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Research Article

Effect of soya meat on the quality of beef patties

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Abstract

The study was conducted to characterize nutritional, sensory quality and economic feasibility of beef patties as affected by adding soya meat. Therefore, the experiment was conducted with a view to investigate inclusion of soya meat in beef patties with five 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 replications. The results indicated that adding soy meat to beef patties decreased CP and EE but increased cooking yield and ash. Differences in moisture, CP, EE, ash, CHO, and cooking yield were highly significant (p<0.0001). pH fell in the samples as storage time increased, but increased when soy meat was added and it was found highly significant (p<0.0001) varied. With a high level of soy meat incorporation, L* values increased while a* values decreased. Except for L* values, no discernible variation in the color parameter was found. By using soy meat in beef patties, production costs were reduced. In terms of sensory evaluation, beef patties treated with 50% and 75% soy meat were found to be more acceptable.

Introduction

Red meat has been consumed by humans for thousands of years, and meat actually played a significant role in the evolution of humans (Akter et al., 2009 and 2022; Akhter et al., 2009 and 2022; Alam et al., 2011; Milton, 2003). The essential nutrients iron, zinc, vitamin B_{12}, and folic acid are all found in meat, making it a significant source of protein (Scollan et al., 2006; Schonfeldt & Gibson, 2008). 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 (Apata et al., 2011). Meat and meat products can minimize this problem as a contributor of high-quality protein (Hashem et al., 2021, 2022 and 2023; Hasan et al., 2022; Hossain et al., 2021 and 2022; Talukdar et al., 2014). Among the processed meat products e.g. meat balls, frankfurters, nuggets, steaks, patties, burgers etc. are available in the market (Khatun et al., 2022; Saba et al., 2018; Siddiqua; Jahan et al., 2018; Boby et al., 2021; Bithi et al., 2020; Disha et al., 2020), of which patties is more popular as it requires less time to prepare and is nutritionally more acceptable than other food items. 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 also known 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). However, very few research works have been done on beef patties. Therefore, the present study was conducted to evaluate the effect of incorporation of soya meat on nutritional, sensorial quality and economic feasibility as compared with available commercial beef patties 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 replications of beef nugget.

Preparation of Beef Patties

At room temperature (26.2^{o}C), the frozen minced beef and blended soy meat was thawed. 644g of minced beef and soy meat were weighed and divided into 5 equal parts (0, 25, 50, 75, and 100%). Beef patties were mixed in 400g batches, with 257.52g, 193.2g, 128.8g, 64.4g, and 0g of beef incorporated into 0g, 64.4g, 128.8g, 193.2g, and 257.52g of soy meat. As shown in Table 1, spices (garlic paste 9.6g, onion chopped 20.6g, chopped green chili 4g, chopped coriander leaves 10.32g, ginger paste 8.6g, garammasala powder 0.52g, black pepper powder 0.88g, tomato sauce 3.44g, and soy sauce 5.16g), bread 24g, milk 34.32g, egg 19.24g, and salt 1.72g were added to each sample. Following that, each sample was thoroughly mixed by hand while wearing a hand glove, and the finished meat batters were weighed into 100g portions before being manually stamped to produce a uniform beef patty. Following completion of all of these processes, each patties sample was tagged, wrapped in zipper bags, and immediately stored at -18^{o}C until used for analysis.

Table 1. Ingredients used in beef patties preparation

Variable	Treatment				
	T_0	T_1	T_2	T_3	T_4
Beef (g)	257.52	193.2	128.8	64.4	0
Onion (g)	20.6	20.6	20.6	20.6	20.6
Garlic (g)	9.6	9.6	9.6	9.6	9.6
Ginger (g)	8.6	8.6	8.6	8.6	8.6
Chillies (g)	4	4	4	4	4
Fresh parsley (g)	10.32	10.32	10.32	10.32	10.32
Soya sauce (g)	5.16	5.16	5.16	5.16	5.16
Tomato sauce (g)	3.44	3.44	3.44	3.44	3.44
Salt (g)	1.72	1.72	1.72	1.72	1.72
Pepper (g)	0.88	0.88	0.88	0.88	0.88
Garammasala (g)	0.60	0.60	0.60	0.60	0.60
Egg (g)	19.24	19.24	19.24	19.24	19.24
Milk (g)	34.32	34.32	34.32	34.32	34.32
Bread (g)	24	24	24	24	24
Soy meat (g)	0	64.4	128.8	193.2	257.52

T_0 (100% beef); T_1 (75% beef+25% soy meat); T_2 (50% beef+50% soy meat); T_3 (25% beef+75% soy meat); T_4 (100% soy meat

Determination Proximate composition

Following the Association of Official Analytical Chemists' recommended standards, the proximate composition of the nuggets was examined (AOAC, 1997). Three copies of each experiment were performed.

