International Journal of Agricultural Technology 2020 Vol. 16(6):1415-1424
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Effect of sterility value on qualities of Chinese braised culled steer beef in retort pouch

Kumueang, C., Tangwatcharin, P.[*] and Sorapukdee, S.

Department of Animal Production Technology and Fisheries, Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok 10520, Thailand.

Kumueang, C., Tangwatcharin, P. and Sorapukdee, S. (2020). Effect of sterility value on qualities of Chinese braised culled steer beef in retort pouch. International Journal of Agricultural Technology 16(6):1415-1424.

Abstract The results showed that their cook values were 72.42, 87.05 and 95.04 min, respectively. Microbiological analysis and sterility test were proved that the samples were safety for microbiological quality. However, parameters of texture profile (hardness, gumminess, springiness and chewiness) decreased as F_0 value was increased (p<0.05). Similarly, shear force decreased with increasing F_0 value (p<0.05). The CIE L* value increased and CIE a* values decreased as F_0 value was increased. For sensory evaluation, semi-trained panelists mostly impressed this product which produced by F_0 value of 10 min (p<0.05). Therefore, the development of Chinese braised beef in retort pouch was satisfied with F_0 value of 10 min.

Keywords: Braised beef top round, Toughness beef, Retort pouch, Moist heat sterilization, F_0 value

Introduction

In Thailand, beef cattle have been consumed progressively. The top round muscle of culled steer is low value because it has low marbling, providing tough (Moon, 2006). There have been studied on poor quality of meat. The long time moist heat has been used for poor quality meat due to decreasing toughness (Chumngoen *et al.*, 2018). The fast growing economy of Thailand, people tended to spend less time on preparing food. Over the past few years, food industries have been developed convenience food along with ready for consumption and ready made products to appropriate the life style of clients. The main concerns of sterilization food are food quality and safety. Generally, the extremely problematic microorganism in low acid food (pH>4.5) is *Clostridium botulinum* due to producing botulinum toxin. For sterilization process, the minimal suggested process is to reach 12 D reductions for *C. botulinum* by the temperature of 121 °C. This is used in link against the z value

[*] **Corresponding Author**: Tangwatcharin, P.; **Email:** putang3009@hotmail.com

for *C. botulinum* to creation of standard lethality table. It's probable to sum the lethalities for a process and estimate the total effects of integrated lethality or F_0 value. Thus, thermal process is one of the most preserving and extending shelf-life effects (Brennan *et al*., 1990).

Normally, the ready to eat products have associated to long shelf-life due to external regions transportation as the export commodities more than other food products. These products have nutritive and sensory values as well as protect them from the attacks of insects and microbes (Gopinath *et al.,* 2007). Retort pouch is the one of most progress in food packaging. The retortable pouches were used to transport easier than steel cans due to making form laminate of flexible plastic and metal foil. Hence, it helps the lower weight and safe storage space (Majumdar *et al*., 2015). Traditional meat curry of Kashmir in retort pouch produced by F_0 value of 9 min had the highest overall acceptability (Shah *et al.,* 2017). Various researchers demonstrated that thermal processed meat in retort pouches had flavorsome and shelf life more than one year stored at room temperature (Mohan *et al.,* 2006; Bindu *et al*., 2007; Maheswara *et al.,* 2011; Tribuzi *et al.,* 2015 and Shah *et al.*, 2017).

However, there have been few studies on the thermal process for added value of poor quality beef. Thus, the aim of this study was carried out the effect of thermal processing on quality of Chinese braised beef in retort pouch at different F_0 values.

Materials and methods

Process of Chinese braised culled steer beef in retort pouch

The *semimembranosus* (top round muscle) was selected on the basis of a culled steer carcass (Brahman×native×Chalolais). The culled steer had less than 549 kg of weight and 30 months of age from a beef cattle farm in Rayong Province, Thailand. The visible connective tissue and fat were removed. After that, it was stored at -20 ± 2°C before used. The frozen meat was thawed at 4°C on the two day before test. It was cut into small cubes of 4×3×2.5 cm.

The flow chart for production of Chinese braised beef in retort pouch was shown in Figure 1. The recipe of Chinese soup comprising 0.2% golgi berry, 0.2% cinnamon, 0.3% star anise, 0.3% black pepper, 0.1% coraninder seed, 0.2% cadamon, 9.0% soy sauce and 10.0% sugar were boiled in water until seethe. For the prepareation of Chinese braised beef, meat was boiled in the Chinese soup in the ratio of 1:1 (meat:water) for 2 hour. The product was cooled and packed in retort pouches.

