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Taste Panel Evaluation and Acceptance of Soy-beef Burger

ABDUL SALAM BABJI, AMINAH ABDULLAH and FATIMAH YUSUF
Department of Food Science and Nutrition,
Faculty of Life Sciences,
Universiti Kebangsaan Malaysia,
Bangi, Selangor, Malaysia.

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ABSTRAK

Kajian ini dilakukan untuk menentukan kesan campuran protein soya tekstur pada 0%, 20%, 30%, 40% dan 50% pada burger soya daging dari aspek kualiti dan penerimaan oleh penguji rasa dan pengguna. Analisis yang dijalankan pada tiap tiga minggu, termasuk nilai TBA, keupayaan mengikat air, masakan, penilaian deria dan penerimaan oleh pengguna. Penambahan protein soya tekstur dalam produk menyebabkan penurunan nilai TBA dan kehilangan masakan, tetapi meningkatkan keupayaan mengikat air. Secara amnya kualiti produk menurun semasa penyimpanan beku. Penilaian deria menunjukkan penambahan protein soya menyebabkan peningkatan bau kacang dan rasa kacang. Warna produk menjadi kurang menarik dengan peningkatan protein soya tekstur, tetapi tidak mempengaruhi kualiti atribut seperti rupa, tekstur, kemasinan dan kejusian. Kajian penerimaan pengguna menunjukkan produk-produk yang mengandungi 0%, 20% dan 30% protein soya tekstur dapat diterima tanpa perbezaan yang bererti.

ABSTRACT

This study was conducted to investigate the effect of the addition of textured soy protein (TSP) at 0%, 20%, 30%, 40% and 50% levels on the quality and general acceptance of soy-beef burgers by trained taste panels as well as the consumer. Analyses carried out at three-week intervals include TBA values, water holding capacity, cooking loss, sensory evaluation and consumer acceptance. The increase of textured soy protein levels in beef burger resulted in significant decrease in TBA values and cooking loss. The addition of textured soy protein also increased the water holding capacity of the products. Generally, storage time reduced the quality of these products. Sensory properties showed that the substitution of meat with textured soy protein increased the intensity of beany flavour and taste. The addition of textured soy protein decreased the colour acceptance but had no specific effect on the quality attributes such as appearance, texture, saltiness and juiciness of the product. Results of the consumer acceptance test showed that there were no significant differences in preference for the 0%, 20% and 30% levels of textured soy protein in beef burger.

INTRODUCTION

The world situation on food and nutrition has changed so drastically in recent years that many countries now seek new approaches to solve the problem of providing enough food for growth, development and health of their population. A technological advancement was the discovery of extrusion technology which enabled the manufacture of textured vegetable protein (TVP) or textured soy protein (TSP).

In recent years, food technologists have achieved a major breakthrough in the technology of blending soy proteins with meat and other products. As such it is possible to for-

mulate a high quality protein food with an amino acid profile and utilizable protein that can match high protein foods like milk, eggs and meat. While animal proteins provide the most complete balance of amino acid requirements for growth, high cost and limited supply preclude their use in many parts of the world.

Soy protein products are allowed in the U.S. school lunch programme in combination with meat, poultry, or seafood as an alternative food to meet part of the meat/meat alternate requirement of the meal patterns for the child nutrition programmes (USDA, Food and Nutrition Service). A fully hydrated soy protein product may not exceed 30 parts soy protein to 70 parts of uncooked meat, poultry or seafood, in such items as beef patties, chicken patties, meat loaf, pizza toppings and other products (Forbes, 1985).

The popularity of fast foods such as hamburgers and hotdogs in ASEAN can be seen by the many significant western fast food franchises in the cities. Many reasons can be sighted, among them the support of ASEAN youths who patronize these places, advertisements and convenience. To children, it is probably just their kind of food. However, the local entrepreneurs are also quick to imitate the western fast foods by producing local beef burgers and frankfurters, and setting up local fast food establishments. They are successful in competing with foreign franchises because of reformulation to suit local taste and lower retailing price due to non-meat fillers blended in their products. However, a closer look will reveal that their appearance, colour, texture and ingredients are being seriously abused without much consideration being given to quality control and nutritional quality. Reasons for use of non nutritive fillers and less meat are obviously related to increased profits. This has led to locally manufactured beef burgers, chicken burgers and hotdogs having low protein and nutritional quality, and are often poor in overall quality.

This study is aimed at illustrating the potential usage of blended textured soy protein with beef at various levels to produce a soy-beef burger formulation that is acceptable to Asians from both an economic as well as a nutrition point of view.

MATERIALS AND METHODS

Soy-beef burgers were formulated using local beef (80 : 20 lean : fat) and textured soy protein with the brand name of CENTEX (Chemurgy Division of Central Soya Company, Inc. USA) was obtained from Aunty May's Food Consolidated. The spices used included onions, garlic, pepper and chilli powder. Beef flavour was obtained from Food Ingredients Specialities Department, Nutritional Products Sdn. Bhd. Malaysia.

