Journal of Food Health and Bioenvironmental Science
Journal homepage : http://jfhb.dusit.ac.th/

Property Changes of the Traditional Beef Curry Product *'Gulai-Besar'* Packed in Retort Pouch during Storaging

Nutchanet Tayeh[a]*, Angsana Ayukhen[b] & Yasmi Louhasakul[c]

[a] *Food Science and Technology Program, Faculty of Science Agriculture and Technology, Yala Rajabhat University, Yala, 95000 Thailand*
[b] *Research and Innovation Unit, The Halal Science Center Chulalongkorn University, Bangkok, 10330 Thailand*
[c] *Biology Program, Faculty of Science Agriculture and Technology, Yala Rajabhat University, Yala, 95000 Thailand*

Article info

Article history:
Received: 2 November 2019
Revised: 25 December 2019
Accepted: 26 December 2019

Keywords:
Gulai-Besar, Beef curry, Retort Pouch, F_0 Value

Abstract

The main objective of this study was to figure the changes of physicochemical as well as the sensory properties of the traditional beef curry product *'Gulai-Basar'* packed in retort pouch during storage up to 9 months. *Gulai-Besar* was prepared according to the local recipe. It was packed in retort pouch (250 g) and processed in a retort at 116°C for 26 minutes and the F_0 Value of 5.77. The retort processed *Gulai-Besar* was analyzed for microbiological, sensory and chemical characteristics under refrigerated (4±2°C), ambient temperature (30±2°C), and accelerated temperature (55±2°C) for 9 months. All the processed samples showed an increasing trend of peroxide value (PV), free fatty acid (FFA), ash and sensory attributes while a decreasing trend of pH, protein and moisture content were showed. The fat slightly increased during storage time in all conditions. However, mesophile aerobes and anaerobes were absent and the samples were safe with acceptable sensory attributes entire storage period. The shelf life study indicated that the products were well acceptable up to 9 months based on the assessment of physicochemical, microbiological and sensory attributes. This implies that it is feasible to produce *Gulai-Besar* to commercial scale.

Introduction

Traditional foods play a crucial role in local identity, consumer behavior, the transfer of cultural heritage for future generations, and also the interaction of the interaction of this heritage with the remainder of the globe (Albayrak & Gunes, 2010). In the south of Thailand, *Gulai-Besar* could be a classic ancient beef curry. It mostly consists of large pieces of meat with coconut milk and varied spices. Quite often, this local cuisine is tied to some form of religious occasions such as Eid festival, Ramadan, and also the bridal ceremony. *Gulai-Besar* is commonly consumed among the Muslim households of Thailand and other parts of the Nusantara region (Southeast Asia).

The ready to eat (RTE) meal market has grown significantly in recent years because of an increasing demand for convenience food (Van der Horst et al., 2010). Retort pouch processing technology has been widely recognized as one of alternative to metal containers

* Corresponding Author
e-mail: nutchanet.t@yru.ac.th

because of their lighter, more appealing, and convenient end use (Al-Baali & Farid, 2006). It is a thermal process that imparts increased shelf life with good retention of nutrients and sensory parameters.

People are buying different type of food as lifestyle changes; work hours increase and more women work outside the home. Speed and convenience are increasing priorities for busy consumers short on time work, driving sales of instant foods. Thus, food companies need to keep ahead of the trends and competition because the consumer would prefer their traditional food on daily basis.

The objective of this study was to investigate a method for thermal processing of *Gulai-Besar*, a traditional Muslim dish packed in pouches and process in retort. The task was to evaluate the product in regard to physicochemical properties, microbiological status and sensory quality in different storage conditions.

Materials and methods

1. Preparation of *Gulai-besar*

Fresh deboned beef was collected from private beef farm, slaughtered by halal method. Beef was trimmed-off lean and cut into a piece of 1x2 inches (W/L) using sterilized meat cutting knife. The pieces were roasted at 80±2°C for 10 minutes and dried using a fan for 30 minutes. The beef was packed in highdensity polyethylene (HDPE) bags and stored at -20±2°C till further use. The formulation for the *Gulai-Besar* was standardized from the popular restaurant of Betong named "Hantana restaurant", Thailand. The ingredients were purchased from local markets, presented in Table 1 and the making process is illustrated in Fig. 1.

