constants at T=100°C.

The vacuum-sealing machine supplied by M/s ACEPACK, Mumbai was used for sealing the pouch with fish sandwich paste. Secondary sealing was done by Foot operated hydraulic heat sealing machine supplied by M/s Alpha Steritech, Bangalore.

Proximate composition

The moisture content of fish muscle and sandwich paste of tilapia was determined by using Automatic Moisture Analyzer (Denver Moisture Analyzer, Model IR 120, Bohemia, N.Y., U.S.A.). The sample was heated initially at 100˚C and later at a temperature of 170˚C. Moisture content corresponds to the weight loss of the sample. The crude protein content of the sample was determined by estimating Total Nitrogen by Kjeldahl method (AOAC, 2000). Crude protein content (Total nitrogen ×6.25) was calculated by multiplying the nitrogen content with 6.25. Fat was determined by the method described by the AOAC (2000) using the Soxhlet extraction system. Ash content was determined by ashing in a microwave furnace (Phoenix, Ariz., U.S.A) at 550°C ± 10°C for 5 hours and sodium chloride content was determined by AOAC (2000) method.

The pH was determined by blending 10 grams of tilapia sandwich paste and fish muscle with 90 ml distilled water in a homogenizer (Kinematica AG, Polytron System PT 2100, Lucerne, Switzerland) each for 30 seconds using a digital pH meter (Eutech Instruments, Singapore) standardized at pH 4 and 7 (APHA 1998).

Thiobarbituric acid (TBA) value

TBA value was determined using the method of Tarladgis et al., (1960). The TBA number was expressed as milligram malonoldehyde equivalents per kilogram sample. The absorbance was determined by a spectrophotometer at 532 nm against a blank containing distilled water and TBA solution.

Estimation of minerals

About 0.2 - 0.5 g of sample was weighed and digested with 5 ml of concentrated nitric acid and 1 ml of 30% perchloric acid using microwave based closed vessel (Anton Parr, USA). The sample containing vessels were capped and heated in the microwave unit at 1200 W to a temperature of 190°C for 25 minutes at a pressure of 25 bars. The digested samples were

diluted to 50 ml and kept in polypropylene bottles for analysis, by atomic absorption spectrophotometer (Analyst 800, Perkin Elmer, III., U.S.A.) using flame ionization with hollow cathode lamp; air- acetylene for flame; burner head temperature of 2400 °C , lamp current setting of 30 mA and results are expressed as ppm.

Commercial Sterility Test

The thermally processed samples of three types of products processed at different F_0 value and at different temperatures were incubated at 37^0C for 15 days and 55^0C for minimum of 5 days. The incubated pouches were aseptically opened and 1-2 g of the samples was inoculated into the sterilized fluid thioglycolate broth in test tubes. Sterilized liquid paraffin was put on to the top of the broth to create anaerobic condition and incubated at 37^0C for 48 hrs and at 55^0C for 4 days (IS: 2168 1971), respectively.

Instrumental analysis of Colour and Texture

The colour of the meat was measured using a Hunter - Lab scan XE – spectrocolorimeter (Hunter Associates Laboratory, Reston, USA.). The samples were analysed for quantifying the Commission Internationale de L 'Eclairage's lightness or luminance (L*) redness (a*), yellowness (b*) and hue angle (arcton, b*/a*), which describes hue or colour of the ground meat and saturation index $(a^{*2}+b^{*2})^{0.5}$ which depicts the brightness or vividness of colour (Hunt, 1991). Apart from the analysis of above parameters, textural characteristics like hardness, adhesiveness, resilience and stringiness were also analysed. In colour analysis, L* is given as measure of lightness which includes the value from '0' (considered as black) to the maximum 100 (considered as white). Whereas, a* is measure of redness which ranges the value from - 60 (considered as green) to + 60 (considered as red). In the case of b* which indicates yellowishness of the meat and it also carries similar value as redness from – 60 (blue) to + 60 (yellow). However, the nature of colour for respective values varies between blue to yellow. All values were determined from the mean of eight measurements of each fish steak at 28 ± 2^0C using the A/10^o observer. The spectrocolorimeter was standardized using white (L*=100), and black (L*=0) standard tiles and working standards, before being used. The results of the colour profile analysis were tabulated using EasyMatch software (EasyMatchQC, Version 4).

