Preparation and storage stability of retort processed Chettinad chicken

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Abstract Chettinad chicken was prepared using boneless meat derived from spent hen and boiler breeder packed in retort pouches (250 g) and processed in retort at the product temperature of 121.1 °C and the corresponding F_0 value of 5.2. The product was stored at ambient temperature (35 ± 2 °C) up to 180 days. The sensory scores for texture of the Chettinad chicken prepared from spent hen and broiler breeder meat decreased significantly however the scores were rated very acceptable even on 180th day. The thiobarbituric acid (TBA), tyrosine values and acid value increased gradually during storage but *E. coli*, *Salmonella spp*, *Clostridium spp*, *Staphylococci spp*, *Streptococci spp*, yeast and mould could not be detected during the entire storage period. The cost of production of Chettinad chicken (250 g) prepared from spent hen meat and broiler breeder meat was Rs.37 and Rs.50, respectively. It was concluded that the retort processed Chettinad chicken prepared from spent hen and broiler breeder meat can be safely stored up to 180 days at ambient temperature.

Keywords Spent hen meat · Chettinad chicken · Retort processing · Storage stability

Spent hens either layer or broiler breeder are the by-products of layer/broiler poultry industry. Spent hen meat is tough, dry and sinewy and hence the demand for marketing of spent hens for meat is limited. With proper processing or value addition the tough meat can be converted in to acceptable meat product and thereby can increase the profit

margin of the poultry farmers. Chettinad chicken is a famous traditional meat product of Tamil Nadu originated from Karaikudi region. High perishability of meat and meat products is a serious problem in developing countries including India due to climatic condition and limited refrigeration facilities (Bachhil 1982). It is necessary to develop shelf stable product to attract consumers. A ready-to-serve consumer product of good shelf-life will definitely have good market. This situation naturally demands appropriate technologies for its profitable and proper utilization (Bindu et al. 2004). Retort processing enables to providing ready to eat processed food products which are stable at ambient temperature. Present study was planned to assess the storage stability of retort processed Chettinad chicken at ambient temperature up to 180 days.

Materials and methods

Preparation of Chettinad chicken: layer Spent hen birds and broiler breeder birds weighing about 1.5 kg and 4 kg, respectively were purchased from Private poultry farms and birds were slaughtered by Halal method. Deboned meat from breast and thigh region was packed in low density polyethylene (LDPE, 250 gauge) bags and kept under frozen storage (-20 °C). The recipe for Chettinad chicken was standardized. The ingredients (in parts) for the Chettinad chicken recipe were chicken meat (boneless) 100, chilly power 7.5, coriander powder 5.0, turmeric powder 0.3, big onion 50, tomato 50, curry leaves 0.3, coriander leaves 0.4, garlic 5.0, ginger 2.5, anise seed 2.0, salt 2.5, refined oil 50, spice mix (cinnamon, cloves, cardamom powders mixed in equal parts) 0.6. Dry spices, onion, garlic and ginger were fried in refined oil and mixed with the precooked meat. The whole mix was fried for about 10 min and cooled.

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Retort processing Retort processing was done at Varsha Fresh Meat Products Limited, processing plant near by Govindapuram in Kerala. Chettinad chicken (250 g) was carefully filled in four laminated retort pouch (M/s. Pradeep Laminators Pvt. Ltd., Pune). The hermetically sealed pouches on the trays were loaded in the retort machine (M/s. Lakshmi Engineering Works, Chennai). For heat penetration studies, a sample pouch was fixed with thermo couple glands through which thermocouple was inserted into meat pieces for recording the core temperature during heat processing. The filled and sealed pouches (along with sample pouch) were subjected to thermal processing at 121.1 °C and 5.2. F_0 value for 36 min. Pressure was maintained at 20 psi throughout the process. Rapid cooling was done to 55 °C. The processed retort pouches were stored in cool dry place for further storage studies at ambient temperature (35±2 °C).