Indigenously manufactured retortable pouch (Royal Meiwa Pax Co., Ltd. Samut Sakhon, Thailand) having a four – layer (12 µm polyethylene

terephthalate/15 µm nylon/9 µm aluminium foil/80 µm cast polypropylene) and size of 15×20 cm were used. About 120±2 g beef and 210±2 g Chinese soup was contained in retort pouch, then the retort pouch was sealed in a vacuum sealing machine. Ninety pouches were distributed evenly into three batches. After that, the pouches were placed on perforated trays and then moved batch wise into retort vessel. The horizontal stationary retorting system (Km Grand Pack Co., Ltd., Samut Prakan, Thailand) was used. The retort pouch was fixed with thermocouple glands and thermocouple probe in coldest point. Thermocouple output was determined using Ellab CTF 9008 data recorder (Ellab A/S, Roedovre, Denmark). The retort temperature was maintained at 121 °C and processing time was different to F_0 values of 8, 10 and 12 min. The pouches were cooled to 45 °C after retort processing.

Cook value

The cook value was determined by measuring the extent of cooking and nutritional loss during processing in a manner similar to the F_0 value, except that the reference temperature is 100 °C instead of 121 °C, and the z value of 33 °C, which is required for the denaturation of thiamine (Ranganna *et al*., 2002).

Microbiological analysis and sterility test

Twenty-five gram of sample was aspectically transferred into 225 milliliters of 0.85% sodium chloride and homogenized for 1 minnute in a Stomacher Bag Mixers (400 model VW, France) and cultured on media for microbial enumeration. The mosophilic, thermophilic aerobic and anaerbobic were determined by pour plate technique on plate count agar incubated at 37 °C for 48 h. and 55 °C for 72 h. under aerobic and anaerobic condition (IS Indian Standard, 1971) respectively. The number of colonies was counted and declared as log cfu/g (BAM, 2001a). Total yeast and mold (BAM, 2001b), *Staphylococcus aureus* (BAM, 2001c), *Clostridium perfringens* (BAM, 2001d), coliforms and *Escherichia coli* (BAM, 2002), *Salmonella* spp. (BAM, 2007) and *C. botulinum* (BAM, 2007) were analyzed.

Sterility test method was analyzed and followed by Tribuzi *et al*. (2015). Twelve samples were divied for two blocks and incubated at 36 ± 1 °C for 10 days and at 55 ± 1 °C for 5 days. When finished of incubation period, the retort pouches were optically to identify possible swelling. After that, the products were opened of verify the off-odors at room temperature and determined microbiological analysis.

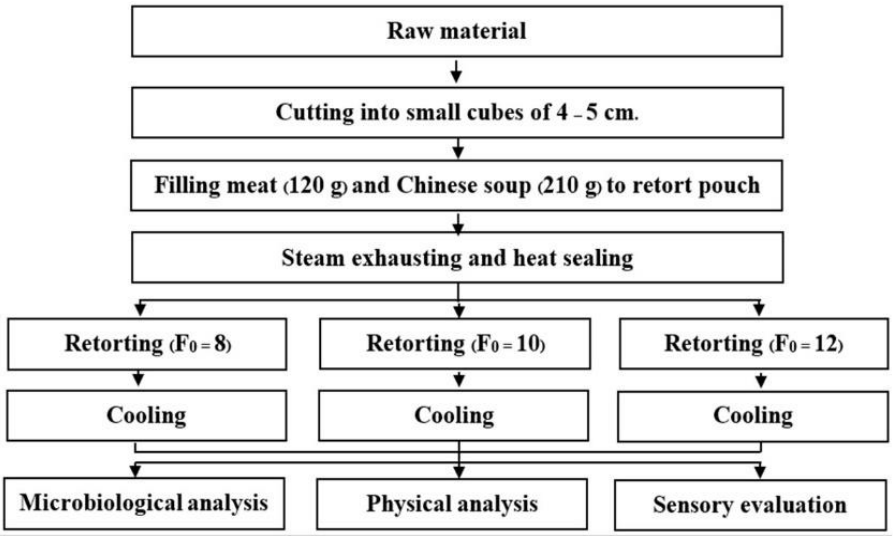

Figure 1. Pre – cooking and thermal processing of Chinese braised beef in retort pouch

Physical analysis

The color of samples was estimated in the CIE L*, CIE a* and CIE b* mode, using a color measurement Hunter Lab colorimeter (MiniScan EZ, HunterLab, Reston, VA, USA). Three locations of each sample were accomplished. The resulting average was used in data analysis.