Table 1 Recipe of the curry sauce for *Gulai-Besar*

Ingredients	Percentage, %	Ingredients	Percentage, %
Beef	45.00	Curry Powder	2.20
Coconut Milk	24.75	Lime Juice	2.00
Shallot	8.25	Roasted Coconut	1.65
Garlic	3.85	Ginger	1.65
Palm Sugar	3.85	Shrimp Paste (Shrimp, Salt)	0.55
White Sugar	3.30	Dry Chili	0.55
Coconut Sugar	2.20	Spices	0.20

2. Retort pouch processing

Retortable pouches (140x180 mm) made with four layers (PET12/ NY15/Al9/CPP80 Microns) were purchased from PAYA BELL Corporation Co., Ltd., Pathum Thani, Thailand. The beef (80 g) were filled in

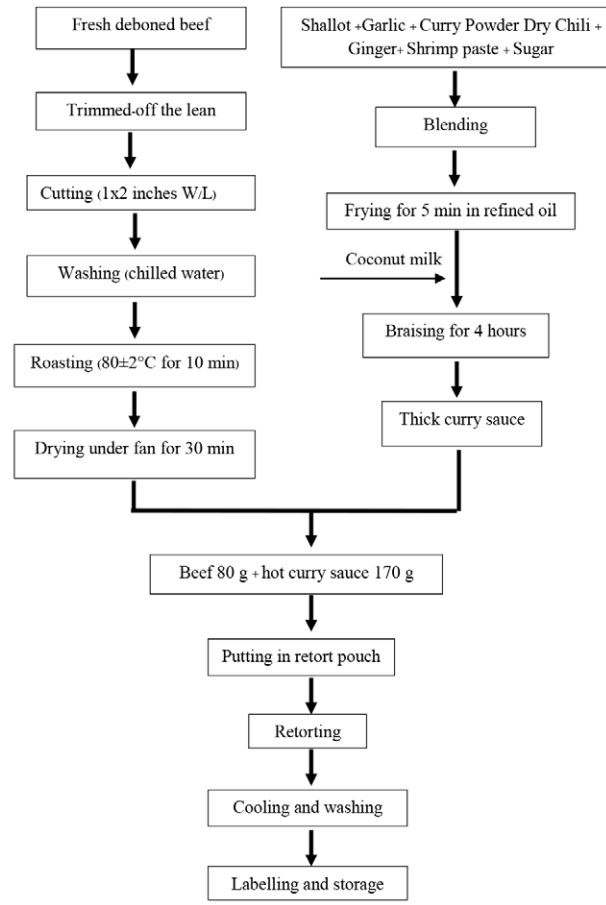

Fig. 1 The process of Gulai-besar in retort pouch.

pouches with 170 g hot curry sauce, maintaining a pack weight of about 250 g. Residual air was removed manually and sealed by impulse sealing machine. All 10 temperature measurement lines are placed between multiple packaging points in the machine to find the coldest heat point. Sealed pouches were subjected to thermal processing by using steam-air moisture heating (model PP500, capacity 500 liters, size 1690x2400x2030 mm) and water-air mixture was used while cooling. The product core temperature was recorded every 60 seconds using the Programmable Logical Control Device (E Val Pro System, Ellab, Denmark). The factor of heating (I_h), slope of the heating curve (f_h), and time for sterilization (U) were calculated. The heat penetration data were plotted on semi-log paper with temperature deficit ($RT-T_c$) on the log scale against timing. The parameters f_h/U, process time, F_0 value and Total process time were

calculated by the mathematic method (Patashnik' method lethal rate summation). Retort pouch processing of *Gulai-Besar* was done at Halal Food Science Center (HFSC), department of Food Science and Technology, Prince of Songkla University, Pattani, Thailand.

