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Research Article

Characteristics of beef nuggets affected by adding soya meat

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Abstract

The study was conducted to characterize nutritional, sensory quality and economic feasibility of beef nuggets as affected by adding soya meat. Therefore, the experiment was conducted with a view to investigate inclusion of soya meat in beef nuggets with five (5) treatments (T_0 = 100% beef; T_1 = 75% beef + 25% soya meat; T_2 = 50% beef + 50% soya meat; T_3 = 25% beef + 75% soya meat and T_4 = 100% soya meat) having three (3) replications. The results indicated that the incorporation of soya meat decreased moisture, crude protein, ether extract and cooking loss but increased amount of carbohydrate, ash and cooking yield in beef nugget. Highly significant (<0.001) differences were observed in moisture, crude protein, ether extract, ash, carbohydrate and cooking yield. L^* values increased and a^* values decreased with high level of soya meat incorporation. No significant difference was observed in color parameter except in L^* values. Incorporation of soya meat decreased aroma and taste score of beef nugget whereas appearance and texture indicated the highest score. Production cost was reduced for incorporating soya meat in beef nugget. Beef nugget treated with 25% to 75% soya meat inclusion found to be more acceptable in terms of sensory evaluation and economic feasibility.

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Introduction

Nutrients are the key components required by an individual for the proper development and maintenance of health (Blake, 2012). Among the essential nutrients protein is the major as it plays the vital role in body building but majority of the population in developing countries is suffering from protein shortage (Akter, et al., 2009; Akhter et al., 2009; Apata et al., 2011). Meat and meat products can minimize this problem as a contributor of high quality protein (Talukdar et al., 2014). Among the processed meat products e.g. meat balls, frankfurters, nuggets, steaks, patties, burgers etc. available in the market (Pandey et al., 2014), nugget is more popular as it requires less time to prepare and is nutritionally more acceptable than other food items (Talukdar et al., 2014). However, processed meat products are widely consumed, unfortunately their cost, especially for the developing countries is high (Yogesh et al., 2013). Moreover, numerous research studies have proven a positive association between meat consumption and major health problems such as colon cancer, obesity, cardiovascular diseases and several other disorders (Cross et al., 2008). Due to these heath concerning issues and the high price of meat in developing countries, non-meat ingredients can be extensively incorporated in processed meat products to improve the quality and reduce health hazards and production cost (Yadav et al., 2013). Considering health conscious consumers' demand, incorporation of milling by-products as non-meat ingredients in processed meat products might be a possible solution (Xu, 2001). Keeping in view these facts the major goal of the meat industry in recent years has been developing healthier meat products incorporated with health enhancing ingredients (Cofrades et al., 2000). At present, meat alternatives such as textured vegetable protein alsoknown as soy protein or soya meat might be used commercially due to availability in market with low price (Lim et al., 1990; Omwamba, 2014). The quality of soya protein is high without saturated fat and cholesterol (SANA, 2016) and improves flavor and moisture retention; and provides juicy and meaty mouth feeling (Feiner, 2006). Regular consumption of soya protein reduces the risk of both breast and prostate cancer; hot flashes, cholesterol levels and osteoporosis (Jooyandeh, 2011). The increase in awareness of healthier diet and demand for higher quality meat alternatives have led to changes in the formulation of nugget (Sadler, 2004). Researchers showed the nutritional characteristics of nugget prepared by chicken, mutton, pork and chevon (Bithi et al., 2020, Disha et al., 2020; Habiba et al., 2021; Islam et al., 2018; Saba et al., 2018; Siddiqua et al., 2018). However, very few research works have been done on beef nugget. Therefore, the present study was conducted to evaluate the effect of incorporation of soya meat on nutritional, sensorial quality and economical feasibility as compared with available commercial nuggets in market.

Materials and Methods

Raw materials

Minced beef and soya meat were collected from a super shop named Safe and Save in Khulna city, Bangladesh. Other ingredients and spices were purchased from a commercial shop at the same time.

