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Standardization of Retort Pouch Processed Mini Chevon Patties Incorporated with Sesame Seed Paste

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ABSTRACT

There is increasing demand for ready to eat shelf stable meat products, which has easy marketing potential. In this study, an attempt was made to standardise the process schedule for retort processed chevon patties. The control and patties with SSP were used to standardize retort pouch processing schedule. The product core temperature reached its first lethality rate of 0.001, when the product core temperature was 94^{0}C, retort temperature was 121^{0}C in treatment 1, in treatment 2 they were 92^{0}C and 118^{0}C, and in treatment 3 they were 90^{0}C and 114^{0}C, respectively. Treatment 3 required a heating time of 15 minutes, cooling time of 7 minutes and total lethality (F_0) of 11.093. The heating lag factor (J_h) was 1.10 and the cook value was 73.26 min. The cooling lag factors (j_c) were 1.00, 1.10 and 1.20 for treatments 1, 2 and 3, respectively.Thef_h/U ratio of mini chevon patties were 2.80, 2.24 and 1.93 for treatments 1,2 and 3, respectively. The highest heating rate index, heating lag factor, heating time, cook value and time for sterilization and lowest f_h/U values were recorded in treatment 3. The patties processed with F_0 of 11.093 had better sensory scores.

Key words: Retort pouch, Chevon patties, Sesame seed paste, heat penetration characteristics, thermal processing

INTRODUCTION

Due to climate conditions and insufficient refrigeration facilities, high perishability of meat and meat products is a great concern in developing countries such as India (Bacchil, 1982). For easy marketing and to attract consumers, shelf-stable meat products has a very high potential. Thermal processing is a food processing technique that uses heat to enhance food's texture, flavour, and palatability as well as to destroy bacteria and enzymes, extending the food's shelf life (Yancui Huang *et al.*, 2016).According to Fellows (2017), meat and its products are considered low-acid foods (pH>4.5) and should be cooked to 121.1^{0}C for two to three minutes. This ensures that every food particle reaches the desired temperature and offers a significant safety margin against estimated levels of contamination in raw materials. Accordingly, heating temperatures necessary to create products that are safe for consumption and microbiologically sound are related to thermal processing of packaged foods (Hassoun *et al.*, 2021).

The special set of benefits given by flexible packaging materials drives the shift from traditional rigid containers, such as metal cans, to flexible pouches. The advantage of flexible packaging is the more efficient use of packaging material and packaging space, which saves storage and transportation costs as well as trash for disposal (Mohan *et al*.,2015). Processed food products that are ready to eat and stable at room temperature can be produced using retort processing. This unique kind of food is described as a catering system based on the partial cooking of food, followed by thermal processing at high temperatures while being stored under ambient conditions, and then thorough reheating of the meat prior to consumption (Gokhale and Lele, 2014).

For the purpose of thermal processing and food product storage, a retort pouch is a flexible laminated pack with adequate strength and heat resistance. Because they provide the convenience of "eating off the shelf" and do away with the tediousness of preparing meals at home, retort pouch processed foods are regarded as the "ultimate processed foods" with a very high value addition. This type of products is also important among processed foods because it contains no chemical preservatives and can be stored without refrigeration for at least a year (Rajkumar*et al*.,2010). Thus with the growing need for products with less fat or calorie and high level of convenience it becomes necessary to develop meat products using attractive and appropriate packaging technology that are pertinent to present day consumer demand. Hence, the present study has beenenvisaged with standardizing the process protocol of retort pouch processed mini chevon patties.

MATERIALS AND METHODS

Preparation of mini chevon patties

The mini chevon patties were prepared as per our earlier study (Jeyapriya et al, 2023). Briefly, food processor was filled with chopped chevon, curing materials, and ice flakes. Proteins were extracted by chopping for 3 minutes on high speed, after adding goat fat/sesame seed paste (2.8% SSP) to the mixture, the chopping was maintained at high speed for 3 minutes. After adding the binder (maida), dry spice mix, and green condiments, the procedure was repeated for another 30 seconds to make the final batter. Raw patties with an average weight of 25grams were moulded using petri plates (40mm internal diameter x 12mm height) from the prepared batter. The patties were grilled in a preheated electrical grilling oven at 180^{0}C for 30 minutes, or until the interior core temperature reached 80^{0}C. Patties were flipped after 15 minutes of cooking to ensure even cooking. The control and treatment patties were made, and the products were then processed in retort pouches.