Compression tests were carried out by placing the samples of fresh and cooked fish streak meat on the base plate of the TA-XT2i Texture Analyzer (Stable Microsystems, UK). After compressing the streaks twice, the Texture Profile Analysis (TPA) was carried out using a cylindrical stainless steel probe of 5mm diameter provided in the texture analyser. The load

cell used was of 50 kg capacity with the following test conditions viz., pre test speed: 1.0mm/s, test speed: 0.5mm/s, post-test speed: 10.0mm/s, distance: 3mm/s for fish steaks, trigger force: 5g, return distance:15mm and contact force: 5g. Force by time data for each test was used to calculate mean values for the TPA parameters. The values for hardness, cohesiveness, springiness, stringiness, adhesiveness, resilience, gumminess and chewiness were determined at 28 ± 2^0C as described by Bourne (1978). The results of TPA were tabulated using Texture Expert Exceed software.

Sensory test

Thermally processed tilapia sandwich paste pouches were randomly selected (4 retort pouches for each treatment) and heated in boiling water for 5 min. The contents of samples were placed in cooled while enamel plates and served warm to panelists along with sandwich breads in separate booths equipped with proper illuminations water were provided to panelists for use before and after evaluation of each sample, to restore taste sensitivity (IS: 6273 [II] 1971; Vijayan 1984).

The changes in the sensory characteristics of the tilapia sandwich paste samples were evaluated by a panel of 7 researchers from the Institute, who have previously participated in the evaluation of similar products on a 10 point scale. The panelists were assign a score of 1 to 10 (1=dislike extremely, 2=dislike very much, 3=dislike moderate, 4= dislike slightly, 5= neither like or dislike, 6= like slightly, 7=like moderately, 8=like very much, 9=like extremely, 10= excellent) for appearance, color, flavor, odour, taste, texture and overall acceptability as prescribed by Vijayan (1984) .

Statistical analysis

The SPSS 10.00 (SPSS 2000) statistical packaging was used for analysis of the experimental results. The results were expressed as mean ± standard deviation and Duncan test was used to asses statistical significance ($p<0.05$) between the samples stored at ambient temperature during storage study. The correlation coefficients between the parameters were carried out using the same software.

Results and Discussion

Physical characteristics

The average length and weight of tilapia fish used in the present study was 24.88 ± 1.73 cm and 267.64 ± 22.57 gm, respectively. The yield of tilapia fish mince was found to be 33.39 ± 1.4%. Venugopal (2006) observed that the minced meat yield tilapia with 33.2%.

Proximate composition fresh tilapia mince

The moisture, protein, fat, ash and sodium chloride content of fresh tilapia mince was found to be 79.85±0.50%, 15.50±0.21%, 1.37±0.06 %, 1.07±0.04 % and 0.58±0.01%, respectively. The composition of the mince revealed higher quantity of moisture and lower fat content. Many researchers have indicated that tilapia fish is a lean variety, where fat content is less than 2% (Zain 1979; Akande 1989 and Asiedu et al., 1991; Murthy et al., 2008; Ninan et al., 2008; Dhanapal et al., 2010). The total crude protein is comparable to other tilapia species and fresh water fishes (Siddaiah 1994; Arekere 1993; Akande 1989; Zain 1979).

The copper, iron, zinc, magnesium and manganese content of fresh tilapia mince were 3.76±0.23 ppm, 4.88±0.68 ppm, 8.338±0.13 ppm, 270.98±2.06 ppm and 0.83±0.374 ppm, respectively. Viswanathan and Suseela (2000) observed the iron content of fresh tilapia meat to be 15 ppm. The content of iron observed in the present study was due to the biomass of Muthukur waters and the characteristics of soil, which is said to be rich in Iron.

Biochemical and microbiological characteristics of fresh tilapia mince

Fresh Tilapia mince had a pH of 6.8, Thiobarbutric Acid (TBA) of 0.57±0.01 mg%, Total Volatile Base Nitrogen (TVBN) of 3.57±0.10 mg% and Total plate count (TPC) of $4.9x10^4$ cfu/g. Murthy et al., (2008) reported a pH of 7.0 in fresh tilapia mince. The higher pH value observed may be due to the recording of the result during rigor or post rigor period. However, the TPC, TBA, and TVBN level were below the approved food standard limit.

Standardization of thermal process for fish sandwich paste in retort pouch

The fish sandwich paste was processed in retort pouch at four different F_0 values *viz.* 6, 7, 8 and 9 at 121.1^0C and evaluated for organoleptic parameters optimum F_0 value. Based on the commercial sterility, sensory evaluation, colour and texture profile analysis of the finished products, $F_0$8 at 121^oC was selected due to superior quality. Standardization of thermal processing of fish sandwich paste F_0 was set at around 8 to achieve target lethality. The heat penetration characteristics of each F_0 are given in Table 2. The processing parameters were obtained by plotting the graph and process time was calculated by using the Formula Method of Stumbo (1973). A higher F_0 value was found to affect the colour and harden the texture, as observed by Thankamma *et al.* (1998) and reported that the fish paste processed in retort pouch at F_0 value 6.83 arrived on trial and error method was safe. The F_0 recommended for fish products ranged from 5 - 20 (Frott and Lewis, 1994).The higher the F_0 value may be due to the presence of slightly more oil, potato combination and other ingredients. The sandwich paste processed at higher temperatures and F_0 values are having lesser a*, b*, Hue angle and

Saturation index than paste processed at lower temperatures and this may be caused due to heat denaturation of proteins and maillard's reactions.