Experimental design

The study was conducted using a completely randomized design (CRD) having five (5) treatments (T_0 = 100% beef; T_1= 75% beef + 25% soya meat; T_2 = 50% beef + 50% soya meat; T_3 = 25% beef + 75% soya meat and T_4 = 100% soya meat) with three (3) replications of beef nugget.

Preparation of beef nuggets

Soya meat was boiled, then drained out all excess water and blended using a blender machine. Both minced beef and blended soya meat were packed in zipper bags separately and stored at -18°C till the product processing. It reveals from the Table 01 that 5 treatments were prepared having three replications. Beef nugget mix (400g for each) was prepared using 202.24g, 151.68g, 101.12g, 50.56g and 0g of minced beef; and 0g, 50.56g, 101.12g, 151.68g and 202.24g of blended soy meat, respectively. About 41.04g buttermilk, 37.92g egg, 8.92g chopped onion, 4.44g chopped garlic, 6.68g ginger paste, 24g peanut paste, 4.48g sugar, 3.36g salt, 1.08g black pepper powder, 1.32g red chili powder, 12 ml soya sauce, 4 ml lemon juice, 17g flour and 31.56g bread crumb were added to each sample.

Table 1. General formulation of beef nugget

Ingredients	Treatments				
	T_0	T_1	T_2	T_3	T_4
Beef (g)	202.24	151.68	101.12	50.56	0
Onion chopped(g)	8.92	8.92	8.92	8.92	8.92
Garlic paste (g)	4.44	4.44	4.44	4.44	4.44
Ginger paste (g)	6.68	6.68	5.68	6.68	6.68
Red chili (g)	1.32	1.32	1.32	1.32	1.32
Peanut paste (g)	24	24	24	24	24
Soya sauce (g)	12	12	12	12	12
Salt (g)	3.36	3.36	3.36	3.36	3.36
Black pepper (g)	1.00	1.00	1.00	1.00	1.00
Flour	17.00	17.00	17.00	17.00	17.00
Egg (g)	37.92	37.92	37.92	37.92	37.92
Butter Milk (g)	41.04	41.04	41.04	41.04	41.04
Bread crumb(g)	22.32	22.32	22.32	22.32	22.32
Lemon juice (g)	4.00	4.00	4.00	4.00	4.00
Soya meat (g)	0	50.56	101.12	151.68	202.24

T_0 =100% beef; T_1 =75% beef+25% soya meat; T_2 =50% beef+50% soya meat; T_3 =25% beef+75% soya meat; T_4 =100% soya meat

Determination of proximate composition

The proximate composition of nuggets was analyzed according to the standard procedures of Association of Official Analytical Chemists (AOAC, 1997). All experiments were done in triplicate.

Determination of pH

The pH was determined by blending sample with 50 ml of distilled water using an Ultra Turrax T 25 tissue homogenizer (Janke and Kunkel, IKA Labortecnik, Staufen, Germany) at 8000 rpm for 1 minute. The pH of the suspension was recorded by dipping combined glass electrode of Elico digital pH meter, model LI 127(Elico Limited, Hyderabad, India).

Determination of cooking yield and cooking loss

Cooking yield and cooking loss were determined according to Murphy et al., 1975).

$$\text{Cooking loss (\%)} = \frac{\text{Uncooked nugget weight} - \text{Cooked nugget weight})}{\text{Uncooked nugget weight}} \text{x100}$$

$$\text{Cooking yield (\%)} = \frac{\text{Cooked nugget weight}}{\text{Uncooked nugget weight}} \text{ x 100}$$