DeterminationpH

An Ultra Turrax T 25 tissue homogenizer (Janke and Kunkel, IKA Labortecnik, Staufen, Germany) was used to blend the sample with 50 ml of distilled water and measure the pH for 1 minute. By dipping the combined glass electrode of an Elico digital pH meter, model LI 127, the pH of the suspension was measured (Elico Limited, Hyderabad, India).

Determination of cooking yield and cooking loss

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

$$\text{Cooking Loss (\%)} = \frac{\text{Uncooked Nugget Weight} - \text{Cooked Nugget Weight}}{\text{Uncooked Nugget Weight}} \times 100$$

$$\text{Cooking Yield (\%)} = \frac{\text{Cooked Nugget Weight}}{\text{Uncooked Nugget Weight}} \times 100$$

Measurement of instrumental colour 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 colour 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. Colour 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 panellists rinse properly and neutralize carryover flavours in their mouth. Panellists 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 analysed 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<0.0001.

Result and Discussion

Nutritional composition of beef patties

The proximate composition of beef patties are shown in Table 2.

Table 2. Proximate composition beef patties with varying amounts of soy meat

Parameters %	Treatment					Significant Level
	T_0	T_1	T_2	T_3	T_4	
Moisture	$70.30^{a}\pm0.11$	$69.40^{b}\pm0.14$	$69.07^{b}\pm0.07$	$68.20^{c}\pm0.5$	$67.95^{c}\pm0.24$	***
CP	$49.88^{a}\pm0.18$	$45.38^{b}\pm0.21$	$40.28^{c}\pm0.14$	$36.90^{d}\pm0.34$	$35.97^{e}\pm0.15$	***
EE	$24.85^{a}\pm0.11$	$18.80^{b}\pm0.17$	$13.80^{c}\pm0.20$	$6.62^{d}\pm0.19$	$2.97^{e}\pm0.12$	***
Ash	$5.80^{e}\pm0.13$	$6.62^{d}\pm0.14$	$7.83^{c}\pm0.017$	$8.42^{b}\pm0.17$	$9.40^{a}\pm16$	***
CHO	$19.47^{e}\pm0.30$	$29.20^{d}\pm0.39$	$38.08^{c}\pm0.33$	$48.03^{b}\pm0.36$	$51.67^{a}\pm0.38$	***

T_0 (100% beef); T_1 (75% beef+25% soy meat); T_2 (50% beef+50% soy meat); T_3 (25% beef+75% soy meat); T_4 (100% soy meat);*= p<.05; **= p<0.01;***= p<0.0001; Mean with different superscripts within same row differ significantly (p<.0001).

Moisture contents were noted down 70.30%, 69.40%, 69.07%, 68.20% and 67.95% in T_0, T_1, T_2, T_3 and T_4, respectively. Moisture content was highest in T_0 than those of other treatments. Moisture content gradually decreased from T_0 to T_4. The loss of moisture probably associated with incorporation of soy meat as soy meat contains less amount of moisture. There was a highly significant (p<0.001) differences in moisture content of the beef patties among the treatments. Similar results were obtained by Kotula et al. (1974) who reported that patties with 20% TSP rated slightly lower in moisture than the control (all beef). This study agreed to the present study.These results also showed partial similarity with the observation of Gehan et al. (2010).

In T_0 the CP was 49.88%. The CP was found 45.38%, 40.28%, 36.90% and 35.97% in T_1, T_2, T_3 and T_4, respectively. The CP value was decreased with the increasing incorporation of soy meat as it contains less amount of protein than the beef. There was a highly significant differences (p<0.001) in CP content of the beef patties among the treatments. The decrease in protein content is consistent with the work of Ray et al. (1981) that as the soy level increased in ground meat, the protein decreased. Similar trends were reported by Christine et al. (1982) when hydrated granular soy concentrate was used to substitute beef in beef burgers.

The EE content in T_0 was 24.85% while that for T_4 was 2.97% representing approximately 90% reduction in fat. This reduction was due to the low fat content of rehydrated soy meat used to replace minced beef. The EE content of the beef patties was highly significant (p<0.0001) in the treatments. Rhee et al. (1983) reported a decrease in fat content in raw ground beef patties with addition of up to 30% rehydrated TSP. Similar trends were reported by Anwar et al. (2011) and Gehan et al. (2010) when TSP was used to substitute beef in beef burger.