The Warner–Bratzler shear force (WBSF) of sample was estimated. A sample was cut into eight rectangular cubes along the longitudinal of muscle fiber for each beef (1 ×1 ×2.5 cm). The sample was sheared with a WBSF equipment attached to an Instron universal testing machine (3344, Instron Engineering Corp., Canton, MA, USA). The maximum force (N) was recorded (Sorapukdee and Tangwatcharin, 2018).

Texture profile analysis of sample was performd 5 times in every treatments on the beef using an Instron universal testing machine model 3344 (Illinois Tool Works Inc., USA) with a compression plate surface. A sample was cut into eight cubes along the longitudinal of muscle fiber (1.5 ×1.5 ×0.5 cm). TPA parameters were determined at room temperature. The crosshead speed was 60 mm/min and compressed twice to 40 was set for experiment condition. The processing and data recording were used by the Bluehill 2 software (Instron Engineering Corp., USA). The hardness (N), cohesiveness (ratio), gumminess (N), springiness (ratio), and chewiness (N) were estimated from the force-time curves generated for sample (Bourne, 1978).

Sensory evaluation

Sensory attributes of sample consider to appearance, spice odor, taste, texture and overall acceptability of the sample were evaluated by 30 semi-trained panelists, who are familiar with the stew beef from academic staffs and graduate students of Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang. Sensory attributes were evaluated using a nine-points hedonic scale form 1 = dislike extremely to 9 = like extremely.

Statistic Analysis

The experiment was conducted by randomized complete block design. Three indepentdent batch replications were conducted. Significant effects (p<0.05) were performed by one-way ANOVA and mean comparison were compared by the Duncan's multiple range test. Data were analysed using SPSS (v.17. IBM SPSS Inc.).

Results

Thermal processing and cook value

The retort pouch was processed three different F_0 values of 8, 10 and 12 min. Result showed the heat penetration curve of products during sterilize which could be concerned in three parts including, come up time, heating and cooling (Figure 2). The total process time of three different F_0 values was 17, 21 and 23 min, respectively. All process times were sufficient to obtain commercially sterile products. The cook values of the heat treatment related to nutrient degradation which were 75.42, 87.05 and 95.24 min, respectively.

Microbiological analysis and sterility test

The numbers of microbe in all samples were counted by standard plate count (SPC) procedures for four ambients, total yeast and mold, *S. aureus* and *C. perfringens* which detected as <1 log cfu/g. *Salmonella* spp. and *C. botulinum* were not detected in sample 25 g. Coliforms and *E. coli* were <3 MPN/g. For sterility test, samples were analyzed by visuality after the incubation. They did not swell and find any microorganisms by SPC procedure.

Physical quality

The physical parameters of sample thermally processed at different F_0 values were shown in Table 1. The results of CIE L* indicated that sample

processed by F_0 values of 8 min higher than those of F_0 values of 12 min (p<0.05), but it was not different when compared to F_0 values of 10 min. In the case of CIE a* value, sample processed by F_0 values of 10 min was a higher than those of F_0 values of 8 min (p<0.05), although it was not different when compared to F_0 values of 12 min. No differences were found between treatments for CIE b* value (p>0.05).

The shear forces value of braised beef in retort pouch at F_0 values of 12 min conditions was a lower than other treatment (p<0.05). For TPA analysis, hardness, gumminess, springiness and chewiness values of sample decreased as F_0 values increased (p<0.05).