Measurement of instrumental color parameters

Nugget samples were individually vacuum packaged and frozen at −20 °C. Each frozen nugget sample was standardized into two 2.54 cm thick steak samples (AMSA, 1995) for objective color evaluation (L, a*, b*, c* and h*). Readings were taken near the center of each core using a CM (Minolta Chromometer CR-400, Osaka, Japan) with a 1 cm aperture, illuminant C and a 2 viewing angle. Before data collection, the instrument was calibrated with a white calibration plate (L* = 97.06, a* = 0.14, b* = 1.93) covered in the same film wrapping the samples. Lightness (L*), redness (a*), yellowness (b*), chroma (c*), and hue angle (h*) were evaluated. Color coordinates (L*, a* and b*) were observed with a digital Minolta CR400 Chromometer (Minolta Co., Osaka, Japan) on the surface exposed by cutting. Coordinate a* ranged from red (+a*) to green (−a*) and coordinate b* from yellow (+b*) to blue (−b*) (Hunterlab, 1996). Three readings of L*, a*, b*, c* and h* values were obtained at different sites.

Sensory evaluation

This was conducted following the procedures of Peryam and Pilgrim (1957). Seven members trained taste panel participated in the sensory evaluation. Five samples were coded and presented to sensory panel to evaluate samples according to degree of likeness in respect to appearance, aroma, taste, texture and overall acceptance. Water was served in between samples assessment to enable panelists rinse properly and neutralize carryover flavors in their mouth. Panelists were served in a separate location far away from the cooking place and preparation room; samples were coded to reduce bias. All samples were served in one time use dishes. A 9-point hedonic scale having 1 (like extremely) as the highest score and 9 (dislike extremely) as the lowest score was used.

Statistical analysis

Data were analyzed using the GLM procedure of SAS version 9.1, 1994 (SAS Institute, Inc.). DMRT was used to compare the treatment means with significance considered at $p<0.05$.

Results and Discussion

Nutritional composition

Nutritional composition of beef nugget is given in Table 02. Beef nugget had 60.95% moisture content in T_4 and 62.47% in T_0. It was significantly differentiated ($p<0.01$) among the treatments. The loss of moisture probably associated with the increased incorporation of soy meat, since soy meat contains less moisture than that of beef. The present findings were agreed to the findings of Singh et al. (2014) and showed that moisture content gradually decreased due to the increasing incorporation of soya chunk and chick pea flour in chicken nuggets. These results also showed partial similarity with the observation of Omwamba (2014). Beef nugget having 27.97% crude protein (CP) in T_4 and 38.11% in T_0 was significantly differentiated ($p<0.01$) among the treatments. CP content was decreased with the increasing incorporation of soya meat as it contains less amount of protein than that of beef. The present findings were in conformity with the results of Das et al. (2008) who reported that protein contents were lower in those nuggets incorporated with soya paste and soya granules at 15% level than those without the incorporation. In the case of ether extract content of beef nugget, it was decreased with the increased adding of soya meat. This reduction was due to the low fat content of soya meat used to replace minced beef in nugget preparation. The present findings were well matched with the observations of Singh et al. (2014) who showed that fat contents numerically reduced in those nuggets which were incorporated with soya chunk and chick pea flour in an increasing manner. Another similar finding had been reported by Omwamba (2014) for beef samosas with added textured soya protein (TSP). Similar observation was found in ash content of beef nugget and it was found that ash content was increased with increased incorporation of soy meat as rehydrated soy meat contains high amount of ash. It was significantly varied ($p<0.01$) among the treatments. Singh et al. (2014) analyzed ash content and found that ash content gradually increased in those nuggets incorporated with soya chunk and chick pea flour. This variation in ash contents was due to mixing of extenders which was consistent with the present findings. Results obtained from Omwamba (2014) for beef samosas showed similarity to the present findings. Highly significant difference ($p<0.01$) was observed in carbohydrate content among all the treatments. Carbohydrate content was increased with increasing incorporation of soya meat as extenders like soya meat increases starch content. This present finding waswell matched with the observation of Singh et al. (2014) who reported that carbohydrate contents were higher in those nuggets incorporated with soya chunk and chick pea than those without the incorporation.