3. Storage analysis

Gulai-Besar was stored under different temperatures, i.e. refrigerated temperature (4±2°C), ambient temperature (30±2°C), and accelerated temperature (55±2°C). The samples were analyzed to determine the changes occurred in physicochemical properties, microbial analysis and sensory attributes during 9 months storage.

4. Proximate and chemical analysis of *Gulai-Besar*

The moisture content, protein, lipid and ash content were following AOAC method (AOAC., 2000). The carbohydrate content was calculated by subtracting the percentages of moisture, crude protein, crude fat and total ash from 100. Percentage of free fatty acid (FFA) as palmitic with the AOCS Ca 5a–40 standard method (Firestone, 2004) and peroxide value (PV) were analyzed according the AOAC (2000). The pH was measured by using a digital pH meter (Cyber Scan pH, 510, Merck).

5. Microbiological analysis

The *Gulai-Besar* was analyzed for its commercial sterility. The sample from each condition were determined for total viable count, anaerobic count, *Staphylococcal*, yeast and mold count, and *Clostridium botulinum* by the method of FDA BAM Online (2001). *E. coli* and coliform were examined by the method of FDA BAM Online (2002).

6. Sensory evaluation

The *Gulai-Besar* was evaluated at the interval of 3 months for quality and acceptability. Trained panelists required to evaluate the color, flavor, taste, texture and overall acceptability of the sample, using 9 points hedonic scale (1=dislike extremely, 9=like extremely).

7. Statistical analysis

The statistical analysis was done by SPSS software package for windows (SPSS Version 20; SPSS Inc., Chicago, USA). Data were analyzed by ANOVA and means were separated using Duncan's multiple range test and statistically significant was determined at 95% confidence level ($p<0.05$). All determination was made in triplicate, and data were expressed as mean with standard deviations.

Results and discussion

1. Effect of retort processing on RTE *Gulai-Besar*

RTE *Gulai-Besar* was prepared based on the culinary style preferred in the locality. The product developed was processed at temperature of 116°C and a reference temperature was used to calculate the process lethality for *C. botulinum*. Thermal processing experiment indicated F_0 value of 5.77 as optimum of achieving commercial sterility of retort process of *Gulai-Besar*. The come-up time (CUT) at the first lethality rate of 0.01 after 26 min of processing when the product core temperature was 87.38°C and retort chamber temperature was 116.63°C. Other parameters of the retort processed are shown in Table 2 and the time-temperature history curves of the products are illustrated in Fig. 2. Our results were similar to previous study in which the F_0 value of Indian traditional type chettinad chicken product was 5.2 (Chandirasekaran & Rajan, 2016).

Table 2 Heat penetration characteristics of *Gulai-Besar* in retort pouch

Parameters	Values
Com up time (CUT)	26
Heating time (HT)	36
Cooling time (CT)	11
Total process time (CUT+HT+CT)	73
F_0	5.77
Heating rate index (f_h), min	26.1
Process time, min	47
Cook Value, min	117.42
F_h/U	1.392

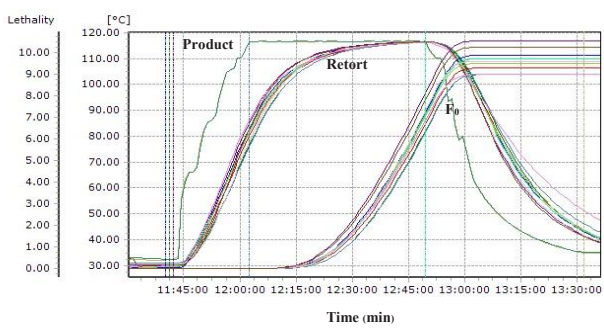

Fig. 2 Heat penetration characteristics of *Gulai-Besar* in retort pouches at the retort temperature of 116 °C.

The process lethality adopted was in agreement within recommendations and findings of other authors. Chanderasekaran and Rajan (2016) found that Indian traditional type chettinad chicken in retort pouches at 121.1°C and corresponding F_0 was sufficient to be able to store the product at 35±2°C for 180 days. Drotz (2012)

recommended a process lethality as low as 6 minutes can be used to achieve a product with better sensory and nutritional qualities.