Determination of retort processing temperatures

Three different retort processing temperatures were selected based on the values reported in the literature with the laboratory model (Model No. LEW/25/2005 – 25 pouches capacity, M/s. Lakshmi Engineering, Chennai) overpressure autoclave (Retort). The retort temperature was maintained at 121.1^{0}C for 10, 13 and 15 minutes, respectively for treatment 1, treatment 2 and treatment 3. By maintaining the product core temperature at 121.1^{0}C for three different time periods of 5, 10 and 11 minutes, each time temperature combination were repeated thrice as (Trial 1, 2, 3) and the desired lethal rates (F_0 values) for treatments 1, 2, 3 were obtained. For calculating the F_0 value the following formula was used.

Lethal rates / F_0 value (min) = $10^{(PCT - 121.1)/10)}$; where PCT = product core temperature. Product core temperature was noted every minute till the product was processed and the F_0 values calculated. Lethal rate (F_0) of minimum 0.001 was taken as base for calculation. F_0values were calculated by adding up all the lethal rates noted every minute (Stumbo, 1973).

Physical properties of retort pouch used for the study

Retort pouches (supplied by M/s Lakshmi Engineering, Chennai) having a three layer configuration and a dimension of 20 cm x 15 cm were utilized for this study. Thickness of retort pouch used 106.0 µm, with pouch length, width and pouch weight of 200 mm×150 mm×7.95 gm. Seal width, side and bottom of 10 mm, with a heat sealing strength of 6.5 Kg/ 15mm, bursting strength of 31 psig and containing water vapour transmission rate of 0.18 gm^2/24 h at 90% RH (Rajkumar et al., 2010)

Preparation of retort pouch processed mini chevon patties

The freshly prepared mini chevon patties of control and treatment groups were filled into the pouches (100g in each pouch) and then immediate sealing was done by vacuum packaging of the pouch. It helps to remove the head space air in the pouch (Model 19/s, Roscherwerke GmbH, Germany). Adequate numbers of pouches were

loaded which contained thermocouples fixed carefully to the core of chevon patties to study the process control parameters. The filled and sealed pouches were laid flat on the trays in the retort.

Determination of thermal processing

The filled and sealed pouches were subjected to thermal processing by maintaining the retort temperature at 121.1^{0}C. Thermal processing was determined as per the previously explained design of experiment. The processing time was determined by slightly modifying the method described by (Gopal *et al*., 2001). Three different combinations of retort and product temperatures were used to obtain the desired F_0 values. Pressure was maintained at 20 psi throughout the process, using steam air mixture while heating and water air mixture while cooling. Rapid cooling was accomplished by recirculating cooling water.

Three thermocouples were placed in three different locations including geometric centre of the pouch. The time needed to reach the target temperature of 121.1^{0}C was recorded. The experiment was repeated three times.

After processing to the required F_0value, they were cooled rapidly, till the core temperature of the product reached 60^{0}C (T_c) by pumping water into the retort and recirculating it. The values obtained were used for the calculation of heat penetration characteristics (Stumbo, 1973). The lag factor for heating (j_h), slope of heating curve (f_h), time in minutes for sterilization at retort temperature (U) and lag factor for cooling (j_c) were calculated. The parameters fh/U, final temperature deficit g, process time B and total process time (TB) were calculated by the mathematical method of Stumbo (1973). The parameters were determined by plotting temperature deficit (RT – Tc) on semi log paper. RT is the retort temperature and T$c$is the product core temperature. Total process time (TB) was determined by adding process time *(B)*to the effectiveness of the come up time (CUT). After processing, all the pouches were wiped dry and kept in a dust proof cabinet at ambient temperature (25 -30^{0}C).