Table 2. Proximate composition of beef nugget with varying amount of soya meat

Parameters %	Treatment					Significant Level
	T_0	T_1	T_2	T_3	T_4	
Moisture	$62.47^{a}\pm0.12$	$62.05^{ab}\pm0.23$	$61.90^{ab}\pm0.14$	$61.72^{b}\pm0.25$	$60.95^{c}\pm0.08$	**
CP	$38.11^{a}\pm0.26$	$35.49^{b}\pm0.09$	$33.33^{c}\pm0.09$	$29.21^{d}\pm0.15$	$27.97^{e}\pm0.23$	**
EE	$17.29^{a}\pm0.12$	$14.28^{b}\pm0.08$	$12.94^{c}\pm0.12$	$6.04^{d}\pm0.08$	$4.29^{e}\pm0.14$	**
Ash	$5.63^{c}\pm0.09$	$6.20^{b}\pm0.12$	$6.40^{b}\pm0.06$	$7.07^{a}\pm0.03$	$7.30^{a}\pm0.06$	**
CHO	$38.96^{e}\pm0.42$	$44.04^{d}\pm0.29$	$47.32^{c}\pm0.27$	$57.69^{b}\pm0.27$	$60.44^{a}\pm0.43$	**

T_0 =100% beef; T_1 = 75% beef + 25% soya meat; T_2 = 50% beef + 50% soya meat; T_3 = 25% beef + 75% soya meat; T_4 = 100% soya meat; ** $p<0.01$: Mean values with different superscripts letters in the same row differ significantly at 0.15% and 0.01% significant level.

pH, cooking yield and cooking loss

It reveals from the Table 3 that after one hour of sample preparation pH was found from 6.30 to 6.89. After 24 hours, 48 hours, 72 hours and 96 hours of sample preparation the range of pH from treatment to treatment was 6.19 to 6.71; 6.01 to 6.58; 5.91 to 6.52 and 5.88, to 6.48, respectively which were found significantly differentiated ($p<0.01$) among the treatments. Beef nugget had cooking yield and cooking loss ranging from 81.10% to 95.81% and 5.32% to 18.90%, respectively which had highly significant difference ($p<0.01$) among the treatments. Cooking yield was the lowest in T_0 and the highest in T_4. Cooking loss was the highest in T_0 and the lowest in T_4. Cooking yield increased and cooking loss decreased with the increase of soya meat incorporation.

Table 3. pH, cooking yield and cooking loss of beef nugget

Parameters	Treatment					Significant Level
	T_0	T_1	T_2	T_3	T_4	
pH after one hour	$6.30^{e}\pm0.01$	$6.34^{d}\pm0.01$	$6.47^{c}\pm0.00$	$6.68^{b}\pm0.01$	$6.89^{a}\pm0.00$	**
pH after 24 hours	$6.19^{e}\pm0.00$	$6.25^{d}\pm0.01$	$6.35^{c}\pm0.00$	$6.58^{b}\pm0.01$	$6.71^{a}\pm0.01$	**
pH after 48 hours	$6.01^{e}\pm0.01$	$6.14^{d}\pm0.00$	$6.29^{c}\pm0.00$	$6.39^{b}\pm0.01$	$6.58^{a}\pm0.00$	**
pH after 72 hours	$5.91^{e}\pm0.00$	$6.11^{d}\pm0.00$	$6.21^{c}\pm0.01$	$6.29^{b}\pm0.00$	$6.52^{a}\pm0.00$	**
pH after 96 hours	$5.88^{e}\pm0.01$	$6.06^{d}\pm0.01$	$6.18^{c}\pm0.00$	$6.25^{b}\pm0.00$	$6.48^{a}\pm0.01$	**
Cooking yield%	$81.10^{e}\pm0.01$	$82.72^{d}\pm0.01$	$91.72^{c}\pm0.01$	$94.68^{b}\pm0.01$	$95.81^{a}\pm0.01$	**
Cooking loss%	$18.90^{a}\pm0.01$	$17.28^{b}\pm0.01$	$8.28^{c}\pm0.01$	$5.32^{d}\pm0.01$	$4.19^{e}\pm0.01$	**

T_0 =100% beef; T_1 =75% beef+25% soya meat; T_2 =50% beef+50% soya meat; T_3 =25% beef+75% soya meat; T_4 =100% soya meat; ** $p<0.01$; Mean values with different superscripts letters in the same row differ significantly at 0.01% significant level.

