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Standardisation of Process Parameters for Ready-to-drink Shrimp Soup in Retortable Pouches

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

Abstract

Present study aims to develop a ready-to-drink shrimp soup. Three different traditional recipes were prepared and one among them was selected based on taste panel studies. Selected shrimp soup was thermal processed in retortable pouches for preserving it in ready-to-drink form. About 200 ml of soup was packed in flexible pouch of 3-ply laminate consisting of outer polyester (12.5 μm), middle aluminium foil (12.5 μm) and inner cast polypropylene (85 μm) and processed at 121.1°C at three F_0 values *viz.*, 4, 5 and 6 min. Total process time was in the range of 13-17 min with cook values of 34, 41 and 46 min, for F_0 4, 5 and 6 respectively. Products processed at F_0 6 had better overall acceptability score (8.4) when compared to F_0 4 and 5.

Keywords: Shrimp soup, ready-to-drink, retortable pouch, thermal processing

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* *E-mail: cnrs2000@gmail.com*

Introduction

Demand for seafood/seafood-based products in ready to cook or ready to serve convenience form is increasing day by day. As far as fish processing industry is concerned, value addition is one of the possible approaches to raise profitability since this industry is becoming highly competitive and increasingly expensive (Gopal et al., 2009).

Soup is a savory liquid food, which is made by combining ingredients such as meat and vegetables in stock or hot water, until the flavour is extracted, forming a broth (Anon, 2007). Studies reveal that soup emptied more slowly inducing a slow and moderate postprandial secretion of insulin which would tend to enhance the satiating power of the meal (Holt et al., 1992; Holt & Miller, 1995). Soup prepared from shrimp is expected to have very good demand worldwide, thus has good commercial value as well. As soup is considered as poor man's rich food, soup prepared from shrimp will find wide acceptance from all classes of society.

At present, soup is either prepared fresh or made from the soup powder. Both these methods are time consuming and laborious. Hence, there is a need for developing ready to drink soup, which can be stored at ambient conditions for longer periods. Thermal processing is one of the most effective means of preserving food (Karel et al., 1975) through which longer shelf life can be achieved at ambient storage. Freshly prepared soup has a shelf life of 4-5 days in refrigerated conditions. Thermal processing can be adopted to extend the shelf life of soup stored at ambient storage conditions. Various fish and shrimp products have been standardized for thermal processing in both metal containers and retortable pouches. (Hu et al., 1995; Ravishankar et al., 2002; Bindu et al., 2004). However, there is no report on thermal processing of shrimp soup. Hence, the present work was undertaken to standardise the process parameters for ready to drink shrimp soup in retortable pouches.

Materials and Methods

For the present study, flexible pouch of 3-ply laminate consisting of outer polyester of 12.5 μm, middle aluminium foil of 12.5 μm and inner cast polypropylene of 85 μm thickness and size 16x20 cm manufactured by M.H. Packaging, Ahmedabad was used. The pouch was found to have process resistance and product resistance. Heat seal strength was determined as per ASTM (1973) and bond strength as per ASTM (1972). Suitability of laminate for product resistance and process resistance was determined as per method described by Gopakumar (1993). Barrier properties such as water vapour transmission rate was determined as per IS: 1060 Part II (1960) and gas transmission rate was done as per ASTM D 1434 (1987). Tensile strength and elongation at break of the pouch was determined as per IS: 2508 (1984). Bursting strength was tested as per Lampi et al. (1976). Residual air test (Shappee & Werkowski, 1972) and overall migration test were determined as per IS: 9845 (1998).

Commercially important and most commonly available species, 'Indian white shrimp' (*Fenneropenaeus indicus*) was used in the present study. Shrimps were collected from Fort Cochin fish landing centre at Cochin and were iced immediately at a shrimp to ice ratio of 1:1 and brought to laboratory in insulated boxes. Shrimp soup was prepared using three different traditional recipes and one recipe among them was selected based on taste panel's judgment. The selected recipe is described below.