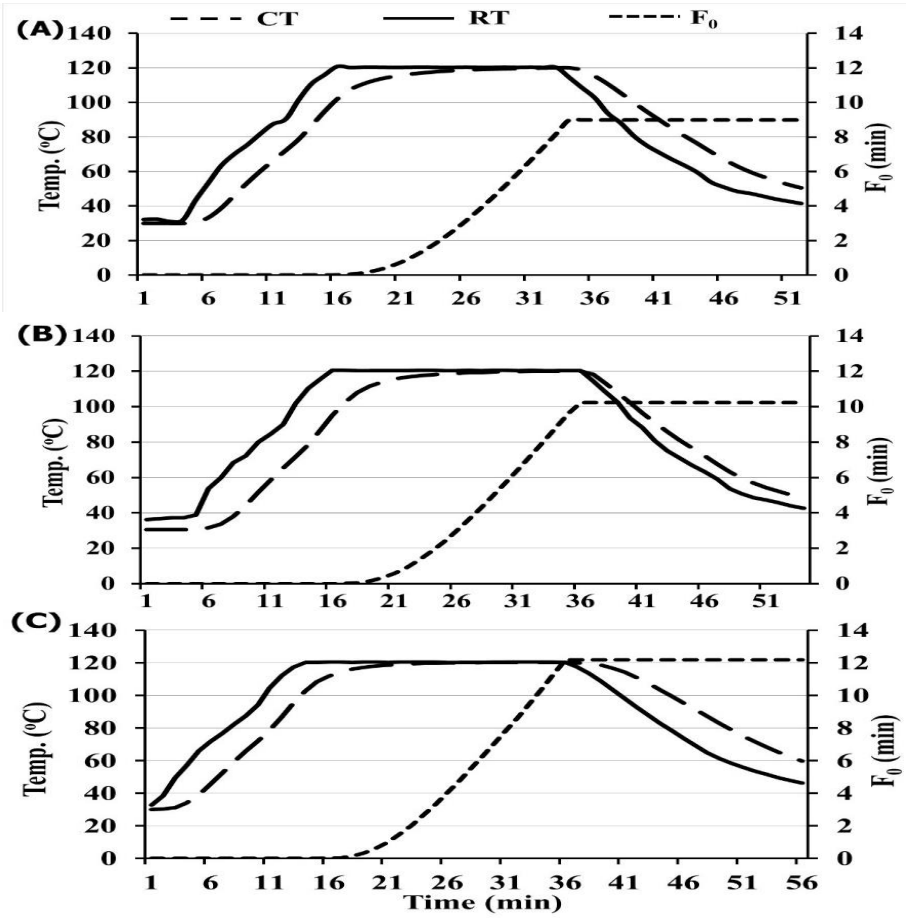

Figure 2. Heat penetration characteristic and F_0 value of Chinese braised beef in retort pouch thermal process at 121°C F_0 = 8 (A), F_0 = 10 (B), and F_0 = 12 (C). CT, product core tempareture, RT, retort tempareture, F_0, F_0 value

Table 1. Physical parameters of Chinese brised beef in retort pouch thermally processed at 121 °C to F_0 values of 8, 10 and 12 min

Physical parameters	$F_0 = 8$	$F_0 = 10$	$F_0 = 12$
Color			
CIE L*	35.14 ± 0.80 [a /1,2]	34.35 ± 2.03 [ab]	33.55 ± 2.88 [b]
CIE a*	10.95 ± 1.71 [b]	12.66 ± 2.20 [a]	11.64 ± 1.20 [ab]
CIE b*	20.20 ± 1.85	19.70 ± 5.84	18.04 ± 2.77
Shear force (N)	33.71 ± 1.04 [c]	14.01 ± 0.11 [b]	9.02 ± 0.25 [a]
Total profile analysis			
Hardness (N)	4.64 ± 0.80 [b]	4.03 ± 0.68 [b]	2.33 ± 0.24 [a]
Cohesiveness (ratio)	0.51 ± 0.10	0.47 ± 0.03	0.46 ± 0.09
Gumminess (N)	2.37 ± 0.54 [b]	1.87 ± 0.22 [b]	1.11 ± 0.33 [a]
Springiness (ratio)	0.84 ± 0.02 [b]	0.79 ± 0.04 [a]	0.74 ± 0.74 [a]
Chewiness (N)	1.75 ± 0.32 [b]	1.43 ± 0.11 [b]	0.92 ± 0.25 [a]

[1/] Each value was expressed as mean ± standard deviation of at least 3 replications;
[2/ a-c] Different letters in the same row were significant difference (P<0.05).

Sensory evaluation

The result of 30 semi-trained panelists sensory evaluation is shown in Table 2. The sample processed by F_0 values of 10 min revealed the highest of spice odor, texture, and overall acceptable liking scores compared to other treatments (p<0.05). No differences were found between treatments for appearance and taste (p>0.05).