2. Proximate and chemical analysis of *Gulai-Besar*

Table 3 shows the proximate compositions of the RTE Gulai-Basar under different storage conditions. It was found that the protein and moisture content were decreased while the fat and ash content were increased with increase in storage time. The moisture reduced after processing due to heat penetration of protein (Rajkumar et al., 2010). According to Leander et al. (1980), when meat is cooked, water and soluble protein are expelled from the tissue. The higher value of fat and ash can be attributed to coconut milk and spices added during cooking (Sunooj & Radhakrishna, 2013). The results from measurement of pH are shown in Fig. 3. The pH of the products had declined gradually from 5.89 to 5.26 with increasing period of storage. As expected, these parameters have values allowing growth of proteolytic *C. botulinum* at pH>4.6 and a_w>0.94. The results supported the use of a high temperature treatment for reduction of bacteria spore (Drotz, 2012). A decreasing trend of pH during storage could be contributed by the curry ingredients like dried chili and lime juice. Further, the changes might be cause by the degradation of proteins and liberation of free amino acids (Devadason et al., 2014). A decrease in pH values had also been observed during storage of Fish Peera (Bindu et al., 2010), chettinad goat meat curry (Rajkmar et al., 2010) and chettinad chicken (Rajan et al., 2014) processed in retort pouches.

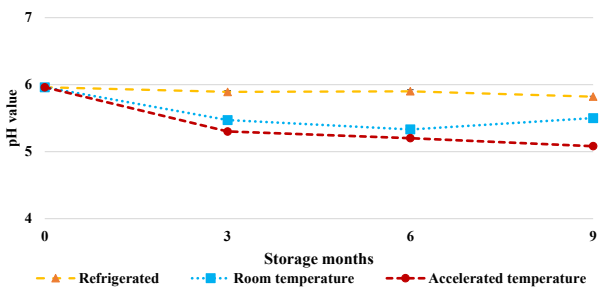

Fig. 3 Change in pH of RTE *Gulai-Besar* during different storage conditions up to 9 months.

The free fatty acid values (FFA) changed significantly during storage period at different temperature. The FFA value in *Gulai-Besar* increased with increased in storage time and the highest value was observed in 9th month of storage up to 5.08±0.10 and 8.14±0.25 % of palmitic acid under ambient temperature (30±2°C) and accelerate temperature (55±2°C) storage, respectively. A significant and steady increase of free fatty acids from 3.40 to 8.14 (% of palmitic acid) was found with increase of storage. Thermal processing at high temperature might have caused an increase in the rate of fat break down into glycerine and free fatty acid resulting more free fatty acids during storage.

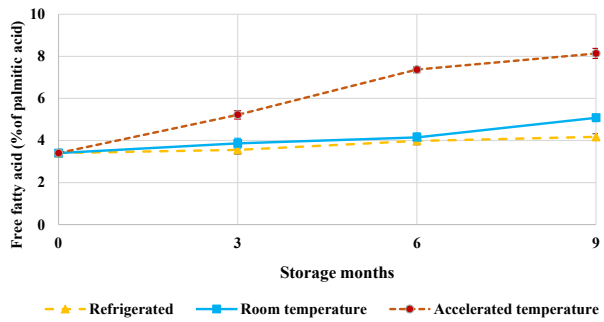

Fig. 4 Change in free fatty acid (FFA) content of RTE *Gulai-Besar* during different storage conditions up to 9 months.

Lipid oxidation in meats might be prepared whereby polyunsaturated greasy corrosive respond with receptive oxygen species, driving to the corruption of lipid and advancement of oxidative rancidity (Amaral et al., 2018). The oxidative degradation of lipid is a major cause of deterioration in the quality of meat and meat products. The peroxide value (PV) of *Gulai-Besar* during storage was slowly increased in range of 0.32-0.42, 0.46-0.68 and 0.54-1.04 mg Eq/kg under refrigerate, ambient and accelerate temperature storage, respectively. The results indicated that the oxidative rancidity development was temperature dependent (Abhishek et al., 2014).