The samples were analyzed for moisture, crude protein, ether extract and total ash as per the standard procedures (AOAC 1995).

pH of Chettinad chicken was determined by AOAC (1995). Thiobarbituric acid (TBA) value was estimated by extraction method described by Witte et al. (1970) and was expressed as mg malonaldehyde (MA) per kg of pet food. The procedure of Strange et al. (1977) was followed for the tyrosine value. Tyrosine value was calculated and expressed as mg of tyrosine per 100 g of sample. Estimation for the free fatty acid content, acid value and peroxide value was done as per AOAC (1995). The microbiological quality of pet foods was assessed in respect of total plate count (TVC), *E. coli*, *Staphylococci spp*, *Clostridium spp*, *Salmonella spp*, yeast and mould count as per the method prescribed by Quinn et al. (1994) and expressed as the log cfu/g of sample. Sensory quality of Chettinad chicken during storage was assessed through an 8-point hedonic scale ranging from 8 (extremely acceptable) to 1 (extremely unacceptable) by the in house semi trained taste panelists. The cost of production of the Chettinad chicken prepared from spent hen meat and broiler breeder meat was calculated based on the market price of the live birds and ingredients. The data (3 replicates) were subjected to analysis of variance (ANOVA) as per Snedecor and Cochran (1989) using Statistical Analytical System (SPSS 1999) version 10.0 for Windows. Significant differences ($p<0.05$) were tested by Duncan's multiple range test.

Results and discussion

The average live weight of spent hen and broiler breeder birds was 1.12 kg and 3.89 kg and the average boneless meat yield per bird was 0.24 kg and 1.24 kg per bird, respectively. The yield of boneless meat from thigh and

breast region of spent hen and broiler breeder was 21.06 and 31.82% live weight, respectively.

Retort processing The thermal processing conditions adopted in the present study were in agreement with Frott and Lewis (1994) who reported that recommended F_0 value for retort processed fish products ranges from 5 to 20. Gopal et al. (2001) maintained the retort temperature at 121.1 °C and the traditional Kerala style fish curry, filled in pouches were heat processed to F_0 values of 6.56 and 8.43. Prince Devadason et al. (2010) also studied thermal processing of shelf stable buffalo meat blocks in retort pouches and the corresponding F_0 value determined was 6.52 (5D of *Clostridium sporogenes* PA 6379). While Rajkumar et al. (2010) reported that retort processed Chettinad goat meat product with F_0 value of 12.10 was rated best by the taste panelists on sensory evaluation. The cooking yield of Chettinad chicken prepared from spent hen and broiler breeder meat was 56.1±0.03 and 55.6±0.03, respectively.

Proximate composition Proximate composition of Chettinad chicken revealed moisture as 51.2±0.02, 53.8±0.04; crude protein as 19.9±0.08, 25.5±0.17; Ether extract as 36.6±0.25, 33.1±0.32 and Total ash as 3.4±0.09, 3.4±0.11, respectively for preparation from spent hen and broiler breeder meat. There was no significant difference in the proximate composition of Chettinad chicken prepared from spent hen and broiler breeder meat. Proximate composition of the retort processed products was determined by Thankamma et al. (1998) in fish paste, Prince Devadason et al. (2010) in buffalo meat block, Bindu et al. (2004) in ready to eat black calm product and Rajkumar et al. (2010) in Chettinad goat meat. Abdullah (2007) reported that in luncheon meat the chemical composition (moisture, protein and fat) did not influence the overall acceptability of the different formulation after retort processing. Variation in the proximate principles might be due to type of meat and product.

Storage stability of Chettinad chicken The moisture content decreased significantly ($P<0.01$) in the Chettinad chicken prepared from spent hen meat and from broiler meat, respectively during the storage period (Table 1). This is in conformity with report of Rajkumar et al. (2010) who stored retort processed chevon up to 10 months. The release of moisture in the gravy during heat denaturation of proteins might have contributed for sampling error during storage studies. Leander et al. (1980) also observed that when meat is cooked, water, soluble proteins, and fats are expelled from the tissue. This was again supported by Martens et al. (1982).