Washed, peeled and deveined shrimp meat was blanched in 6% boiling brine for 1-2 min. Blanched and cooled shrimps (10 g) were packed in retortable pouch. Soup medium was prepared separately incorporating ingredients as given in Table 1. Shrimp was made into paste and fried with butter in frying pan followed by addition of onion, ginger and garlic paste, till the mix turns a light brown colour. Water and corn flour were added and stirred to attain the required consistency, and salt was added as per taste. About 200 ml of hot soup was poured in pouches containing shrimp pieces and the air inside the pouch was exhausted by steam injection.

Pouches were heat-sealed and divided into three batches and were processed in a stationary over pressure retort at 121^0C to F_0 4, 5 and 6. Process data was recorded by inserting three thermocouple needles into the center for each F_0 values of the pouch separately. Pouches were cooled using water to a core temperature of 40°C. Thermocouple outputs were measured by using an Eval precision thermometer and process integrator (Ellab, Denmark). The recorded data were analysed using valsuite software. Heat penetration data were plotted on a semi logarithm paper with temperature deficit (RT-CT) in logarithmic scale on Y-axis against time in linear scale on X-axis. Lag factor for heating (Jh), lag factor for cooling (Jc), slope of heating curve (fh) and time in minutes for sterilization at retort temperature (U) were determined. Process time (B) was calculated by mathematical method (Stumbo, 1973). Actual process time (TPT) was determined by adding process time (B) and the effective heating period during come up time *viz.*, 58% of the come up time. The pouches processed at different F_0 values were tested for commercial sterility as per IS : 2168 (1971).

Table 1. Ingredients used for preparation of soup medium

Ingredients	Quantity added
Shrimp (peeled & deveined)	100 g
Corn flour	40 g
Pepper	10 g
Ginger	10 g
Butter	25 g
Onion	100 g
Water	1000 ml
Salt	To taste

Viscosity was measured using a Brookfield DV II+ Viscometer (Brookfield Engineering Laboratory Inc., Stoughton, MA). Soup was poured in the helipath stand mounted with a T-C spindle that rotated at 1 rpm and readings were noted. Colour of the soup was measured with a Hunter Mini Scan XE Plus. Parameters determined were CIEL* (L* = 0 [black] and L* = 100 [white]), CIEa* (-a = greenness and +a* = redness), and CIEb* (-b* = blueness and +b* = yellowness).

Pouches were cut open, soup emptied into transparent glass bowls, heated in a microwave for 2 min and served hot to the panellists. Sensory evaluation was done by 10 member panel based on characterization and differentiation of the various sensory characters such as appearance, colour, odour, flavour, taste and consistency as per Meilgaard et al. (1999). A score above 5.0 was considered as the margin for acceptance.

Results and Discussion

Physico-chemical properties of the retort pouch are presented in Table 2. Pouches used in the study had good mechanical strength and barrier properties. Migration into n-heptane was higher than those into water and 3% acetic acid. However, all values were well below the prescribed limit of 10 mg dm^{-2} indicating that the pouches were fit for food contact applications.

Table 2. Physico-chemical properties of retort pouch

Parameters	Value*
Tensile strength (kg cm^{-2})	
Machine direction	425.20 ± 0.05
Cross direction	406.58 ± 0.09
Elongation at break %	
Machine direction	20 ± 2.1
Cross direction	20 ± 2.3
Heat seal strength (kg cm^{-2})	
Machine direction	378.34 ± 0.007
Cross direction	361.48 ± 0.08
Bond strength (g 25 mm^{-1} width)	
Inner ply	109.52
Outer ply	180.32
Bursting strength (psig)	30 ± 0
Gas transmission rate (c$cm^{-2}24^{-1}$ h at 1 atm. pressure)	10.18 ± 0.05
Water vapour transmission rate (g$m^{-2}24^{-1}$ h at 37^0C and 92% RH)	0.24 ± 0.04
Overall Migration (mg dm^{-2})	
Distilled water (121^0C 2 h^{-1})	0.6 ± 0.03
3% acetic acid (121^0C 2 h^{-1})	0.9 ± 0.02
n-heptane (66^0C 2 h^{-1})	3.64 ± 0.06
Residual air after processing (ml 100 ml^{-1})	1.32 ± 0.07