Table 2: Heat penetration characteristics of tilapia sandwich paste at 121.1°C with four different F_0 values in retort pouch

Parameter	$F_0$6	$F_0$7	$F_0$8	$F_0$9
F_0 value	6.12	7.14	8.08	9.11
J_h	0.49	0.34	0.50	0.61
J_c	1.09	1.09	1.03	0.98
f_h	16.00	22.50	17.50	16.00
U	6.12	7.14	8.08	9.11
f_h/u	2.61	3.15	2.17	1.76
g	1.54	1.96	1.10	0.84
B	22.64	26.65	28.17	29.09
CUT	6.00	5.00	7.00	7.00
TPT	26.12	29.55	32.23	33.15
Cook value	69.00	40.31	75.02	79.81

Where, J_h = lag factor of heating, J_c = lag factor of cooling, f_h= slope of heating curve, U = time in minutes for sterilization at retort temperature, g = final temperature deficit, B = Ball's process time, CUT= Retort come up time, TPT = total process time,

The flavour and the overall acceptability of sandwich paste processed at 121.1°C for F_0 8 were rated high by the sensory panel (Table 3). Sandwich paste processed at 121.1°C for F_0 8 has good colour, taste, texture, spreadability and overall acceptability when compared to other F_0 values.

Table 3: Sensory scores* of tilapia sandwich paste at four different F_0 during standardization

	F_0 6	F_0 7	F_0 8	F_0 9
Appearance	7.86±0.40	7.82±0.47	**7.83±0.71**	7.89±0.34
Colour	8.08±0.64	8.13±0.60	**8.08±0.52**	7.56±0.58
Flavour	8.03±0.87	8.08±0.79	**8.29±0.62**	7.80±0.68
Odour	7.89±0.80	7.89±0.61	**7.97±0.72**	7.87±0.60
Taste	8.03±1.00	8.06±1.01	**8.63±0.76**	8.12±0.93
Spreadability	8.38±0.70	8.51±0.72	**8.52±0.80**	7.31±0.71
Texture	7.92±0.79	8.03±0.87	**8.06±0.73**	7.90±0.36
Overall Acceptability	8.03±0.70	8.21±0.65	**8.52±0.43**	7.99±0.56

*Each value is represented as the arithmetic mean, ± SD of n= 7

Sandwich paste processed at 121.1°C for different F_0 values were analysed for color parameters viz. L*, a*, b*, Hue angle and Saturation index. The changes in colour of sandwich paste before and after heat processing at F_0 8 are presented in the Table 4. From the table, it is clear that sandwich paste processed at higher temperatures and F_0 values are

having a*, b*, Hue angle and Saturation index values lesser than paste processed at lower temperatures.

Table 4: Colour of tilapia sandwich paste with different F_0 values

Parameters	L*	a*	b*	Hue	Saturation index
Before heat treatment	53.12±0.01	13.56±0.04	59.11±0.01	4.36±0.01	60.65±0.01
F_0 6	50.14±0.03	14.75±0.03	52.26±0.03	3.54±0.02	54.30±0.02
F_0 7	49.29±0.01	14.13±0.02	51.18±0.05	3.62±0.02	53.09±0.02
F_0 8	48.84±0.02	14.66±0.05	49.39±0.04	3.37±0.02	51.52±0.02
F_0 9	48.16±0.01	14.69±0.02	50.57±0.02	3.44±0.01	52.66±0.01

*Each value is represented as the arithmetic mean, ± SD of n= 7
L* is a measure of lightness (0 = black and 100 = white).
a* is a measure of redness (-60 = green and + 60 = red.).
b* is a measure of yellowness (-60 = blue and + 60 = yellow).

Instrumental TPA (Texture Profile Analysis) data for tilapia sandwich is given in Table 5. The TPA of Sandwich paste before retorting was 736.99±6.45gf and after retorting it varied significantly. Product processed at 121.1^{0}C with F_0 6 got 1006.43±7.78gf. The values increased with increasing in the F_0 values. Sandwich paste processed at 121.1^{0}C for F_0 8 got 1975.21±14.75 gf.