The lowest value of ash was found in T_0. The ash content was increased with the increasing incorporation of soy meat as it had a higher concentration of ash than the beef. The highest value was found in T_4. There was a highly significant difference (p<0.0001) in the ash content of beef patties among the treatments. The increase in ash content is consistent with the work of Gehan et al. (2010) that as the soy level increased in ground meat, the ash content increased. Similar findings were reported by Kotula et al. (1974).

The lowest value of CHO was found in T_0. The carbohydrate content in beef patties increased with the increasing incorporation of soy meat and it could be due to an increase of starch content (acts as extender) to substitute for raw meat in the manufacturing of beef patties. The highest value was found in T_4. There was a highly significant difference (p<0.0001) in the CHO content of beef patties among the treatments. Gehan et al. (2010) reported an increase in carbohydrate content in raw ground beef patties with addition of up to 20% rehydrated TSP. Similar trends were reported by Bilek et al. (2009) when flaxseed flour was used in beef burger.

pH

pH of samples was analysed within one hour to 96 hours after preparing samples and the results are presented in Table 3. The initial mean levels of pH of beef patties was found 6.55 in T_0 and 7.09 in T_4. It was found that pH increased with addition of soy meat into beef patties. The reduction in pH might be due to the production of acid from the fermentation of carbohydrates of meat, binders and spices. An increase in pH due to TSP addition into beef patties formulation and frozen storage was reported previously by Kotula et al. (1974) and Anwar et al. (2011).

Table 3. pH, cooking yield and cooking loss of beef patties with varying amounts of soy meat

Parameters	Treatment					Significant Level
	T_0	T_1	T_2	T_3	T_4	
pH after one hour	$6.55^e±0.02$	$6.63^d±0.01$	$6.81^c±0.02$	$6.94^b±0.01$	$7.09^a±0.01$	***
pH after 24 hours	$6.45^e±0.00$	$6.52^d±0.01$	$6.68^c±0.01$	$6.81^b±0.02$	$6.92^a±0.02$	***
pH after 48 hours	$6.33^e±0.01$	$6.43^d±0.01$	$6.55^c±0.00$	$6.67^b±0.01$	$6.87^a±0.01$	***
pH after 72 hours	$6.12^e±0.01$	$6.23^d±0.01$	$6.33^c±0.01$	$6.44^b±0.01$	$6.88^a±0.01$	***
pH after 96 hours	$6.05^d±0.01$	$6.14^c±0.00$	$6.18^c±0.02$	$6.41^b±0.01$	$6.84^a±0.01$	***
Cooking yield	$61.06^e±0.01$	$67.87^d±0.01$	$77.56^c±0.01$	$88.17^b±0.01$	$89.28^a±0.01$	***
Cooking loss	$38.95^a±0.01$	$32.13^b±0.01$	$22.40^c±0.01$	$11.83^d±0.01$	$10.72^e±0.01$	***

T_0 (100% beef); T_1 (75% beef+25% soy meat); T_2 (50% beef+50% soy meat); T_3 (25% beef+75% soy meat); T_4 (100% soy meat); NS = Non significant;*= p<.05; **= p<0.01;***= p<0.0001; Mean with different superscripts within same row differ significantly (p<.0001).

Cooking yield and cooking loss

The percent cooking loss and cooking yield of soy-beef patties is shown in Table 3. It was observed that cooking loss decreased when more textured soy protein is blended with the beef patties i.e. increase the cooking yield, due to its ability to hold up water and fat during cooking. The cooking yield in T_0, T_1, T_2, T_3 and T_4 were 61.06%, 67.87%, 77.56%, 88.17% and 89.28%, respectively. There was a highly significant (p<0.0001) difference in the percent cooking yield of beef patties among the treatments. Anderson et al. (1975) reported that the level of soy in a meat product determines the amount of moisture retention. A functional property of soy is to retain moisture; consequently the cooking yield of soy-extended products is greater than that of all beef products. The cooking losses in T_0, T_1, T_2, T_3 and T_4 were 38.95, 32.13, 22.40, 11.83 and 10.72%, respectively. There was a highly significant (p<0.0001) difference in the percent cooking loss of beef patties among the treatments. Reports by Abdul et al. (1986); Gehan et al. (2010); and Anwar et al. (2011) also indicated soy protein ability to reduce cooking loss when compared to products with 100% meat in it.