Table 4. Instrumental color measurement of beef nugget

Parameters	Treatment					Significant Level
	T_0	T_1	T_2	T_3	T_4	
L*	56.30^{ab}±0.46	54.75^{b}±0.20	59.14^{a}±0.14	58.23^{a}±1.58	58.24^{a}±0.56	*
a*	5.07^{a}±0.23	6.00^{a}±0.79	5.35^{a}±0.14	5.05^{a}±0.39	5.83^{a}±0.32	NS
b*	30.94^{a}±0.25	32.46^{a}±2.51	33.01^{a}±2.83	33.15^{a}±1.90	34.26^{a}±1.24	NS
c*	31.36 ^{a}±0.22	33.01^{a}±2.61	33.45^{a}±2.77	33.53^{a}±1.94	34.76^{a}±1.28	NS
h*	80.69^{a}±0.49	79.58^{a}±0.56	80.71^{a}±1.01	81.35^{a}±0.17	80.36^{a}±0.18	NS

T_0 = 100% beef, T_1 =75% beef + 25% soya meat, T_2 = 50% beef+50% soya meat, T_3 = 25% beef + 75% soya meat, T_4 = 100% soya meat; *L** = Lightness, *a** = Redness, *b** = Yellowness; * p<0.05; Mean values with different superscripts letters in the same row differ significantly; NS= indicates not significant.

Instrumental color parameters of beef nugget

Table 04 is presented to show instrumental color parameters of nugget in formsof *L**, *a**, *b**, *c** and *h**. Though no significant difference was observed in color parameter of *a**, *b**, *c** and *h**, except only significant (p<0.05) difference was observed in higher lightness values (*L**) of nugget among the treatments. In the present study, the color of nugget showedlightness values (*L**) ranging from 54.75 to 59.14, redness values (*a**) from 5.05 to 6.00, blueness values (*b**) from 30.94 to 34.26, chroma values (*c**) from 31.36 to 34.76 and hue angle values (*h**) from 79.58 to 81.35. The value of *L** wasnot consistent with the findings of Dogan et al. (2005) as they reported the *L** values of nuggets prepared with soya flour were numerically lower than that of chicken nuggets. They also reported that *a** value for the soya flour nuggets were always numerically higher than that of chicken nugget which is similar to the present findings and also *b** values also showed the similarity to the present findings.