Sensory evaluation and Visual examination

Initially, suitable retort processing temperature for the three different time temperature combinations of the product was determined. All the freshly prepared products were subjected to sensory evaluation using 8 point hedonic scale. Sensory evaluation of the samples was carried out as described by Keeton (1983).

Visual examination were carried out daily twice at 12 hours interval to observe any deformity in the retort processed pouches. All the experiments were repeated thrice and the suitable retort processing temperature from the three different time temperature schedule was determined based on the heat penetration characteristics, sensory scores and visual observation and the selected product was subjected for further microbial analysis.

Microbiological analysis

All the microbiological parameters standard plate count, anaerobic count, Clostridium botulinum, yeast and mould count were determined by using standard methods of APHA (1984). Readymade media (Hi-Media, India) were used for all the microbiological examination.

Statistical analysis

The data generated from this study were subjected to statistical analysis by standard procedures like analysis of variance (ANOVA) using SPSS software 17. The data recorded in this experiment were analyzed using two way ANOVA. Significant difference were tested using the Least Significance Difference Test (LSD) as per Snedecor and Cochran, (1994).

RESULTS AND DISCUSSION

Three different retort processing schedules were tried for processing the control and treatment samples. In the beginning, the retort processing temperature and the product core temperature were 35^{0}C and 30^{0}C, respectively. The product core temperature reached its first lethality rate of 0.001, when the product core temperature was 90^{0}C in treatment 3 (Table 1, Fig 1). These findings were similar to the results reported by Gopal *et al*. (2001) for retort pouch processed fish curry; Devadason (2014) for shelf stable buffalo meat blocks; Rajkumar *et al*. (2010) for retort pouch processed chettinad goat meat curry and Nalini *et al*. (2018) for retort pouch processed pepper chicken product.

The heating time was recorded as 10, 13 and 15 minutes for treatment 1, 2 and 3, respectively based on the time taken for the product core temperature to reach 121.1^{0}C. Cooling time was 5, 6 and 7 minutes for treatment 1, 2 and 3, respectively, after attaining necessary product core temperature of 121.1^{0}C. After cooling the retort temperature was brought to 45^{0}C and the product core temperature was recorded to be 60^{0}C. The above results were in agreement with Devadason (2014) in thermal processing of shelf

stable buffalo meat blocks and Majumdar *et al*. (2017) in retort pouch processed fresh water prawn curry.

Total lethality (F_0) received for the products were found to be 5.086, 10.086 and 11.093 minutes for treatment 1, 2 and 3, respectively. These results were in agreement with the findings of Gopal *et al*. (2001) who recorded total lethality (F_0) values of 6.56 to 8.43 in Kerala style fish curry and Shankar *et al*. (2002) who recorded the lethality (F_0) value of 11.5 min in heat processed seer fish curry. However, Rajkumar *et al*. (2010) reported these values as 16, 18 and 22 mins in processed Chettinad goat meat curry; whereas, Nalini *et al*. (2015) reported this value as 5.2 minutes in retort pouch processed chettinad style chicken. Recently, Priyanka *et al*. (2017) reported F_0value of 6.5 minutes in shelf stable cereal based chicken stew and Nalini *et al*. (2018) reported 7.2 minutes in retort pouch processed pepper chicken. These variations in F_0 values might be due to variations in the type of products.

Total processing time was 39, 42 and 45 mins for treatment 1, 2 and 3, respectively. Total processing time was highest for treatment 3. The results were in agreement with Gopal *et al*. (2001) who recorded 38.43 min for Kerala style fish curry. However, Rajkumar *et al*. (2010) reported 46, 49 and 55 mins of total processing time for retort processed chettinad goat meat curry which were little higher than the total processing time recorded in the present study. Almost similar processing time as recorded in the present study were reported by Majumdar *et al*. (2015) for rohu kalia; Priyanka *et al*. (2017) for retort processed cereal based chicken stew and Nalini *et al*. (2018) for retort processed pepper chicken.