Table 5: Textural changes of Tilapia sandwich paste with different F0 values

Parameters	Hardness (gf)	Adhesiveness (gs)	Stringiness (mm)	Resilience (gs)
Before heat treatment	979.73±27.03	-226.23±6.68	9.64±0.01	0.06±00
F_0 6	1006.43±7.78	-192.97±7.86	9.65±00	0.06±
F_0 7	1241.75±14.80	-189.41±0.98	9.51±00	0.08±00
F_0 8	1975.21±14.75	-120.36±1.36	9.30±00	0.09±00
F_0 9	1658.30±19.76	-28.56±0.68	9.45±00	0.10±00

*Each value is represented as the arithmetic mean, ± SD of n= 7

Storage Studies of Tilapia Sandwich Paste in Retort Pouch

The sandwich paste thus processed at 121^{0}C, F_0 value 8 was kept at ambient temperature to for further studies. The aim of this was to see the effect of retorting on the changes in the sandwich paste during storage and also for determining shelf life. The heat penetration data are given in Table 6 and heat penetration pattern in Fig 1&2. The processing parameters were obtained by plotting the graph, and process time was calculated by using the formula method (Stumbo, 1973). The results of the storage studies conducted and the changes in the values of different parameters analysed are presented in this chapter.

Table 6: Heat penetration characteristics of tilapia sandwich paste at 121°C at F_0 8 in retort pouch for storage

1	F_0 value	8.03
2	J_h	0.50
3	J_c	1.03
4	f_h	17.50
5	U	8.03
6	f_h/u	2.18
7	g	1.12
8	B	28.09
9	CUT	7.00
10	Total process time	32.15
11	Cook value	74.91

Where, J_h = lag factor of heating, J_c = lag factor of cooling, f_h= slope of heating curve, U = time in minutes for sterilization at retort temperature, g = final temperature deficit, B = Ball's process time, CUT= Retort come up time

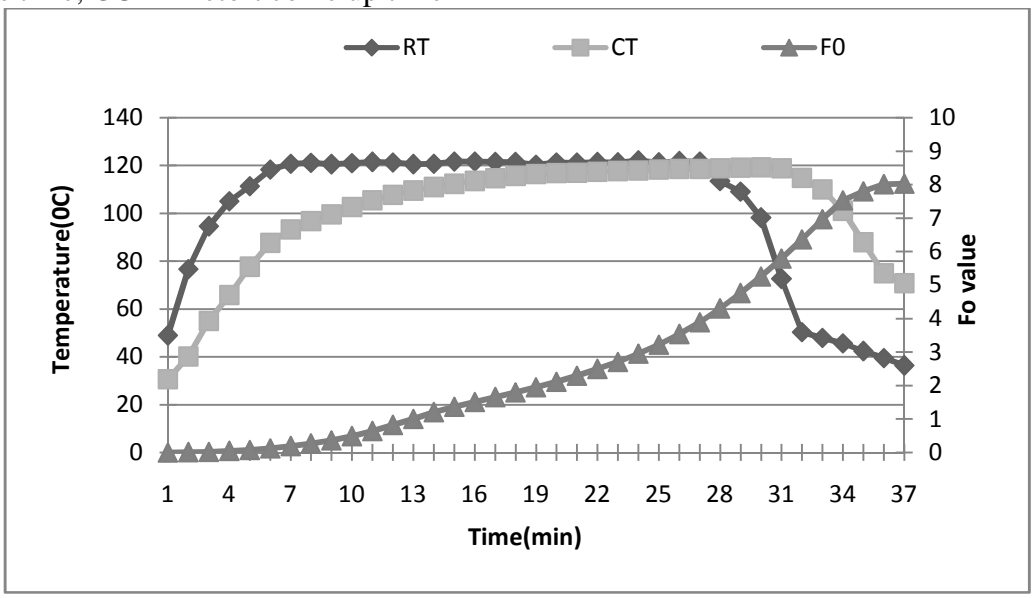

Fig. 1: Heat Penetration pattern and F_0 value of thermally processed tilapia sandwich paste at 121.1°C to F_0 value 8