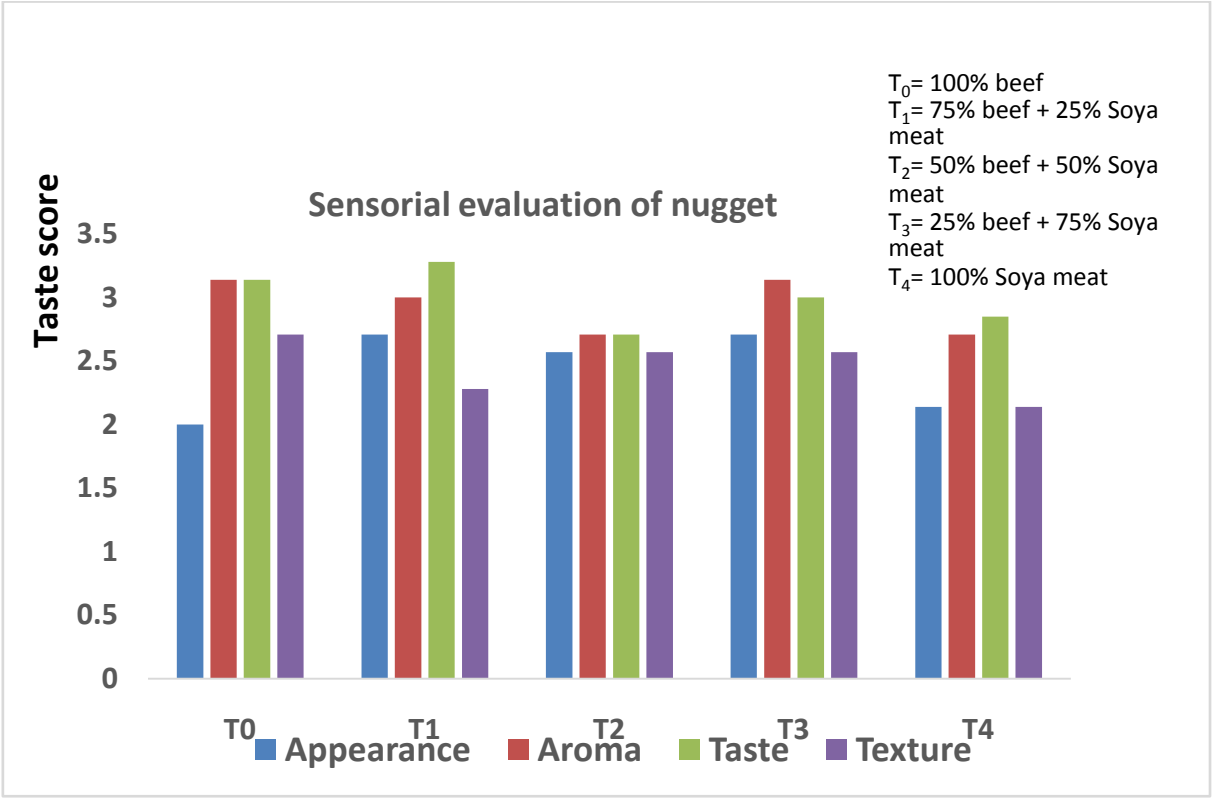

Figure 1. Sensorial evaluation of beef nugget

Sensory characteristics of beef nugget

Sensorial characteristics including appearance, aroma, texture and taste of beef nugget are presented Figure 1. Appearance score was found from 2.00 to 2.71, aroma score from 2.71to3.14, texture score from 2.71 to 3.28, taste score from 2.14 to 2.71. Incorporation of soya meat decreased aroma and taste score of beef nugget whereas; appearance and texture indicated the highest score. Aroma and taste score decreased due to the beany flavor of soya meat. It was observed that T_2 and T_4 were more acceptable than others by the panelists. These present findings showed dissimilarity to the findings of Das et al. (2008) for goat meat nugget prepare by soya protein.