Table 2. **S**ensory evauation of Chinese braised beef in retort pouch thermally processed at 121 °C to F_0 values 8, 10 and 12 min

Sensory attribute	$F_0 = 8$	$F_0 = 10$	$F_0 = 12$
Appearance	7.13 ± 1.31 [/1]	7.17 ± 1.42	6.90 ± 1.49
Spice odor	6.53 ± 1.23 [b /2]	7.80 ± 1.33 [a]	6.50 ± 1.25 [b]
Taste	6.73 ± 1.37	7.50 ± 1.19	6.36 ± 1.43
Texture	7.13 ± 1.28 [b]	8.13 ± 1.32 [a]	6.37 ± 1.60 [c]
Overall acceptable	7.10 ± 1.30 [b]	8.13 ± 1.16 [a]	6.53 ± 0.91 [c]

[1/] Each value was expressed as mean ± standard deviation of at least 3 replications;
[2/ a-c] Different letters in the same row were significant difference (P<0.05).

Discussion

The microbiological analysis did not detect the microbial growth in all samples. It demonstrated that the microorganism has been entirely destroyed by the thermal process (Shah *et al*., 2017). The F_0 value agreed with Brennan *et al*. (1990). F_0 value of 10 min was perfectly used for meat products on the United Kingdom market.

The present study, the lightness (CIE L*) value decreased with F_0 value increased. Similar to result of previous studies, CIE L* value of fish curry and meat curry in retort pouch were decreased with F_0 value increased, due to longer heating time (Majumdar *et al.*, 2015; Shah *et al.*, 2017). In addition, it might be reason from maillard reaction between sugar and amino acid which is changed to brown and protracted heat treatment. It affects the color of the beef which is changed darker (Bindu *et al.*, 2008; Majumdar *et al.*, 2015 and Shah *et al*., 2017). Whereas, CIE a* value in this study increased with increased in F_0 value. Similarlly, CIE a* value of catla in curry medium product was a increasing red with increasing the F_0 value (Majumdar *et al*., 2015). The processing time had no significant effect on CIE b* value.

In this study, shear force value decreased with increased in F_0 value. According to study of Shah *et al*. (2017), who reported the shear force value of meat curry, decreased with F_0 value increased. Similar to study of Palka (1999), it might be noted to the the cooking or heating improves tenderness by making collagen soluble, which is the main reason for thoughness. A hight temperature and long heating time result in gelatin formation and tenderness.

In this experiment, TPA values (hardness, gumminess, springiness and chewiness) were decreased with F_0 value increased. Moreover, Chinese braised beef in retort pouch after thermal process was lower value of hardness, gumminess, springiness and chewiness value than these of product before thermal process (data not show). Similar to study of Majumdar *et al.* (2015) the hardness, gumminess, springiness and chewiness of catla in curry medium decreased with F_0 value increased. These decreases of TPA values were mainly due to increase in the heat time. According to study of Bindu *et al.* (2007), it might be noted to the reasons from denaturation of protein content and the destruction of muscle cells during retort processing.

For sensory evaluation, Chinese braised beef at F_0 value of 10 min showed the highest scores for spice odor, texture and overall acceptable. The panelists explained that sample processed by F_0 value of 10 min was the best texture. Whereas, the texture at F_0 value of 8 min was too tough, but it at the F_0 value of 12 min was too soft. Similarly, shear force value decreased with increased in F_0 value.

The results of product indicated that the microorganisms were completely destroyed since F_0 value of 8 min. However, sample processed by F_0 value of 10 min had the best sensory evaluation which were the highest scores of spice odor, texture and overall acceptable. Therefore, F_0 value of 10 min was an optimum thermal processing for commercially sterile of Chinese braised culled steer beef in retort pouch.

Acknowledegements

The authors would like to acknowledge financial support provided by Surasing farm, Rayong, Thailand and Thailand Science Research and Innovation (TSRI).

Reference

BAM (2001a). Aerobic Plate Count. U.S. Food and Drug Administration. Retrieved from https://www.fda.gov/food/laboratory-methods-food/bam-aerobic-plate-count.

BAM (2001b). Yeasts and Molds. U.S. Food and Drug Administration. Retrieved from https//www.fda.gov/food/laboratory-methods-food/bam-yeasts-molds-and-mycotoxins.

BAM (2001c). *Staphylococcus aureus*. U.S. Food and Drug Administration. Retrieved from https://www.fda.gov/food/laboratory-methods-food/bam-staphylococcus-aureus.