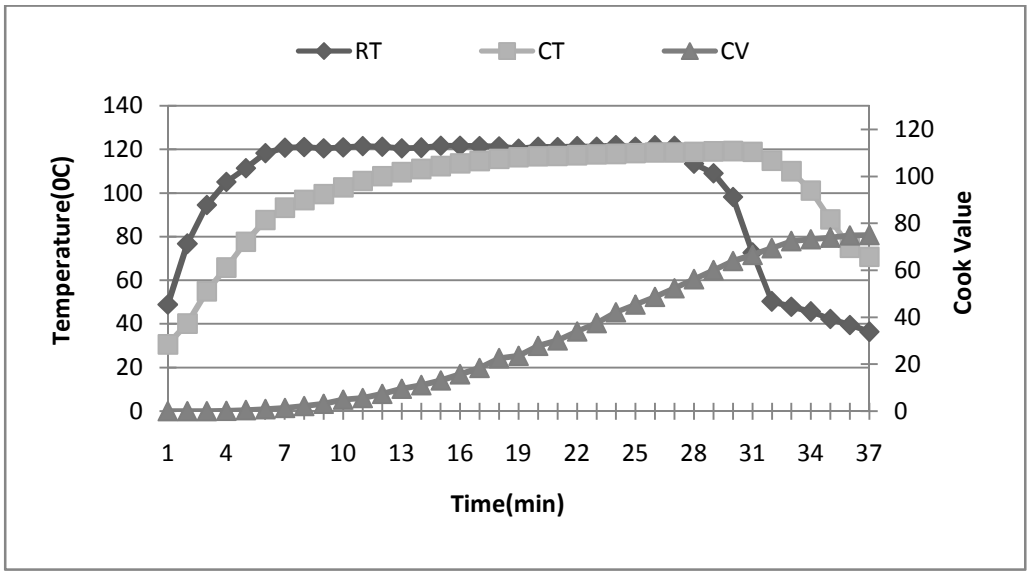

Fig. 2: Heat Penetration pattern and *cook* value of thermally processed tilapia sandwich paste at 121.1^{0}C to F_0 value 8

Biochemical changes of sandwich paste in retort pouch during storage

The pH, moisture, protein, fat and ash content of the sandwich paste are presented in Table 7. During the period of storage, no significant change was observed in the content of moisture, protein, fat and ash. pH of the products showed a slight decrease during storage. Heating of muscle or isolated myofibrils usually results in an increase of pH (Hamm, 1966; Roberts and Lawrie, 1974; Fogg and Harrison, 1975) whereas, the moisture content showed no significant change throughout the storage period (Table 8). Thankamma *et al.* (1998) observed similar changes in the moisture content of the fish paste stored in the retort pouch. The initial decrease in the moisture content of all the samples may be due to the heat induced coagulation of protein and cross linking of peptide bonds. The high content of fat in the paste is due to the fat added to make the paste smooth and more spreadable.

The changes in the TBA of tilapia sandwich paste is given in the table 7. The TBA value of tilapia sandwich paste showed increasing trend unto sixth month and later decreased till the end of the study period. In addition, brine (NaCl) has been reported to enhance the lipid oxidation and that of the highly unsaturated lipids (Harris and Tall 1994). Several studies have confirmed that pressure increases the rate of lipid oxidation in muscle systems, and have attributed this effect mainly to the water content and/or metal ions released from hemoprotein complexes during pressure treatment (Tanaka *et al.* 1991; Cheah and Ledward, 1995; Cheah and Ledward, 1997). Bindu *et al.* (2004, 2007) and Siriamornpun *et al.* (2008) reported that the TBA value showed an increasing trend during storage period in retort pouch and can

respectively. A decreasing trend in TBA value has been reported in canned fish by Mallick *et al*. (2006), Manju *et al*. (2004) and Tanaka *et al*. (1985). Aubourg *et al.* (1990) has suggested that the decrease in TBA value of canned fish meat might be due to dilution of secondary oxidation product 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 case of Tilapia sandwich paste, the TBA content gradually increased in the initial period of storage. The increase in the TBA value is probably due to the fact that the processed tilapia sandwich paste produced primary oxidative compounds during heat processing changed to secondary compounds and decrease towards the end of storage may be caused by the involvement of TBA in protein-lipid interactive reactions.

Table 7: Biochemical changes of tilapia sandwich paste in retort pouch during storage

Period (month)	pH	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	TBA (mg malonaldehyde /kg)
0	5.53±0.01	67.18±0.01	10.16±0.74	13.35±0.04	2.95±0.02	0.058±0.002
3	4.85±0.03	64.87±0.20	10.03±0.01	13.59±0.15	3.07±0.08	0.506±0.003
6	5.13±0.03	66.79±0.09	10.37±0.07	13.42±0.01	3.02±0.02	0..666±0.025
9	5.10±0.00	64.94±0.12	10.01±0.04	13.71±0.10	3.11±0.02	0.630±0.002
12	5.00±0.00	66.08±0.11	9.97±0.07	13.67±0.07	3.03±0.03	0.432±0.005

*Each value is represented as the arithmetic mean, ± SD of n= 3

Colour changes of fish sandwich paste during storage

At the initial stage of storage period the colour L* value slightly increases in the first month and then there was no significant change in the colour of the tilapia sandwich paste till the end of the storage period of one year where as a*value and b* value increases slightly and the same trend continued till the end of the storage period. Where as, Hue colour and saturation index increased in the first month and showed declining trend towards the end of the study period (Table 8). Tarr (1962) reported a brown discoloration in white-fleshed fish upon heating. Changes in the salmon color pigments upon heating have been studied by Naughton *et al.* (1956). Tarr (1958) stated that free ribose accounts for much of the Maillard type of reaction when fish is heated in presence of carbohydrates.