Instrumental color measurement

The instrumental color measurement results of raw beef patties are shown in Table 4. The lightness values (L*) of beef patties in T_0, T_1, T_2, T_3 and T_4 were 48.79, 48.81, 53.45, 51.27 and 51.02, respectively. The redness values (a*) of beef patties found in T_0, T_1, T_2, T_3 and T_4 were 1.47, 2.02, 1.08, 1.48 and 1.56, respectively. The yellowness values (b*) of beef patties found in T_0, T_1, T_2, T_3 and T_4 were 15.09, 14.39, 16.22, 16.09 and17.36respectively. The chroma values (c*) of beef patties found in T_0, T_1, T_2, T_3 and T_4 were 15.19, 14.54, 16.27, 16.16 and 17.43, respectively. The hue angle values (h*) of beef patties found in T_0, T_1, T_2, T_3 and T_4 were 84.61, 82.07, 86.20, 84.76 and 84.87, respectively. There was no significant difference (p>0.05) in color of the beef patties among the treatments except lightness values (L*). There was a significant difference (p<0.0031) in the lightness values (L*) of beef patties among the treatments. The lightness (L*) of beef patties with varying amount of soy meat was comparable to the control, while those with soy meat displayed greater lightness than the control. Seideman et al. (1977) had shown in their study that raw patties containing 20% or 30% TSP were lighter in color than control (all-beef) patties and this study agree with the present study.

Table 4. Instrumental colour measurement of beef patties with varying amounts of soy meat

Parameters	Treatment					Significant Level
	T_0	T_1	T_2	T_3	T_4	
L*	$48.79^c±0.14$	$48.81^c±0.19$	$53.45^a±0.61$	$51.27^b±0.46$	$51.02^b±0.61$	**
a*	2.02^a ±0.41	1.47^a ±0.87	1.08^a ±0.45	1.48^a ±0.23	1.56^a ±0.13	NS
b*	$15.09^b±0.67$	$14.39^b±0.46$	$16.22^{ab}±0.49$	$16.09^{ab}±0.18$	$17.36^a±0.66$	NS
c*	$15.19^b±0.75$	$14.54^b±0.51$	$16.27^{ab}±0.47$	$16.16^{ab}±0.20$	$17.43^a±0.67$	NS
h*	**$84.61^a±3.03$**	**$82.07^a±1.34$**	**$86.20^a±0.1.74$**	**$84.76^a±0.75$**	**$84.87^a±0.32$**	NS

T_0 (100% beef); T_1 (75% beef+25% soy meat); T_2 (50% beef+50% soy meat); T_3 (25% beef+75% soy meat); T_4 (100% soy meat); NS = Non significant;*= p<.05; **= p<0.01;***= p<0.0001; Mean with different superscripts within same row differ significantly.

Sensory evaluation

The results of the taste panel evaluation on the various quality attributes such as appearance, aroma, taste and texture of soy-beef patties are summarized in Table-5. The scores for appearance was found 1.5 to 3.38. Beef patties samples produced with 50% soy meat were chosen as beef patties with the most desirable appearance. The scores for flavor was found 2.5 to 3.63. As the addition of soy meat increased, the perception of meat flavor intensity decreased. The lower sensory scores of flavor in soy meat extended patties might be due to decrease in fat content and/or the beany flavor detected by the panelists in the soy meat extended patties. The scores for taste were found 1.88 to 3.38. As the addition of soy meat increased, the beef patties were rated higher than the control except T_4. It isprobably due to the increasing juiciness and tenderness with the increasing incorporation of soy meat. Non-meat protein sources such as egg, whey protein and TSP are able to improve the flavor and texture of burgers by increasing the fat and moisture binding ability (Gujral et al., 2002; Rentfrow et al., 2004; Gehan et al., 2010). These studies agree with the present study.

Table 5. Sensory evaluation of beef patties with varying amount of soy meat

Sensory Attributes	Treatment				
	T_0	T_1	T_2	T_3	T_4
Appearance	3.38	3.38	1.5	2.88	3.25
Aroma	2.75	2.5	3	3.63	3.63
Taste	3.25	3	1.88	3.38	3.13
Texture	3.5	3.25	2.38	2.88	3.88

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).