*Each value is represented by the mean ± SD, n = 10

The recommended F_0 value for various fish and fish products is 5–20 (Frott & Lewis, 1994). In the present study, shrimp soup was processed to different F_0 values of 4, 5 and 6 min. Heat penetration data of shrimp soup in retortable pouches processed to F_0 4, 5 and 6 are presented in Table 3. Come Up Time (CUT) should be as shorter as possible (Anon, 1968) and in the present study, the CUT was about 6 min. Process time (B) taken to reach F_0 4, 5 and 6 were 11, 12 and 14 min, respectively. Cook value increased with F_0 value and it was 34, 41 and 46 min, respectively. Total process time was found to be 14, 16 and 17 min for samples processed at F_0 4, 5 and 6 respectively. Relatively low process time required to achieve the F_0 could be attributed to the rapid heat transfer of the soup. Although total process time was in the range of 14-17 min, the products were found to be commercially sterile.

Table 3. Heat penetration data* for standardization of soup at different F_0 values at 121.1^0C

Parameters			
Standardization [F_0 value]	F_0 4	F_0 5	F_0 6
Actual Fo value	3.93	5.12	6.03
J_h	0.91	0.94	0.68
J_c	0.97	1.10	1.08
f_h	6	6	8.4
U	3.93	5.12	6.03
f_h/u	1.53	1.17	1.39
g	1.25	0.76	1.11
B	10.83	12.12	13.90
CUT	5	6	6
TPT	13.73	15.60	17.38
Cook value	33.90	41.37	45.85

Each value is represented by mean ± SD, n = 3; f_h= slope of heating curve, J_h= lag factor of heating, J_c = lag factor of cooling, 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.

Table 4. Sensory scores* of soup processed at three different F_0 during standardization

Characteristics	F_0 4	F_0 5	F_0 6
Appearance	7.0 ± 0.4	7.5 ± 0.5	8.3 ± 0.4
Colour	6.8 ± 0.1	7.2 ± 0.08	8.3 ± 0.09
Odour	7.1 ± 0.4	7.2 ± 0.1	8.3 ± 0.3
Flavour	7.1 ± 0.08	7.3 ± 0.07	8.4 ± 0.08
Taste	7.2 ± 0.05	7.3 ± 0.03	8.5 ± 0.04
Consistency	7.1 ± 0.08	7.4 ± 0.04	8.4 ± 0.09
Overall acceptability	6.9 ± 0.7	7.4 ± 0.6	8.4 ± 0.5

* Each value is represented as mean ± SD, n = 10

L* values of raw and processed soup were 69.8 and 69.50, in terms a* –2.6 and -1.53 and in terms b* it was 4.2 and 4.47 respectively. L* and b* values did not vary much before and after processing but there was a distinct increase in a* value in soup indicating the soup turning more greenish. Panellists did not find the change in soup colour repelling, hence change in a* value had no negative impact on overall acceptability, indicating that thermal processing of soup in ready–to-drink form, did not affect its acceptability.

Viscosity in raw and processed soup was 326.8 cp and 337.2 cp respectively indicating an increase in viscosity in processed soup. This may be due to increase in dry matter and heat transfer rate possibly leading to starch gelatinization as reported by Ikegwu et al., (2009) in '*Achi*' flour.

Results of sensory analysis are presented in Table 4. Soup processed to F_0 4 and 5 had lesser consistency when compared to F_0 5 to 6. This could be attributed to higher process time at F_0 6 compared to F_0 4 and F_0 5. Apart from this, all sensory attributes including colour, appearance and taste were rated higher for F_0 6.0 compared to F_0 4 and 5. Based on sensory panel's rating and other physical parameters, the F_0 6.0 was found superior compared to F_0 4.0 and 5.0.

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