The pH also decreased significantly ($P<0.01$) in the Chettinad chicken prepared from spent hen meat and from

Table 1 Physico chemical composition Chettinad chicken during on storage at ambient temperature

Storage (days)	Moisture (%)	pH	Tyrosine (mg/100 g)	TBA (mg MA/kg)	FFA (%)	Acid value (ml/g)
Spent hen meat						
0	52.8 ^k ±0.10	6.3 ^a ±0.01	83.0 ^a ±11.49	4.1 ^a ±0.72	0.1 ^e ±0.00	0.6 ^a ±0.05
15	52.5 ^j ±0.11	6.2 ^g ±0.00	89.4 ^b ±1.45	4.2 ^b ±0.22	0.1 ^e ±0.00	0.6 ^b ±0.05
30	51.9 ⁱ ±0.09	6.2 ^e ±0.02	90.5 ^{bc} ±0.89	4.4 ^{bc} ±0.10	0.1 ^e ±0.01	0.6 ^b ±0.05
45	51.6 ^h ±0.05	6.2 ^{cde} ±0.01	91.1 ^{bc} ±1.07	4.6 ^{cd} ±0.15	0.1 ^e ±0.01	0.7 ^{bc} ±0.05
60	51.4 ^g ±0.10	6.2 ^g ±0.01	94.0 ^{bcd} ±0.73	4.8 ^{de} ±0.05	0.1 ^d ±0.00	0.8 ^{bc} ±0.05
75	51.2 ^f ±0.05	6.2 ^{cd} ±0.01	95.3 ^{cd} ±0.45	4.9 ^{def} ±0.09	0.1 ^d ±0.00	0.8 ^{bcd} ±0.04
90	50.9 ^e ±0.06	6.2 ^{bcd} ±0.08	96.7 ^{de} ±0.25	5.0 ^{ef} ±0.04	0.1 ^d ±0.00	0.9 ^{bcd} ±0.05
105	50.8 ^{de} ±0.09	6.2 ^{abc} ±0.00	97.4 ^{de} ±0.33	5.0 ^{ef} ±0.01	0.1 ^{cd} ±0.00	0.9 ^{bcd} ±0.04
120	50.5 ^d ±0.07	6.2 ^{abc} ±0.01	97.6 ^{de} ±0.23	5.1 ^{ef} ±0.01	0.1 ^{bc} ±0.00	1.0 ^{bcd} ±0.05
135	50.2 ^c ±0.07	6.2 ^{ab} ±0.00	98.2 ^{de} ±0.08	5.1 ^{gf} ±0.02	0.1 ^a ±0.00	1.0 ^{bcd} ±0.04
150	49.8 ^b ±0.14	6.2 ^{ab} ±0.01	98.4 ^{de} ±0.26	5.2 ^{gf} ±0.02	0.1 ^a ±0.00	1.0 ^{cde} ±0.08
165	49.7 ^b ±0.09	6.1 ^a ±0.00	99.2 ^{de} ±0.06	5.2 ^g ±0.10	0.1 ^a ±0.00	1.1 ^{de} ±0.05
180	49.6 ^a ±0.11	6.1 ^a ±0.00	99.3 ^{ade} ±0.10	5.3 ^g ±0.01	0.1 ^a ±0.00	1.2 ^e ±0.00
Broiler breeder meat						
0	53.8 ^m ±0.09	6.3 ^h ±0.01	79.4 ^a ±8.4	4.0 ^a ±0.56	0.1 ⁱ ±0.01	0.7 ^a ±0.05
15	53.3 ^l ±0.13	6.2 ^h ±0.01	85.6 ^a ±2.48	4.2 ^{abc} ±0.24	0.1 ^{ghi} ±0.00	0.6 ^a ±0.05
30	52.8 ^k ±0.09	6.2 ^h ±0.01	88.6 ^a ±0.24	4.1 ^{ab} ±0.39	0.1 ^{hi} ±0.00	0.7 ^a ±0.05
45	52.3 ^j ±0.08	6.2 ^g ±0.01	90.0 ^b ±0.67	4.4 ^{bc} ±0.13	0.1 ⁱ ±0.01	0.7 ^{ab} ±0.08
60	52.1 ⁱ ±0.04	6.2 ^g ±0.01	92.4 ^{bcd} ±0.71	4.6 ^{cd} ±0.06	0.1 ^{figh} ±0.00	0.7 ^c ±0.05
75	51.9 ^h ±0.10	6.2 ^f ±0.01	95.4 ^{cdef} ±0.47	4.7 ^{de} ±0.02	0.1 ^{efg} ±0.00	0.7 ^b ±0.00
90	51.8 ^g ±0.11	6.2 ^{ef} ±0.00	98.2 ^{defgh} ±0.15	4.9 ^{ef} ±0.05	0.1 ^{efg} ±0.00	0.8 ^d ±0.05
105	51.4 ^f ±0.02	6.2 ^{de} ±0.00	98.4 ^{efgh} ±0.37	5.0 ^{ef} ±0.03	0.1 ^{def} ±0.00	0.8 ^{de} ±0.05
120	50.9 ^e ±0.07	6.2 ^{cde} ±0.01	99.1 ^{figh} ±0.27	5.2 ^{fg} ±0.05	0.1 ^{cde} ±0.00	0.9 ^{ef} ±0.04
135	50.8 ^d ±0.11	6.2 ^{bcd} ±0.00	99.8 ^{ghi} ±0.49	5.4 ^{gh} ±0.03	0.1 ^{cd} ±0.00	0.9 ^{fg} ±0.04
150	50.5 ^c ±0.08	6.2 ^{abc} ±0.00	101.8 ^{hij} ±1.62	5.4 ^{gh} ±0.15	0.1 ^{bc} ±0.00	1.0 ^{gh} ±0.04
165	50.1 ^b ±0.10	6.2 ^a ±0.01	103.2 ^{ij} ±0.11	5.6 ^{hi} ±0.01	0.1 ^{ab} ±0.00	1.0 ^h ±0.04
180	49.8 ^a ±0.07	6.2 ^a ±0.00	103.7 ^j ±0.08	5.8 ⁱ ±0.01	0.1 ^a ±0.00	1.1 ⁱ ±0.00