Frozen beef (stored at $-20°C$) was thawed to $5°C$, cut into cubes than minced through a 4 mm grinder plate. Textured soy protein (TSP) was hydrated with two portions of cold water ($0°C$) to one portion of TSP for a period of 30 minutes.

The five combinations of beef and TSP at 0, 20, 30, 40 and 50 percent is shown in Table 1.

Processing

Spices, salt and beef flavour were added to the beef and TSP blends and mixed for three minutes in a bowl chopper. The formulations of the five products are shown in Table 2. Mixing was continued for another five minutes to ensure even distribution of spices, salt and beef flavour in the beef-TSP mixes. After mixing, the meat batch was transferred to a Hollymatic Patty maker. Burger patties each weighing 75 grams were packed, two to a package, and stored in a freezer ($-18°C$) until ready for laboratory analyses.

Analyses

The following physico-chemical analyses were carried out on the samples. Thiobarbituric Acid Test (TBA), Water Holding Capacity and Cooking loss.

The degree of oxidation and rancidity of the products was measured by the Thiobarbituric Acid Test in mg TBA/kg of samples. The method used was that of Tarladgis *et al.* (1960). Distillates of the meat product were reacted with TBA and the colour formation measured with a Spectronic 20 (Bauch and Lomb) spectrophotometer at 538 nm. The malonaldehyde value in mg/1000 g sample was obtained by multiplying absorbance by a factor of 7.8.

The Water Holding Capacity (WHC) of meat products was determined using the method of Wierbicki *et al.* (1962). The percentage of WHC was calculated using the formula:—

$$\% \text{ WHC} = \frac{4\,(b-a) - (c-a)}{(c-a)} \times 100$$

where a = weight of empty centrifuge tube
b = weight of centrifuge tube plus precipitate
c = weight of centrifuge tube plus homogenate

Cooking loss was measured by the formula:

$$\% \text{ cooking loss} = \frac{\text{wt. of raw burger} - \text{wt. of cooked burger}}{\text{wt. of raw burger}} \times 100$$

Scoring and the Hedonic Scale methods were used for the sensory evaluations of the cooked soy-beef burgers. Nine trained panel members evaluated the formulated products every three weeks for a period of nine weeks,

TABLE 1
Percentage of beef and textured soy protein in the five formulations

Formulation	Percent beef	Percent TSP
A	100	0
B	80	20
C	70	30
D	60	40
E	50	50

TABLE 2
Amounts of ingredients in soy-beef burger formulation

Ingredients (grams)	Formulation A	B	C	D	E
Beef	1800	1440	1260	1080	900
Water	—	240	360	480	600
TSP	—	120	180	240	300
Onions	20	20	20	20	20
Garlic	10	10	10	10	10
Salt	18	18	18	18	18
Pepper powder	9	9	9	9	9
Chilli powder	6	6	6	6	6
Beef flavour	4	4	4	4	4

using the scoring method. Coded samples were evaluated for intensity of flavour, appearance, colour, texture, saltiness, hotness, juiciness and overall acceptability with 1, denoting unfavourable and 5, favourable response. Sixty untrained panel members were also asked to evaluate the acceptance of the soy-beef burgers at the end of the nine weeks storage using the 5 point Hedonic scale method i.e. 1 for very poor and 5, very acceptable response.

The analysis of variance was carried out using the Statistical Analysis System (SAS) while the Duncan Multiple Range Test was used to detect differences between means.

RESULTS AND DISCUSSION

Thiobarbituric acid values of soy-beef burgers with 0%, 20%, 30%, 40% and 50% TSP measured at 0, 3, 6 and 9 weeks of frozen storage are shown in Table 3. TBA values were found to decrease significantly ($P<.05$) with an increase in the percentage of TSP in soy-beef burgers. Similarly with an increase in storage time even at $-18°C$, there is a significant increase in the values of TBA with all soy-beef formulations. The addition of TSP resulted in a decrease in the fat content of the soy-beef product, thus reducing oxidative rancidity, which normally occurs more actively in lipid products. Results of a similar nature was reported by Younathan *et al.* (1980) who noted that the TBA value was greatly reduced with a 25% addition of TSP when compared to a 100% pure beef burger. They also observed that addition of TSP resulted in a much slower rate of oxidative rancidity reaction. The increase in TBA value during frozen storage is not surprising as any food product stored for some time tends to get rancid. Studies by Keller and Kinsella (1973) observed that hamburgers stored at $-18°C$ had higher TBA values. The increased surface area of minced meat during processing liberate and expose phospholipids which are readily oxidised (Lea, 1957 and Castell 1971). However, this study indicated that addition of TSP could be beneficial from a storage point of view in that soy-beef products, can last longer and get less rancid as compared to a fully lean meat product.