The heating rate indices (f_h) of mini chevon patties were 28, 28 and 29 mins for treatment 1, 2 and 3, respectively. The results of the study were in accordance to the findings of Rajkumar *et al*. (2010) who reported 25, 28 and 32 in retort processed chettinad goat meat curry. Gouthamy *et al*. (2021) reported the values of 24.5 and 23 min for ready to eat shrimp masala which were lower than the values recorded in the present study. The heating rate indices (f_h) of 25 to 32 min indicated that the heat penetration was by both convection and conduction.

The heating lag factors (J_h) were 1.07, 1.02 and 1.10 for treatment 1, 2 and 3, respectively. These observations were in accordance to the findings of Mohan *et al*. (2015) who recorded 1.00 for both tuna blended with sunflower oil, groundnut oil and coconut oil and crab sandwich in retortable pouches.

Cooling lag factor (J_c) were 1.00, 1.10 and 1.20 for treatment 1, 2 and 3, respectively. Similar findings were recorded by Mohan *et al*. (2006) which were 1.09 to 0.95 for shrimp kurma in cans and pouches and 1.02 – 1.18 for Rohu curry (Manjumdar *et al*. 2015). The results of J_h andJ_c values in this study were within the range of 0.8 to 1.5 as indicated by Ranganna (2000). These values vary with the type of the product and size of the retort used.

Cook values of mini chevon patties for treatment 1, 2 and 3 were 41.60, 60.12, 73.26 min, respectively. Ali *et al*. (2006) reported a cook value of 75.55 for tuna in oil processed in retort pouches and Rajkumar *et al*. (2010) reported a cook value of 45.39, 59.93 and 75.35 for retort processed chettinad goat meat curry.

The f_h/ U ratios of chevon patties were 2.80, 2.24, 1.93 for treatments 1, 2 and 3, respectively. The lethal value conferred during cooling is accounted for the equation of the heating curve through the relationship of the ratio of f_h/ U (Ranganna. 2000).

Table 1: Heat penetration characteristics of mini chevon patties during retort processing (Mean ±SE)

PARAMETERS	TREATMENT-I (F_0 = 5.086)	TREATMENT- II (F_0 = 10.086)	TREATMENT-III (F_0 = 11.093)
Heating rate index (*fh*) min	28.00±0.00^a	28.00±0.00^a	29.00±0.00^b
Heating lag factor (*Jh*)	1.07±0.00^b	1.02±0.00^a	1.10±0.00^c
Cooling lag factor (*Jc*)	1.00±0.00^a	1.10±0.00^b	1.20±0.00^c
Process time (min)	16.00±0.00^a	18.5±0.00^b	22.00±0.00^c
Cook value (min)	41.60±0.00^a	60.12±0.00^b	73.26±0.00^c
Time for sterilization (U) or heating time (min)	10.00±0.00^a	12.5±0.00^b	15.00±0.00^c
***fh*/U**	2.80±0.00^c	2.24±0.00^b	1.93±0.00^a

All values under the head treatment are based on 6 observations (n=6)
Means bearing different superscripts between columns differ significantly (P <0.05)

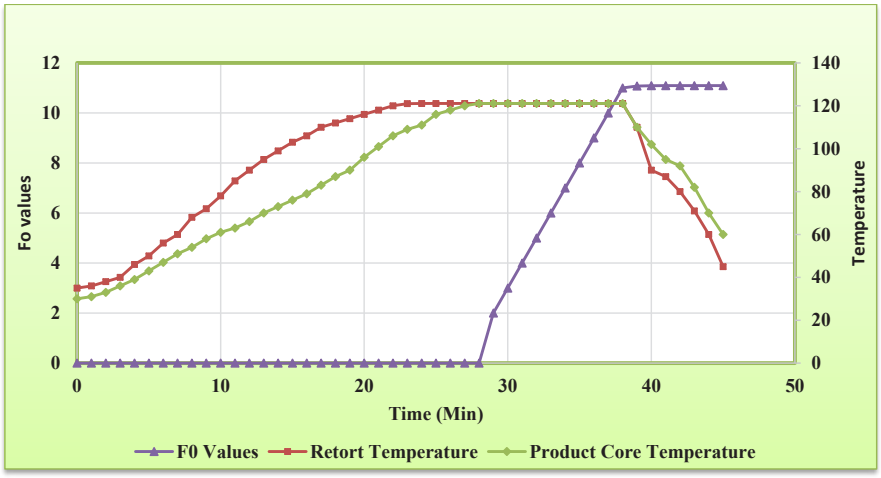

Fig. 1. Heat penetration characteristics of mini chevon patties during retort pouch processing