Mean with different superscript in a row differ significantly (* $P<0.01$; ** $p<0.05$), $n=6$

broiler meat, respectively during storage period (Table 1). Similar trend was also observed during storage by Prince Devadason et al. (2010) in retort processed buffalo meat block and Rajkumar et al. (2010) in retort processed Chettinad goat meat. This might be due to degradation of proteins and liberation of free amino acids.

As expected tyrosine values increased significantly ($P<0.01$) during the storage (Table 1). The increase was in agreement with the observations of Prince Devadason et al. (2010) in retort processed buffalo meat block and Rajkumar et al. (2010) in retort processed Chettinad goat meat. Tyrosine value increases during storage time until deamination of amino acid limits the formation of free amino acids (Pearson 1968). Similarly an increase of tyrosine value during storage was also reported buffalo meat patties (Kulkarni et al. 1993).

The TBA values increased significantly ($P<0.01$) during the storage (Table 1). A significant and linear increase of TBRS (thio barbituric acid reacting substances) during storage

was reported by Prince Devadason et al. (2010) in retort processed buffalo meat block and Rajkumar et al. (2010) in retort processed Chettinad goat meat, respectively. The increase in TBA value might be due to residual oxygen remaining in the pouch as the pouches were not vacuum sealed. The development of slow oxidative rancidity was also reported by Chia et al. (1983) in retort pouch fish products. However Zipser and Watts (1961) stated that the production of antioxidants in meat itself at high temperature was responsible for stability against oxidative rancidity.

The free fatty acid decreased significantly ($P<0.01$) during storage in the Chettinad chicken (Table 1). Free fatty acids are the products of enzymatic or microbial lipolysis of lipids. Increase in FFA in retort processed black calm meat was also observed by Bindu et al. (2004) during a storage period up to 12 months.