Table 8: Changes of sandwich paste colour in retort pouch during storage

Months	L*	a*	b*	Hue angle	Saturation Index
0	48.57±0.01^{a}	16.09±0.01^{a}	44.69±0.01^{a}	2.78±0.00^{b}	47.50±0.01^{a}
3	51.39±0.02^{b}	17.80±0.02^{d}	47.57±0.02^{ab}	2.67±0.00^{a}	50.80±0.03^{c}
6	55.35±0.00^{f}	17.33±0.01^{b}	47.89±0.00^{c}	2.76±0.00^{b}	50.93±0.00^{c}
9	53.29±0.02^{c}	17.30±0.01^{b}	47.12±0.03^{b}	2.72±0.00^{ab}	50.19±0.03^{b}
12	54.60±0.38d^{e}	17.66±0.15^{cd}	50.57±0.57^{ef}	2.86±0.06^{c}	53.57±0.49^{e}

*Each value is represented as the arithmetic mean, ± SD of n= 8
^{a,b,c,d} Averages followed by the same small letters in the table are not significantly different by Duncan at (P>0.05)

Textural changes of fish sandwich paste during storage

There was no much significance in gumminess, springiness, resilience, stringiness, chewiness and cohesiveness in samples. Whereas hardness slightly decreases initially and then showed upward trend on third month and further there was no significant change afterwards. The adhesiveness showed slightly increasing trend up to fourth month and again shown declining trend on the fifth month and further slight increase in the value towards end of the study (Table 9). This may be due to the heat induced coagulation of protein, and cross linking of peptide bonds. Low pH and Maillard type of reactions. Tarr (1958) stated that free ribose accounts for much of the Maillard type of reaction when fish is heated in presence of carbohydrates.

Table 9: Changes of texture in sandwich paste during storage in retort pouch

Months	Hardness(gf)	Adhesiveness(gs)	Stringiness(mm)	Cohesiveness
0	947.60±7.15^{d}	150.00±22.08^{c}	9.50±0.06^{a}	0.53±0.05^{a}
3	940.00±4.67^{d}	200.00±10.17^{bc}	9.50±0.03^{a}	0.54±0.00^{ab}
6	640.00±12.20^{a}	370.00±99.75^{abc}	9.70±0.06^{abc}	0.71±0.02^{c}
9	880.00±9.03^{c}	570.00±58.36^{a}	9.90±0.07^{c}	0.55±0.04^{ab}
12	610.00±8.14^{a}	460.00±15.20^{a}	9.80±0.05^{bc}	0.62±0.01^{b}
Months	**Resilience**	**Springiness**	**Gumminess**	**Chewiness**
0	0.06±0.00^{d}	1.00±0.00^{c}	500.00±51.44^{bc}	510.00±54.13^{a}
3	0.05v0.00^{b}	1.00±0.01^{bc}	510.00±1.78^{bc}	510.00±1.76^{b}
6	0.05±0.00^{b}	1.00±0.00^{bc}	450.00±6.29^{ab}	460.00±5.51^{b}

9	0.06±0.00^{cd}	0.99±0.01^{ab}	490.00±44.27^{bc}	480.00±38.75^{b}
12	0.05±0.00^{b}	0.99±0.01^{abc}	380.00±10.71^{a}	380.00±11.19^{b}

*Each value is represented as the arithmetic mean, ± SD of n= 8
^{a,b,c,d} Averages followed by the same small letters in the table are not significantly different by Duncan at (P>0.05)

Organoleptic quality of Tilapia sandwich paste in retort pouch during storage

The mean sensory scores for all the attributes along with the overall acceptability of the products are presented in Table 10. The overall mean score in the tilapia sandwich paste were found to be good even at the end of 360 days of storage. No significant difference (p>0.5) was observed among the products during the entire period of storage. The products are commercially sterile throughout the storage period of one year. Evancho *et al.* (1973) and Mallick *et al.* (2006) were also reported similar observations in retort pouch products.