Table 2: Effect of retort processing with different lethal values (F0 value) on the sensory attributes of freshly prepared mini chevon patties

Parameters		Treatment – I ($F_{0=}$5.07)	Treatment - II ($F_{0=}$ 10.09)	Treatment – III ($F_{0=}$11.09)
Appearance	Control	6.30 ± 0.08^{aB}	6.70 ± 0.09^{bB}	7.13 ± 0.10^{cB}
	Treatment (2.8% SSP)	5.33 ± 0.12^{aA}	5.66 ± 0.12^{bA}	6.03 ± 0.13^{cA}
Flavor	Control	6.13 ± 0.11^{aB}	6.90 ± 0.11^{bB}	7.03 ± 0.11^{bB}
	Treatment (2.8% SSP)	4.48 ± 0.09^{aA}	6.03 ± 0.13^{bA}	6.96 ± 0.14^{cA}
Juiciness	Control	6.73 ± 0.13^{aB}	6.96 ± 0.11^{bB}	7.00 ± 0.11^{Bb}
	Treatment (2.8% SSP)	5.86 ± 0.13^{aA}	6.13 ± 0.13^{bA}	6.26 ± 0.15^{bA}
Texture	Control	6.93 ± 0.10^{B}	6.86 ± 0.09^{B}	7.03 ± 0.08^{B}
	Treatment (2.8% SSP)	5.93 ± 0.10^{A}	5.76 ± 0.13^{A}	5.80 ± 0.12^{A}
Overall acceptability	Control	6.20 ± 0.11^{aB}	7.03 ± 0.10^{bB}	7.20 ± 0.11^{aB}
	Treatment (2.8% SSP)	5.20 ± 0.12^{aA}	5.93 ± 0.11^{bA}	6.26 ± 0.13^{cA}

A,B means bearing similar superscripts in a column within a parameter do not differ significantly (P<0.05); a, b means bearing similar superscripts in a row within a parameter do not differ significantly (P<0.05)

Determination of suitable retort processing schedule for retort processed mini chevon patties by sensory evaluation

The freshly prepared control and treatment patties of different F_0 values were subjected to sensory evaluation using 8 point hedonic scale. The results of sensory evaluation of the fresh retort pouch products are presented in table 2.

Significant (P<0.05) differences were noticed between all the F_0 values for treatment and control samples, whereas, treatment 3 with F_0 value of 11.093 for both control and 2.8% SSP containing samples had the highest appearance scores. There was a linear increase in appearance scores with increase in F_0 values. Similar findings were reported by Majumdar *et al.* (2017) in retort processed fresh water prawn in curry medium and Gouthamy *et al.* (2021) in ready to eat shrimp masala.

Significant (P<0.05) differences for flavor scores were recorded between F_0 values of 5.086 and 10.086 for control and 2.8% SSP treated patties, whereas, no significant(P>0.05) difference was noticed between F_0 values of 10.086 and 11.093, respectively. But the highest scores were noticed for F_0 values of 11.093. Majumdar *et al.* (2017) reported similar results in retort processed fresh water prawn in curry medium.

There was no significant (P>0.05) difference in texture scores between F_0 values of 5.086, 10.086 and 11.093

in both control and 2.8% SSP treated patties. Texture scores for 2.8% SSP were significantly (P<0.05) lower than control sample on all the F_0 values. Numerically the highest scores were recorded for F_0 value of 11.093 in 2.8% SSP treated products. Similar findings were reported by Sreenath *et al.* (2007) in ready to eat squid masala.

Significant (P<0.05) differences were found between F_0 values of 5.086, 10.086, 11.093 for both control and 2.8% SSP treated product, but no significant (P>0.05) difference was observed between 10.086 and 11.093. Juiciness scores for control were significantly (P<0.05) higher than 2.8% SSP treated product on all F_0 values. But the highest scores were noticed for F_0 values of 11.093. Similar findings were reported by Sreenath *et al.* (2007) in ready to eat squid masala.