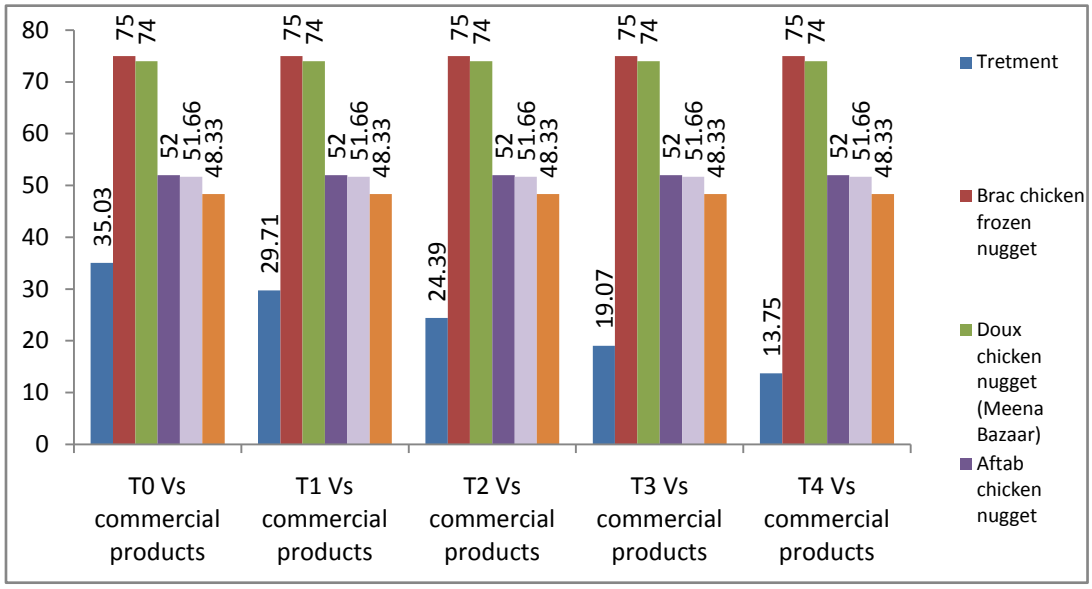

Figure 2. Comparison of prices (Bangladeshi currency in Taka, 1$≈85.00 BDT.) among experimental beef nuggets and commercial nuggets

Benefit cost ratio

The production cost of beef nugget was shown in Figure 2 which reveals that the production cost per unit of experimental beef nuggets was lower with comparison to the products of other companies e.g. BRAC Chicken Frozen Nugget, Doux Chicken Nugget, Aftab Chicken Nugget, Golden Harvest Chicken Nugget and Rich Mini Nugget. The figure also showed that the unit price of the products was gradually reduced with the gradual incorporation of soya meat.

Conclusion

Soya meat was used as a non-meat protein source to replace costly beef in the nugget. From this study it can be concluded that addition of soya meat resulted in the decrease of moisture, ether extract, crude protein and cooking loss; and increase of ash, carbohydrate, cooking yield and pH at different times. Hence it is suggested that soya meat inclusion in prepared nugget should be limited to 25% and 75% inclusion levels, e.g. T_1 and T_3in the case of taste (score 3.28) and aroma (score 3.14) respectively, were favorable, preferred and accepted. Due to the results found lower cooking losses soya meat inclusion provides its economical acceptability.

Conflict of interest

There is none competing for the interests regarding the submitted manuscript, and the conducted research, except the authors mentioned in the list of authors.

References

Akter H, S Akhter, SME Rahman, MM Rahman, MM Hossain, CS Ra, JM Kim and DH Oh. 2009. Effect of different preservation methods on physicochemical qualities of beef. Journal of Food Hygiene and Safety. 24 (3): 217-225.

Akhter S, Rahman MM, Hossain MM, Hashem MA. 2009. Effects of drying as a preservation technique on nutrient contents of beef. Journal of Bangladesh Agricultural University, 7: 63–68.

AMSA.1995. Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh meat. Chicago III. American Meat Science Association and Nutritional Livestock and Meat Board. Analytical Chemists international Maryland, USA.

AOAC. 1997. Association of Official Analytical Chemists. Official methods of analysis (15th ed.). Washington, USA.

Apata ES, Akinjute OF, Apata OC, Okubanjo AO. 2011. Quality evaluation of beef patties extended with cowpea (Vigna unguiculata (l) walp) flour. Journal of Agriculture, Forestry and the Social Sciences, 9: 204–212.

Bithi MAA, Hossain MA, Rahman SME, Rahman MM, Hashem MA. 2020. Sensory, nutritive, antioxidant and antimicrobial activity of Telakucha (*Coccnia cordifolia*) leaves extract in broiler meatball. Journal of Meat Science and Technology, 8: 23-31.

Blake JS. 2012. Nutrition and You. Pearson Benjamin Cummings, San Francisco, CA.

Cofrades S, Guerra MA, Carballo J, Fernández-Martín F, Colmenero FJ. 2000. Plasma protein and soy fiber content effect on bologna sausage properties as influenced by fat level. Journal of Food Science, 65: 281–287.

Cross A, Leitzmann M, Gail M, Hollenbeck A, Schatzkin A, Sinha R. 2008. A Prospective Study of red and processed meat intake in relation to cancer risk. PLoS Medicine, 4: e325.