Table 10: Sensory scores* of sandwich paste during storage in retort pouch

Month	Appearance	Colour	Flavour	Odour	Taste	Spreadability	Texture	Overall acceptability
0	9.00±0.00^{c}	8.60±0.19^{a}	8.60±0.19^{a}	8.20±0.12^{ab}	7.90±0.24^{a}	7.70±0.30^{a}	8.00±0.22^{ab}	8.30±0.12^{a}
3	9.00±0.32^{c}	8.80±0.20^{a}	8.20±0.20^{a}	8.20±0.20^{ab}	8.20±0.37^{a}	8.60±0.40^{b}	8.60±0.40^{b}	8.00±0.40^{a}
6	8.60±0.24^{abc}	8.70±0.20^{a}	8.00±0.27^{a}	7.90±0.24^{ab}	7.70±0.30^{a}	8.20±0.12^{ab}	8.20±0.12^{ab}	8.10±0.29^{a}
9	8.21±0.26^{ab}	8.14±0.14^{a}	8.14±0.26^{a}	8.29±0.26^{b}	7.64±0.37^{a}	8.36±0.14^{ab}	8.21±0.24^{ab}	8.03±0.24^{a}
12	8.17±0.31^{ab}	8.17±0.17^{a}	8.08±0.27^{a}	8.17±0.28^{ab}	7.50±0.37^{a}	8.25±0.11^{ab}	8.17±0.28^{ab}	7.67±0.25^{a}

*Each value is represented as the arithmetic mean, ± SD of n= 7
^{a,b,c,d} Averages followed by the same small letters in the table are not significantly different by Duncan at (P<0.05)

Commercial Sterility

The Sandwich paste showed no growth after processing and during the storage at ambient temperature, which indicates that the process given to the product, was sufficient to attain sterility.

Conclusion

The study demonstrated the suitability of tilapia mince along with potato for the development of sandwich spread in retort pouches. The results shown that the a temperature

of 121.1°C and F_0 value of 8 and cook value of 75.02 min were optimum for thermal processing of tilapia sandwich paste. A convenient ready to serve thermal processed tilapia sandwich paste can be prepared in tilapia mince using retort pouches that remain in good quality after a period of 1 year at ambient temperature.

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References

[1] Akande GR. 1989. Technical note: Improved utilization of stunted *Tilapia sp. Int.* J Food Sci Technol 24:567-571.

[2] AOAC 2000. Official Methods of Analysis of AOAC INTRENATIONAL, 17th Edition, Suite 500, 481 North Frederick Avenue, Gaithersburg, Maryland, USA, 20877-2417.

[3] APHA 1998. Standard methods for the examination of water and wastewater, 20th Edn., Washington, D.C.

[4] Arekere G. 1993. Effect of freezing and frozen storage on the properties of proteins from common carp (*Cyprinus Carpio)* [M.F.Sc dissertation]. Available from: University of Agricultural Sciences, Bangalore, India.

[5] Asiedu MS, Julshamn K, and Lie Q. 1991. Effect of local processing methods (cooking, frying and smoking) on three fish species from Ghana: Part I. Proximate composition, fatty acids, minerals, trace elements and vitamins. Food chem 40:309-321.

[6] Aubourg SP, Sotelo CG, and Gallards JM. 1990. Changes in flesh lipids and fill oil of albacore (*Thunnus alalunga*) during canning and storage. J Agric Food Chem 38 (3):809-812.

[7] Bindu J, Gopal TKS. and Unnikrishnan Nair TS. 2004. Ready-to-eat mussel processed in retort pouches for the retail and export market. Packag Technol Sci 17(3):113-117.

[8] Bindu J, Ravishankar CN. and Gopal T.K.S. 2007. Shelf life evaluation of a ready-to-eat black clam (Villorita cyprinoides) product in indigenous retort pouches. J Food Eng 78:995-1000.

[9] Bourne, M. C., 1978. Texture profile analysis. *Food Technol*., 22:62-66, 72.

[10] Cheah PB. and Ledward DA. 1995. High pressure effects on lipid oxidation. J Am Oil Chem Soc 72:1059–1063.

[11] Cheah PB. and Ledward DA. 1997. Catalytic mechanism of metabolism of lipid oxidation following high pressure treatment in pork fat and meat. J Food Sci 62:1135–1141.

[12] Dhanapal K, Reddy G.V.S, Nayak B.B., Basu S, Shashidhar K.,Venkateshwarlu G., and Chouksey M.K.2010. Quality of Ready to Serve Tilapia Fish Curry with PUFA in Retortable Pouches. J Food Sci 75 (7):S348–354.

[13] Evancho GM, Ashton DH. and Briskey EJ. 1973. Conditions necessary for sterility test of heat processed canned foods. J Food Sci 38:185-188.

[14] Fogg, N.E. and Harrison, E.L.1975. Relationships of electrophoretic patterhis and selected characteristics of bovine skeletal muscle and internal temperature.*Journal of Food Sci*. 40:28.

[15] Frott R, and Lewis AS. 1994. Canning of meat and fish products. London: Chapman and Hall. 202 pp.

[16] Hamm, R., 1966. 'In physiology and Biochemistry of Muscle as food'. Ed. Briskey,R. G. Cassesen and J. C. Trautman. University of Wiscosin Press, Madison, Wiscosin.