BAM (2001d). *Clostridium perfringens*. U.S. Food and Drug Administration. Retrieved from https://www.fda.gov/food/laboratory-methods-food/bam-clostridium-perfringens.

BAM (2002). *Escherichia coli* and the Coliform. U.S. Food and Drug Administration. Retrieved from https//www.fda.gov/food/laboratory-methods-food/bam-4-enumeration-escherichia-coli-and-coliform-bacteria.

BAM (2007). *Clostridium botulinum*. U.S. Food and Drug Administration. Retrieved from https//www.fda.gov/food/laboratory-methods-food/bacteriological-analytical-manual-bam-chapter-5-salmonella.

Bindu, J., Ravishankar, C. N. and Gopal, T. S. (2007). Shelf life evaluation of a ready-to-eat black clam (Villorita cyprinoides) product in indigenous retort pouches. Journal of Food Engineering, 78:995-1000.

Bindu, J., Ravishankar, C. N. and Srinivasa Gopal, T. K. (2008). Investigation of shelf life and heat penetration attributes of ready – to – eat "fish peera" from anchovy (*Stolephorous commersoni)* in tetort pouches. Journal of Food Processing and Preservation, 34:207-222.

Bourne, M. C., Kenny, J. F. and Barnard, J. (1978). Computer assisted readout of data from texture profile analysis curves 1. Journal of Texture Studies, 9:481-494.

Brennan, J. G., Butters, J. R., Cowell, N. D. and Lilly, A. E.V. (1990). Food Engineering Operations, 3rd ed. London, Applied Science Publishers.

Chumngoen, W., Chen, C. F. and Tan, F. J. (2018). Effects of moist and dry heat cooking on the meat quality, microstructure and sensory characteristics of native chicken meat. Animal Science Journal, 89:193-201.

Gopinath, S. P., Kochery Anthony, M. X., Nagarajarao, R. C., Jaganath, B. and Krishnaswamy, S. G. T. (2007). Standardisation of process parametres for ready-to-eat squid masala in indigenous polymer-coated tin-free steel cans. International Journal of Food Science and Technology, 42:1148-1155.

IS Indian Standard (1971). IS2168. Specification for pomfret canned in oil. New Delhi, India, Indian Standards Institution.

Maheswara, K. J., Raju, C. V., Nail, J., Prabhu R. M. and Panda K. (2011). Studies on thermal processing of tuna - a comparatibe study in tin and tin - free steel cans. African Journal of Jood Agriculture Nutrition and Development, 11:5539-5560.

Majumdar, R. K., Dhar, B., Roy, D. and Saha, S. (2015). Study of instrumental and sensory characteristics of catla in curry medium during retort pouch processing to optimize F_0 value. Journal of Food Processing and Preservation, 39:1595-1604.

Mohan, C. O., Ravishankar, C. N., Bindu, J., Geethalakshmi, V. and Gopal, T. K. S. (2006). Effect of thermal process time on quality of "shrimp kuruma" in retortable pouches and aluminum cans. Journal of Food Science, 71:496-500.

Moon, S. S. (2006). The effect of quality grade and muscle on collagen contents and tenderness of intramuscular connective tissue and myofibrillar protein for Hanwoo beef. Asian-Australasian Journal of Animal Sciences, 19:1059-1064.

Palka, K. (1999). Changes in intramuscular connective tissue and collagen solubility of bovine m. semitendinosus during retorting. Meat Science, 53:189-194.

Ranganna, S. (2002). Handbook of Canning and Aseptic Packaging. New Delhi, India, Tata McGraw-Hill Publishing Co., Ltd.

Shah, M. A., Bosco, S. J. D., Mir, S. A. and Sunooj, K. V. (2017). Evaluation of shelf life of retort pouch packaged Rogan josh, a traditional meat curry of Kashmir, India. Food Packaging and Shelf Life, 12:76-82.

Sorapukdee, S., and Tangwatcharin, P. (2018). Quality of steak restructured from beef trimmings containing microbial transglutaminase and impacted by freezing and grading by fat level. Asian-Australasian Journal of Animal Sciences, 31:129-137.

SPSS. (2008). SPSS for windows. Release 17. SPSS Inc., Chicago, IL.

Tribuzi, G., ARAGÃO, G. M. F. D. and Laurindo, J. B. (2015). Processing of chopped mussel meat in retort pouch. Food Science and Technology, 35:612-619.

(Received: 25 August 2019, accepted: 1 October 2020)