Coconut milk is the main ingredient in *Gulai-Besar* and it is susceptible to chemical change, especially change of the PV and FFA values when it is heated. Coconut milk is an emulsion of oil and water that is stabilized by protein (Srivastava & Semwal, 2015). The chemical composition of coconut milk was 2.6-4.4% protein, 50-54% water, 32-40% lipid and 1-1.5% ash (Seow & Gwee, 1997). The event of bad or 'off' flavor is caused by the advancement of free fatty acids resulting from the product of oil hydrolysis (Marina et al., 2009). Hydrolysis is quickened by lipase, which is normally found in tissue containing oils or lipids (Song et al., 2005.) Temperature is one of the components that affects lipase movement. The highest FFA and PV were found

at the accelerated storage condition (55°C) and the ideal temperature for lipase is in range of 30-40°C. (Sukasih et al., 2009).

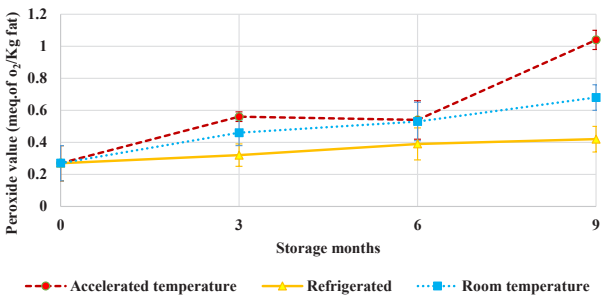

Fig. 5 Change in peroxide value (PV) content of RTE *Gulai-Besar* during different storage conditions up to 9 months.

3. Color

The color values of RTE *Gulai-Besar* under different storage period are presented in Table 4. The pigments, responsible for the color of the product, are affected by temperature conditions. A significant change is observed at the accelerate condition. The product had an initial L value of 44.58±0.10 which reduced dramatically to 32.21±0.20 on 9th month of storage time. Redness (a*) and yellowness (b*) were found to increase slightly with increasing storage time of all conditions. The red color is derived from the mixture of curry dried chili which is responsible for high a* value and the b* value occurred when coconut milk is heated. It changes the color to brown and/or darker (Tayeh, 2018). For determining the colorimetric indexes, the variation of the color was subsequently calculated in form of delta E (ΔE). The accelerate treatment showed a wide variation of parameters (ΔE) when compared to the other treatments, whereas the room storage treatment were observed with little variation in color, these variations were due to degradative processes.

4. Microbial quality

The higher heat resistance of many bacteria causes economical spoilage and disease. Total bacteria counts including anaerobic count, *Staphylococcal, Clostridium* spp., *E. coli* and yeast-mold were analyzed throughout the storage period but no microbial growth was observed in any sample. All microbes were below the approved food standards limit. It indicated that thermal processing led to commercial sterilization of the thermal process applied in processing of *Gulai-Besar* in retort pouches. The result coincides with the study of Chandirasekaran & Rajan (2016) who reported that no microbial growth was detected in retort pouch processed chettinad chicken during 180 days of storage time. Thus, it could be implied that the product was safe to consume.

5. Sensory analysis

The sensory of the RTE *Gulai-Besar* is shown in table 5. There was a slight difference in the sensory scores between refrigerated and room temperature, while accelerating temperature was noticeably decreased ($p<0.05$). The sensory attributes had a significant declined trend with an increase in storage time for all samples. However, the scores were within acceptable criteria in every sample. The lowest score of flavors occurred at the accelerated temperature (55°C) on 9th month of storage time. The decrease in sensory attributes might be due to the degradation of protein and oxidative changes in the product (Rajan et al., 2014).