[17] Harris, P. and Tall, J., 1994. Rancidity in fish. *In: Rancidity in Foods* (A. J. Hamilton, ed.) pp. 256–272, Chapman and Hall, London, U.K.

[18] Hunt, M.C., Acton, J.C., Benedict, R.C., Calkins, C.R., Cornforth, D.P., Jeremiah, L.E., Olson, D.G., Salm, C.P., Savell, J.W. and Shivas, S.D., 1991. AMSA guidelines for meat color evaluation. *In*: *Proceedings 44th Annual Reciprocal Meat Conference* (pp. 3–17), 9–12 July 1991, Kansas State University, Manhattan, KS.

[19] IS: 2168. 1971. Specification for Pomfret canned in oil. Indian Standard Institute, New Delhi, India.

[20] IS: 6273 [II]. 1971. Indian Standard Guide for Sensory Evaluation of Foods (Part II, Methods and Evaluation Cards), Indian Standard Institute, New Delhi, India.

[21] Mallick AK, Gopal TKS, Ravishankar CN. and Vijayan PK. 2006. Canning of rohu (*Labeo rohita*) in north Indian style curry medium using polyester coated Tin Free steel cans. Food Sci Tech Int 12(6):539-545.

[22] Manju, S., Sonaji, E. R., Leema, J., Gopal, T. K. S., Ravishankar, C. N. and Vijayan, P. K., 2004. Heat penetration characteristics and shelf life studies of seer fish moilee packed in retort pouch. *Fishery Technol*., 41 (1):37-44.

[23] Murthy LN, Panda SK. and Shamasundar BA. 2008. Physico-chemical and functional properties of proteins of tilapia (Oreochromis *mossambicus*). J Food Process Eng. In press.

[24] Naughton, J.J., Frodyma, M.M. and Seitlin, H., 1956. Nature of green or off-colour condition in pre-cooked yellowfin tuna. U.*S Fish. Wildlife. Serv. Spec. Sci. Rept*., No.197. 7pp. Cited: Broek, C.J.H., 1965.

[25] Ninan G, Bindu J, and Jose Joseph. 2008. Frozen Storage Studies of Mince Based Products Developed from Tilapia (*Oreochromis mossambicus,* Peters, 1852). Fish Technol Vol.45(1):35-42.

[26] Roberts, P. C. B. and Lawrie, 1974. *J. Fd. Technol*. 9:345

[27] Siddaiah D. 1994. Stability of minced meat of fresh water fish (Silver carp Hypophthalmichys molitrix) at lower temperature and its suitability to prepare paste products. [M.F.Sc.dissertation]. Available from: University of Agricultural Sciences, p 42-95.

[28] Siriamornpun S, Yang L, Kubola J, and Li D. 2008. Changes of omega-3 fatty acid content and lipid composition in canned tuna during 12 month storage. J Food Lipids 15,164-175.

[29] SPSS 2000. SPSS for windows. Release 10. Chicago, I1: SPSS Inc.

[30] Stumbo CR. 1973. Thermobacteriology in food processing (2nd edn.). Academic Press. Inc., New York, 329 pp.

[31] Tanaka, M. and Taguchi, T., 1985. Non-enzymatic browning during thermal processing of canned sardine. *Bull. Japan Soc. Sci. Fish.*, 51 (7):1169-1173.

[32] Tarr, H. L. A., 1958. Biochemistry of Fishes. *Ann. Rev. Biochem*., 27:223-244.

[33] Tarr, H. L. A., 1962. Cause of the browning of certain heat processed fish products. Fisheries research board, Canada, *Progr. Repts. Coast. Sts*. No.92:23-24.

[34] Tarladgis GB, Watts MB, and Younathan TM. 1960. A distillation method for the quantitative determination of malonaldehyde in rancid foods. J Am Oil Chem Soc 37: 44-50.

[35] Thankamma, R., Srinivasa Gopal, T.K. and Iyer, T.S.G., 1998. Storage of fish paste heat- processed in retort pouch, Advances and priorities in fisheries technology, Society of Fisheries Technologists(India), 246-250.

[36] Venugopal V. 2006. Retort pouch packaging. In: *Seafood processing*. (V. venugopal ed.). pp-197-214. CRC press Taylor & Francis Group, New York.

[37] Vijayan PK. 1984. Report on training program on retort pouch processing of fish and fish analysis at Tropical Development and Research Institute and Metal Box (R & D), UK, Cochin: Central Institute of Fisheries Technology.

[38] Viswanathan nair PG, and Suseela Mathew. 2000. Biochemical composition of fish and Shellfish. CIFT Technology Advisory series, CIFT, ICAR. Cochin.

[39] Zain AM. 1979. Spice minced fish from tilapia. In: Advances in Fish Science and Technology, Fishing News (Books).Ltd. London. pp. 223-226.