The acid values increased significantly ($P<0.01$) in the Chettinad chicken prepared during the storage period (Table 1).

In the present study acid value increased with the decrease in the pH during the storage, this might be due to degradation of proteins and liberation of free amino acids (Rajkumar et al. 2010). Increase in the free amino acid content was reported by Prince Devadason et al. (2010) in retort processed buffalo meat block during room temperature storage of 135 days. Peroxide value was nil during the entire storage period.

Microbial quality Total bacterial counts including *E. coli*, *Salmonella spp.*, *Clostridium spp.*, *Staphylococci spp.*, yeast and mould could not be detected in the Chettinad chicken samples during the entire storage. The results were in agreement with Terajima and Nonaka (1996) who reported that commercial heat sterilization of foods in retort pouches reduced undesirable microorganism. Thankamma et al. (1998) reported that *E. coli*, *Staphylococcus*, *V. cholera* and *Salmonella* were absent in retort processed and stored fish paste. Absence of anaerobe colonies in the thermal

processing of shelf stable buffalo meat blocks in retort pouches during storage period was reported by Prince Devadason et al. (2010). Manju et al. (2004) also observed that seer fish curry packed in retort pouch remained sterile throughout storage period of 19 months. Rajkumar et al. (2010) reported that *coliforms*, *clostridium botulinum* yeast and mould, *staphylococcus* were absent in retort processed Chettinad goat meat during storage up to 10 months.

Sensory evaluation The sensory scores of the Chettinad chicken prepared from both broiler spent hen and broiler breeder meat revealed that the texture scores (only in spent hen meat) and overall acceptability scores decreased significantly ($P<0.01$) however the values for all the other sensory parameters of Chettinad chicken did not change not significantly during the entire storage period. (Table 2). The significant decrease in the texture scores from 7.6 (very desirable) to 6.2 (moderately desirable) was also reported

Table 2 Sensory scores of Chettinad chicken during storage at ambient temperature