Prices of beef patties

The difference of prices among present prepared beef patties and commercial beef patties is shown in Figure-1. The price values per 100 g of present prepared beef patties were noted 39.06 BDT in T_0 and 11.97 BDT in T_4. In T_0, T_1, T_2, T_3 and T_4 the values were found 39.06, 32.29, 25.52, 18.74 and 11.97 BDT, respectively. Brac burger patties, Golden harvest beef burger patty, Rich beef burger patty, Aftab chicken burger patty and A.K 24 chicken burger are available in the commercial market. Price per 100 g of Brac burger patties, Golden harvest beef burger patty, Rich beef burger patty, Aftab chicken burger patty and A.K 24 chicken burger are 46.92, 66.3, 68.85, 44.88 and 101.15 BDT, respectively.

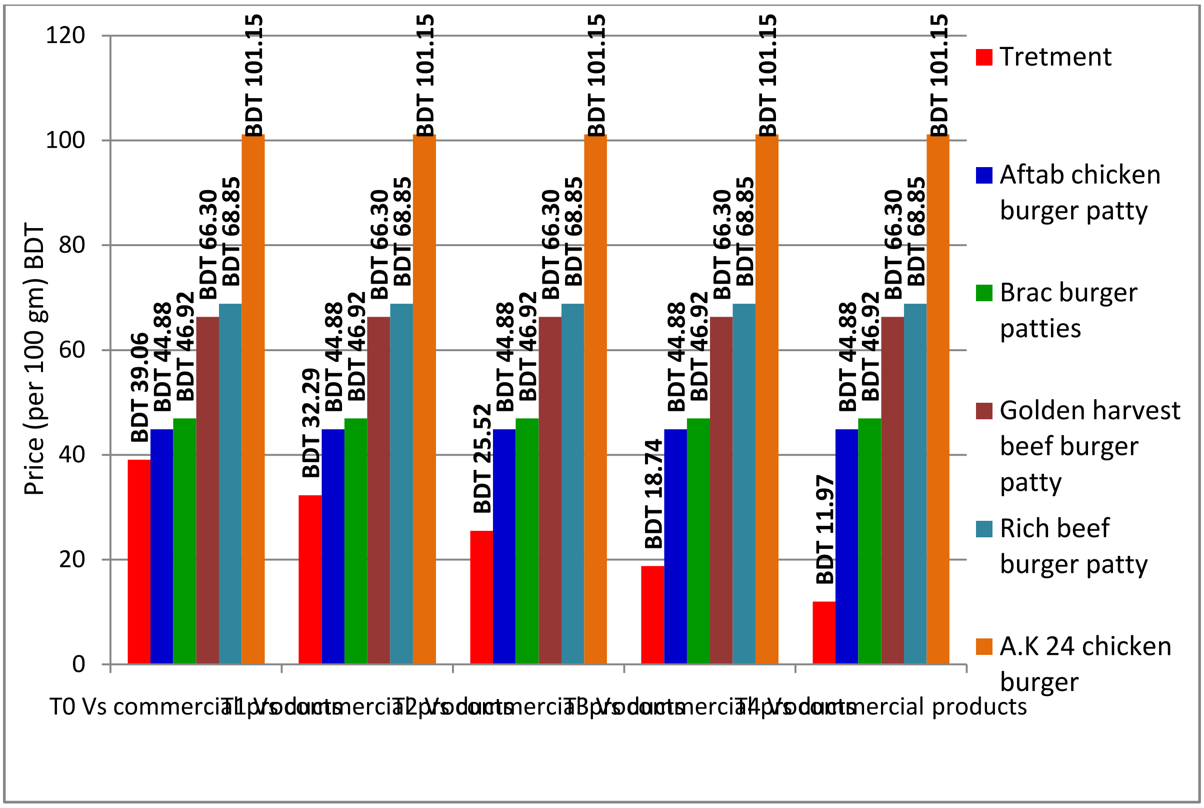

Figure 1. Comparison of prices among commercial and present prepared beef patties.

It is showed in figure 1 that price values of present prepared beef patties are decreased and the difference of the price values among commercial and present prepared beef patties gradually increased with the increasing incorporation of soya meat. This differences cause due to soy meat on the market is less expensive than the real meat counterparts.

Conclusion

Finally, it can be concluded that, addition of soy meat resulted in an increase in the nutritional composition, cooking yield while maintaining the sensory quality of beef patties. A level of up to 50% soy meat can be used in beef patties production to obtain acceptable products that have better textural properties in which the flavor and taste are not significantly different from 100% beef patties. This incorporation could permit a reduction of the formulation cost without affecting sensory descriptors of the product to which the consumer is familiarized.

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