Overall acceptability scores were significantly (P<0.05) higher for F_0values of 10.086 and 11.093 than 5.086 control samples. There was linear increase in overall acceptability scores for both control and treated patties with increase in F_0values. Overall acceptability scores were significantly (P<0.05) higher for control than 2.8% SSP treated patties for all F_0 values. Similar findings were recorded by Majumdar *et al.* (2017) in retort processed fresh water prawn in curry medium.

Daily visual observation result of the retort pouch processed mini chevon patties stored under ambient temperature

Visual observation revealed that both control and 2.8% SSP treated patties retort processed at F_0 value of 5.086 and 10.086 shown bulging of packets in 2 and 4 days at ambient temperature, respectively. Those packets were bulged and when opened, emitted obnoxious odour. The products inclusive of both the control and 2.8% SSP treated patties processed at F_0 value of 11.093 were intact within the packets on visual observation for a time period of a month. All the products processed at F_0 value of 11.093 exhibited no symptoms of spoilage (bulging of packets) on visual examination, suggesting that it received sufficient heat processing at F_0 value of 11.093. Similar finding was reported by Rajkumar *et al.* (2010) in retort processed chettinad goat meat curry. Nambiar (2005) explained that extent of thermal processing, which a food receives depend upon the combination and the physical characteristics of the food product and is the result of the combination of time and temperature of processing. Gopal *et al.* (2001) evaluated the performance of the retort pouch processed kerala style traditional fish curry by direct observation for defects such as pinholes, wrinkles/ creases, leakage of fluids, delamination of inner/ outer ply/ flex cracks etc.

Selection of suitable process schedule for preparation of mini chevon patties by using retort for further microbial analysis

The suitable process schedule for control and treatment samples of mini chevon patties was selected based on the heat penetration characteristics, sensory evaluation and visual observation at different heating time of 10, 13 and 15 minutes with respective F_0 values of 5.086, 10.086 and 11.093. The sensory scores revealed significantly (P<0.05) higher scores for patties made with heating time of 15 minutes (F_0=11.093) for appearance, flavour, juiciness and overall acceptability than the patties processed for 10 minutes (F_0=5.086) and 13 minutes (F_0=10.086) heating time. Thus control and treated samples were retort processed with a heating time of 15 minutes (F_0=11.093) for assessing the microbial safety of the selected product.

Microbial quality of retort pouch processed (F_0=11.093) mini chevon patties stored at ambient temperature

From heat penetration characteristics, sensory evaluation and visual observation, the selected combination of one retort processing temperature and time for control and SSP incorporated mini chevon patties were examined under ambient temperature upto 30 days at 15 days interval and noticed no colony forming unit (cfu) for standard plate count, anaerobic count, clostridium botulinum and yeast and mould count were detected in any of the selected control and treated patties with F_0 value of 11.089, for over a period of 30 days at 15 days interval. The absence of microbial growth during the entire 30 days of examination, might be attributed to the optimal thermal processing schedule followed. The results of the study were similar to the findings of Devadason *et al.* (2014) who also observed no microbial growth in retort processed buffalo meat chunks. Similarly, Priyanka (2017) also could not detect any microbial growth in retort processed cereal based chicken stew.

CONCLUSION

From the three different time temperature schedule of retort processing, the mini chevon patties processed with a total lethality (F_0) value of 11.093, had the highest cook value, heating rate index, heating lag factor, process time and time of sterilization and was also found to have a linear increase in the sensory scores and daily visual observation also showed no bulging of packets or any obnoxious odour

for about a month. On the basis of these above parameters, control and treated patties with F_0 value of 11.093 was found optimum for retort pouch processing of mini chevon patties and hence microbial analysis was carried out to assess the safety of the selected control and treated patties (F_0 value 11.093), which proved that the product had no microbes and remained commercially sterile for a period of 30 days at ambient temperature and confirmed the adequacy of the processing of mini chevon patties as well as fitness of the product for consumption without any appreciable depreciation in quality.

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