Table 3 Chemical composition of RTE *Gulai-Besar* during different storage conditions up to 9 months

Parameters	Initial analysis	Storage period (months)								
		3			6			9		
		Storage condition								
		5 °C	RT	55 °C	5 °C	RT	55 °C	5 °C	RT	55 °C
Protein (%)	15.87±0.12	15.27±0.04^{a}	14.86±0.14^{b}	13.72±0.15^{c}	14.68±0.06^{a}	14.53±0.06^{b}	13.28±0.06^{c}	14.52±0.20^{a}	14.26±0.15^{a}	13.04±0.10^{b}
Fat (%)	9.23±0.21	9.23±0.010^{c}	9.81±0.09^{b}	10.08±0.09^{a}	9.88±0.12^{c}	10.08±0.03^{b}	10.72±0.02^{a}	9.94±0.08^{b}	10.15±0.10^{a}	10.93±0.19^{a}
Moisture (%)	67.94±0.15	66.55±0.14^{b}	65.93±0.14^{c}	67.27±0.04^{a}	65.13±0.09^{c}	66.90±0.10^{b}	67.63±0.15^{a}	65.01±0.10^{b}	65.80±0.06^{a}	65.74±0.12^{a}
Total ash (%)	2.58±0.02	2.62±0.02^{ns}	2.61±0.03^{ns}	2.66±0.03^{ns}	2.64±0.00^{b}	2.64±0.02^{b}	2.68±0.03^{a}	2.68±0.01^{b}	2.66±0.00^{c}	2.81±0.02^{a}
Carbohydrate (%)	4.38	6.33±0.02^{b}	6.79±0.02^{a}	6.27±0.03^{c}	7.67±0.01^{a}	5.85±0.02^{b}	5.69±0.02^{c}	7.92±0.01^{a}	7.13±0.02^{c}	7.48±0.01^{b}

Remark: Each value is presented as mean ± standard deviation (n=3), Different superscripts in the same row (different condition) indicate significant differences ($p<0.05$), ns shows that there was no statistically significant difference at ($p\geq0.05$).

Table 4 L*, a* and b* values of *Gulai-Besar* during different storage conditions up to 9 months

Parameters	Initial analysis	Storage period (months)								
		3			6			9		
		Storage condition								
		5 °C	RT	55 °C	5 °C	RT	55 °C	5 °C	RT	55 °C
L*	44.58±0.10	43.62±0.06^{a}	44.03±0.27^{a}	41.22±0.40^{b}	39.73±0.53^{b}	44.98±0.11^{a}	37.04±0.36^{c}	35.73±0.56^{b}	43.26±0.20^{a}	32.21±0.20^{c}
a*	12.45±0.04	12.26±0.03^{c}	13.95±0.14^{b}	14.83±0.23^{a}	9.56±0.46^{c}	12.91±0.60^{b}	17.34±0.58^{a}	8.12±0.60^{c}	12.80±0.54^{b}	17.22±0.16^{a}
b*	29.80±0.05	29.16±0.02^{c}	30.68±0.12^{b}	32.44±0.70^{a}	27.70±0.35^{c}	30.87±1.56^{b}	40.48±0.69^{a}	27.20±0.50^{c}	29.87±0.85^{b}	38.91±0.70^{a}
ΔE	0.00	1.17	1.15	4.89	6.02	1.23	13.96	11.62	1.37	12.88

Remark: Each value is presented as mean ± standard deviation (n=3), Different superscripts in the same row (different condition) indicate significant differences ($p<0.05$).

Table 5 Microbial changes of RTE *Gulai-Besar* during different storage conditions up to 9 months

Parameters	Initial analysis	Storage period (months)								
		3			6			9		
		Storage condition								
		5 °C	RT	55 °C	5 °C	RT	55 °C	5 °C	RT	55 °C
Total viable count (CFU/g)	<10^6	<10^6	<10^6	<10^6	<10^6	<10^6	<10^6	<10^6	<10^6	<10^6
Anaerobic count (CFU/g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Staphylococcal (CFU/g)	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Coliform (MPN/100 g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Clostridium spp. (CFU/g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
E.coli (MPN/g)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Yeast-mold (CFU/g)	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100

Remark: ND = not detect, each value is presented as mean ± standard deviation (n=3).