Spent hen meat							
Storage days	Appearance	Flavour	Juiciness	Texture	Saltiness	Mouth coating	Overall acceptability
0	7.7±0.14	7.8±0.08	7.6±0.15	7.7 ^b ±0.1	7.8±0.08	7.5±0.15	7.8 ^{ab} ±0.53
15	7.9±0.06	7.9±0.04	7.9±0.07	7.9 ^b ±0.06	7.6±0.10	7.6±0.10	7.9 ^{ab} ±0.28
30	7.9±0.04	7.9±0.04	7.9±0.06	7.9 ^b ±0.04	7.6±0.10	7.5±0.10	7.9 ^{ab} ±0.2
45	7.9±0.04	7.9±0.06	7.9±0.09	7.9 ^b ±0.06	7.6±0.10	7.5±0.10	7.9 ^{ab} ±0.28
60	7.9±0.06	7.8±0.10	7.7±0.12	7.8 ^{ab} ±0.12	7.6±0.12	7.6±0.12	7.8 ^{ab} ±0.48
75	7.9±0.06	7.8±0.10	7.8±0.12	7.7 ^{ab} ±0.11	7.7±0.12	7.6±0.15	7.8 ^{ab} ±0.59
90	7.9±0.07	7.8±0.10	7.8±0.10	7.7 ^{ab} ±0.11	7.7±0.11	7.4±0.15	7.7 ^{ab} ±0.61
105	7.8±0.08	7.8±0.12	7.7±0.12	7.7 ^{ab} ±0.14	7.9±0.07	7.5±0.12	7.7 ^{ab} ±0.59
120	7.8±0.08	7.8±0.12	7.6±0.15	7.7 ^{ab} ±0.14	7.7±0.11	7.5±0.15	7.7 ^{ab} ±0.69
135	7.9±0.06	7.8±0.10	7.7±0.11	7.8 ^{ab} ±0.1	7.7±0.13	7.5±0.13	7.8 ^{ab} ±0.51
150	7.9±0.06	7.7±0.09	7.7±0.09	7.6 ^{ab} ±0.12	7.7±0.12	7.5±0.12	7.7 ^{ab} ±0.46
165	7.8±0.10	7.6±0.13	7.6±0.13	7.5 ^{ab} ±0.15	7.6±0.12	7.5±0.12	7.6 ^{ab} ±0.58
180	8.0±0.00	7.5±0.10	7.7±0.09	7.1 ^a ±0.14	7.8±0.08	7.8±0.08	7.3 ^a ±0.48
Broiler breeder meat							
0	7.7±0.14	7.9±0.07	7.7±0.09	7.7±0.10	7.8±0.08	7.7±0.10	8.0 ^b ±0.05
15	7.8±0.08	8.0±0.00	7.9±0.06	7.7±0.09	7.7±0.10	7.7±0.10	7.8 ^b ±0.08
30	7.9±0.04	7.9±0.07	7.7±0.10	7.8±0.08	7.7±0.10	7.7±0.10	7.8 ^b ±0.06
45	7.9±0.07	7.9±0.07	7.9±0.07	7.8±0.08	7.6±0.10	7.5±0.13	7.9 ^b ±0.07
60	7.9±0.07	7.9±0.07	7.8±0.10	7.8±0.10	7.7±0.10	7.5±0.13	7.9 ^b ±0.07
75	7.9±0.06	7.9±0.06	7.9±0.07	7.7±0.09	7.7±0.09	7.5±0.12	7.9 ^b ±0.06
90	7.9±0.06	7.9±0.07	7.8±0.10	7.7±0.09	7.7±0.11	7.5±0.12	7.9 ^b ±0.07
105	7.7±0.09	7.9±0.07	7.9±0.07	7.9±0.07	7.9±0.07	7.6±0.12	7.9 ^b ±0.07
120	7.8±0.08	7.9±0.07	7.8±0.10	7.8±0.10	7.7±0.11	7.5±0.13	7.8 ^b ±0.10
135	7.9±0.07	7.8±0.10	7.8±0.10	7.9±0.09	7.7±0.12	7.6±0.12	7.9 ^b ±0.06
150	7.9±0.06	7.8±0.08	7.7±0.09	7.7±0.12	7.7±0.12	7.5±0.12	7.7 ^b ±0.09
165	7.8±0.10	7.7±0.13	7.7±0.13	7.6±0.15	7.7±0.11	7.5±0.12	7.7 ^{ab} ±0.12
180	7.7±0.09	7.7±0.10	7.9±0.06	7.7±0.13	7.9±0.07	7.4±0.10	7.4 ^a ±0.10

Mean with different superscript in a row differ significantly (* $P<0.01$; ** $p<0.05$), $n=18$

by Prince Devadason et al. (2010) in retort processed buffalo meat block during room temperature storage of 135 days. This might be also due to slight degradation of proteins and oxidative changes in the product. Rajkumar et al. (2010) observed that the texture scores of the Chettinad chicken goat meat processed in retort pouch decreased from 8.20 to 7.07 during storage up to 10 months, but the scores were above the acceptable limits. The decrease in the texture scores as observed in the present study might be a reason for decrease in the overall acceptability of the Chettinad chicken, however the scores ranged from 7.8 to 7.3 (very acceptable) during the entire storage period and no toughness was detected sensory evaluation.

Cost of production The cost of production of Chettinad chicken (250 g pouch) prepared from spent hen meat and broiler breeder meat was Rs.37 and Rs.50, respectively. This was lower than the cost of the commercially available retort processed meat products.

Conclusion

The tough meat from spent hen and broiler breeder bird can be used in making value added meat product Chettinad chicken and retort processing can be effectively used for tenderizing tough meat of spent hen and broiler breeder while retaining the sensory quality during the entire storage period of 180 days. This could help in popularizing traditional styled products like Chettinad chicken in different places of the country.

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