Das AK, Anjaneyulu ASR, Gadekar YP, Singh RP, Pragati H. 2008. Effect of full-fat soy paste and textured soy granules on quality and shelf-life of goat meat nuggets in frozen storage. Meat Science, 80: 607–614.

Disha MNA, Hossain MA, Kamal MT, Rahman MM, Hashem MA. 2020. Effect of different level of lemon extract on quality and shelf life of chicken meatballs during frozen storage. SAARK Journal of Agriculture, 18 (2): 139-156.

Dogan SF, Sahin S, Sumnu G. 2005. Effects of soy and rice flour addition on batter rheology and quality of deep-fat fried chicken nuggets. Journal of Food Engineering, **71:** 127-132.

Feiner G. 2006. The protein and fat content of meat. In G. Feiner (Ed.), Meat Products Handbook (pp. 3–32). Woodhead Publishing.

Habiba U, Hossain MM, Habib M, Hashem MA, Ali MS. 2021. Effect of adding different types of flour on the quality of low fat beef sausage. Bangladesh Journal of Animal Science, 50 (1):1-11.

Hunterlab. 1996. Applications note: CIE *L* a* b** color scale (Vol. 7). Virginia: Hunterlab.

Islam F, Hossain MA, Rahman MF, Hashem MA, Rahman M, Azad MAK. 2018. Effect of synthetic or herbal preservatives on the quality of beef meatballs at different shelf life periods. SAARC J Agric., 16(1): 23-34

Jooyandeh H. 2011. Soy products as healthy and functional foods. Middle-East Journal of Scientific Research 7: 71-80.
Lim B, DeMan JM, DeMan L, Buzzell RI. 1990. Yield and quality of tofu as affected by soybean and soymilk characteristics. Calcium sulfate coagulant. Journal of Food Science, 55: 1088-1092.
Omwamba M. 2014. Effect of texturized soy protein on quality characteristics of beef samosas. International Journal of Food Studies, 3: 74-81.
Saba NA, Hashem MA, Azad MAK, Hossain MA, Khan M. 2018. Effect of bottle gourd leaf (*Lagenaria siceraria*) extract on the quality of beef meatball. Bangladesh Journal of Animal Science, 47: 105-113.
Sadler MJ. 2004. Meat alternatives—Market developments and health benefits. Trends in Food Science & Technology, 15: 250-260.
SANA. 2016. Soyfoods Association of North America. Soy meat alternative. http://www.soyfoods.org/soy-products/soy-fact-sheets/soy-meat-alternative-fact-sheet (Accessed on February 24, 2016).
Siddiqua T, Hossain MA, Khan M, Hashem MA. 2018. Formulation of value added beef meatballs using tulsi (*Ocimum sanctum*) leaf extract as a source of natural antioxidant. Journal of Bangladesh Agricultural University, 16(2): 260-265.
Singh AK, Sonkar C, Messih D. 2014. Development and physico-chemical evaluation of low fat chicken nuggets using extenders. Journal of Food Processing & Technology, 5: 1-5.
Talukder M, Hashem MA, Rahman SME, Islam S, Hossain M, Ali M, Azad M, Luna R. 2014. Study on varying salt level and storage time on physico-chemical and sensory quality of beef nugget. Progressive Agriculture, 24: 149-158.
Xu Y. 2001. Perspectives on the 21st century development of functional foods: Bridging Chinese medicated diet and functional foods. International Journal of Food Science & Technology, 36: 229-242.
Yadav SK, Kumar Tanwar V, Sharma JK, Yadav S. 2013. Effect of added soy protein on physico-chemical properties of chevon patties. Journal of Meat Science and Technology, 1: 35-39.
Yogesh K, Ahmad T, Manpreet G, Mangesh K, Das P. 2013. Characteristics of chicken nuggets as affected by added fat and variable salt contents. Journal of food science and technology, 50: 191-196.