Table 6 Sensory evaluation results for RTE *Gulai-Besar* during different storage conditions up to 9 months

Parameters	Initial analysis	Storage period (months)								
		3			6			9		
		Storage condition								
		5 °C	RT	55 °C	5 °C	RT	55 °C	5 °C	RT	55 °C
Appearance	8.20±1.02	7.40±1.12^{ns}	7.45±0.08 ^{ns}	7.00±1.25^{ns}	7.46±0.10^{a}	7.22±0.14^{a}	6.27±0.89^{b}	7.20±0.13^{a}	7.00±0.21^{a}	6.00±0.72^{b}
Color	8.68±1.52	7.60±1.06^{a}	7.00±0.93^{ab}	6.60±1.24^{b}	8.27±1.10^{a}	7.53±0.83 ^{b}	6.20±0.68^{c}	8.00±1.24^{a}	6.95±0.08^{ab}	6.11±0.80^{b}
Flavor	8.67±1.40	7.67±1.45^{a}	7.27±1.10^{a}	6.87±1.85^{b}	7.07±1.22^{a}	7.12±1.20^{a}	5.80±1.32^{b}	7.02±1.50^{a}	6.98±1.12^{a}	4.52±0.68^{b}
Taste	8.94±1.15	7.94±1.44^{a}	7.60±1.06^{a}	6.80±1.66^{b}	7.47±1.46^{a}	7.54±1.52^{a}	5.73±1.03^{b}	7.31±1.02 ^{a}	7.20±1.00^{a}	5.65±1.08^{b}
Texture	8.78±1.08	7.80±1.42^{a}	7.80±1.18^{a}	6.80±1.47^{b}	7.73±1.71^{a}	7.40±0.94^{a}	5.70±1.10^{b}	7.56±1.48^{a}	7.34±0.45^{a}	4.89±1.90^{b}
Overall acceptability	8.80±1.00	8.27±1.10^{a}	7.67±0.83^{b}	6.67±1.68^{c}	7.67±1.45^{a}	7.53±1.40^{a}	5.60±1.12 ^{b}	7.63±1.42^{a}	7.50±1.40^{a}	4.90±1.16^{b}

Remark: Each value is presented as mean±standard deviation (n=3), Different superscripts in the same row (different condition) indicate significant differences ($p<0.05$) ns shows that there was no statistically significant difference at ($p\geq0.05$).

Conclusion

Gulai-Besar, a traditional meat product, was developed, packed and processed in retort pouch, and finally stored for 9 months in different conditions (refrigerated; 4±2°C, ambient temperature; 30±2°C accelerated; 55±2°C). The product was good sensory acceptability in all storage conditions with F_0 of 5.77.

All samples were microbial safe for 9 months. The present study suggested that retort pouch processing was suitable for 9 months storage of *Gulai-Besar* at ambient temperature with acceptable quality and safety. Thus, it would help to increase the market demand for traditional product due to convenience and ready to eat features.

Acknowledgment

The authors gratefully acknowledge the financial support from Yala Rajabhat University for this the research project.

References

Abhishek, V., Kumar, R.R., George, J., Nataraju, S., Lakshmana, J.H., Kathiravan, T., Madhukar, N., & Nadanasabapathi, S. (2014). Development of retort process for ready-to-eat (RTE) soy-peas curry as a meat alternative in multilayer flexible retort pouches. *IFRJ., 21*(4), 1553-1558.

Al-Baali, G., Abdulghani, A.G., & Farid, M.M. (2006). *Sterilization of food in retort pouches*. LLC, NY: Springer Science, Business Media.

Albayrak, M., & Gunes, A.E. (2010). Traditional foods: Interaction between local and global foods in Turkey. *Afr. J. Bus. Manage., 4*(4), 555-561.

Amaral, A.B., Silva, M.V.D., & Lannes, S.C.D.S. (2018). Lipid oxidation in meat: Mechanisms and protective factors–a review. *Food Sci. Technol. (Campinas), 38*(1), 1-15.

AOAC. (2000). *Official method of analysis* (17th ed.). Maryland, USA: The Association of Official Analytical Chemists.

Bindu, J., Ravishankar, C.N., Srinivasa Gopal, T.K., & Mallick, A.K. (2010). Investigation of shelf life and heat penetration attributes of ready to eat "Fish peera" from Anchovy (*Stolephorous commersoni*) in retort pouches. *Journal of Food Processing and Preservation, 34,* 207-222.

Chandirasekaran, V., & Rajan, S. (2016). Retort processed, Indian traditional type Chettinad chicken product. *International Journal of Science, Environment and Technology, 5*(4), 2395-2405.

Devadason, I.P., Anjaneyulu, A.S.R., Mendirtta, S.K., & Murthy, T.R.K. (2014). Quality and shelf life of buffalo meat blocks processed in retort pouches. *J Food Sci Techno., 51*(12), 3991-3997.

Drotz, H. (2012). *Development of thermal process for Gaeng Phed Gai in retort pouches* (Master's thesis). Swedish University of Agricultural Sciences, Uppsala, Sweden.

Firestone, D. (2004). *Official methods and recommended practices of the American Oil Chemists' Society,* AOCS. IIlinois, USA: AOCS Press.

Food and Drug Administration, Bacteriological Analytical Manual Online (FDA BAM Online). (2001). *Bacteriological analytical manual.* Retrieved from https://www.fda.gov/food/laboratory-methods-food/bacteriological-analytical-manual-bam

Food and Drug Administration, Bacteriological Analytical Manual Online (FDA BAM Online). (2002). *Enumeration of Escherichia coli and the Coliform Bacteria.* Retrieved from https://www.fda.gov/food/laboratory-methods-food/bam-4-enumeration-escherichia-coli-and-coliform-bacteria

Leander, R.C., Hedrick, H.B., Brown, M.F., & White, J.A. (1980). Comparison of structural changes in bovine longissimus and semitendinosus muscles during cooking. *J Food Sci., 45*(1), 1-6.

Marina, A.M., Man, Y.B.C., Nazimah, S.A.H., & Amin, I. (2009). Monitoring the adulteration of virgin coconut oil by selected vegetable oils using differential scanning calorimetry. *J Food Lipids, 16,* 50-61.

Rajan, S., Kulkarni, V.V., & Chandirasekaran, V. (2014). Preparation and storage stability of retort processed Chettinad chicken. *J Food Sci Technol., 51,* 173-177.

Rajkumar, V., Dushyanthan, K., & Das, A.K. (2010). Retort pouch processing of Chettinad style goat meat curry-a heritage meat product. *J Food Sci Tech., 47*(4), 372-379.

Seow, C.C., & Gwee, C.N. (1997). Coconut milk: Chemistry and technology. *Int J Food Sci Technol., 32,* 189-201.

Song, J.K., Han, J.J., & Rhee, J.S. (2005). Phospholipases: Occurrence and production in microorganisms, assay for high-throughput screening and gene discovery from natural and man-made diversity. *J Am Oil Chem Soc., 82,* 691-705.

Srivastava, Y., & Semwal, A.D. (2015). A study on monitoring of frying performance and oxidative stability of virgin coconut oil (VCO) during continuous/prolonged deep fat frying process using chemical and FTIR spectroscopy. *J Food Sci Technol., 52*(2), 984-991.

Sukasih, E., Prabawati, S., Hidayat, T., & Rahayuningsih, M. (2009). Optimasi kecukupan panas pada pasteurisasi santan dan pengaruhnya terhadap mutu santan yang dihasilkan. *J Pascapanen, 6,* 34-42.

Sunooj, K.V., & Radhakrishna, K. (2013). Physicochemical changes in ready to eat pineapple chicken curry during frozen storage. *Food and Nutrition Sciences, 4,* 119-125.

Tayeh, N. (2018). Development of local Halal food product: Budu Tumih Noni leaf rice crisp. *Journal of Food Health and Bioenvironmental Science, 12*(1), 28-35.

Van der Horst, K., Zurich, E., & Brunner, T. (2010). Ready-meal consumption: Associations with weight status and cooking skills. *Public Health Nutrition, 14*(2), 239-245.