Water Holding Capacity

The ability to bind water in a soy-beef product is one of the important attributes of soy protein in meat product formulation. If one is able to obtain a product with good WHC, the cooked product will retain its water and juice and yield a product that is juicy and appealing to taste. That is why WHC was measured in this

TABLE 3
TBA values (mg melonaldehyde/1 kg) of soy-beef burger formulations measured at three weeks interval frozen storage ($-18°C$)

Storage time (weeks)	Textured soy protein (%)					*Overall mean (effect of storage)
	0	20	30	40	50	
0	0.23	0.22	0.18	0.14	0.10	0.17 d
3	0.58	0.45	0.39	0.32	0.25	0.40 c
6	0.85	0.79	0.67	0.54	0.47	0.66 b
9	1.22	0.95	0.93	0.69	0.46	0.85 a
*Overall mean (effect of beef mixture)	0.72a	0.60b	0.54c	0.42d	0.32e	

*Mean values within the same row with different superscripts are significantly different ($P<.05$)

study. Table 4 shows that effects of storage and TSP addition on the WHC property of the products.

Addition of TSP from 0, 20, 30 and 50% significantly ($P<.05$) increased the WHC of soy-beef products. Differences between 30 to 40% were not significant although there was still overall improvement in WHC. The storage time did not significantly affect WHC of the soy-beef products. Thus here again, there is an added advantage of using TSP in that it blends well with meat protein and is able to retain water in its structure. However, WHC can only be meaningful if the cooked products can still retain the juicy characteristic. This is shown in Table 5, where WHC of soy-beef products was measured after cooking. The ability of cooked products to hold water is higher when compared to raw products. However, although addition of TSP resulted in higher WHC of soy-beef products, these differences were not significant, when the five formulations were compared.

TABLE 4
Mean values of water holding capacity of raw soy-beef burger of five formulations stored for nine weeks at −18°C

	Textured soy protein (%)					
Storage time (weeks)	0	20	30	40	50	*Overall mean (effect of storage)
0	28.6	33.1	36.3	39.7	42.1	36.0 a
3	21.2	25.2	31.4	35.5	42.7	31.2 b
6	23.1	33.4	39.1	41.9	46.2	36.7 a
9	21.1	29.8	37.2	38.0	38.5	31.2 b
*Overall mean (effect of soy-beef mixture)	23.5d	30.5c	36.0b	38.8b	42.4a	

*Mean values within the same row with different superscript are significantly different ($P<05$)

TABLE 5
Mean values of water holding capacity of cooked soy-beef burger of fir formulations stored for nine weeks at −18°C

	Textured soy protein (%)					
Storage time (weeks)	0	20	30	40	50	*Overall mean (effect of storage)
0	39.6	53.9	55.7	54.1	47.4	50.1 b
3	47.1	56.1	57.2	56.9	51.5	53.7 b
6	63.9	62.0	57.4	59.3	51.5	58.8 a
9	57.7	53.9	51.2	47.7	49.6	52.0 b
*Overall mean (effect of soy-beef mixture)	52.1a	56.5a	55.3a	54.5a	50.5b	

*Mean values within the same row with different superscripts are significantly different ($P<.05$)

Soy proteins have been reported to increase functional properties such as emulsification, water holding capacity and stability of the processed foods. Factors such as protein solubility and pH of media can influence the functional properties of soy protein (Crenwelge *et al.*, 1974, Hutton and Campbell, 1977). However, there are limits to which one can add TSP practically. Roberts (1974) reported that although soy protein can be used to replace 40 – 75% of meat protein, there are problems in texture and acceptance by the consumers. Thus in the United States, the USDA sets a maximum limit of not more than 30% soy protein (weight/weight) of the final product.

Cooking Loss

The percent cooking loss of soy-beef burgers is shown in Table 6. It was observed that cooking loss decreased significantly ($P<.05$) when more TSP is blended with the beef burger. The cooking losses at 0, 20, 30, 40 and 50% TSP addition were 30.2, 24.5, 22.9, 21.7 and 21.3% respectively. This is obviously due to the ability of TSP to hold more water after cooking. It was also observed that cooking losses in fresh soy-beef burgers were less compared to those stored up to six to nine weeks. Frozen storage for a long period has been known to exert negative effects on WHC and cooking loss in meat and meat products. Love (1966) and Maryman (1966) reported that ice crystal formation during frozen storage resulted in salt and pH changes that lead to protein denaturation and a loss of WHC. Reports by Wolford (1974); Yoon *et al.* (1974); Bowers and Engler 1975 and Smith *et al.* (1976) also indicated soy protein ability to reduce cooking loss when compared to products with 100% meat in it.

Sensory Evaluation

The results of the taste panel evaluation on the various quality attributes of soy-beef burger are summarized in Table 7 and 8. Table 7 showed the F-values, which indicate the significant effects of soy protein addition on factors such as flavour, colour, texture and taste.

Flavour, appearance, colour and texture atributes (Table 8). Panels were not able to differentiate the flavour with the addition of TSP at 20, 30 and 40%, although the distinction between 0% and 50% addition was obvious. Formulation without TSP addition was prefered compared to those with TSP. The addition of spices and beef flavour may have reduced the blend and beany flavour of TSP at 20, 30 and 40%, thus making it difficult for the panels to

TABLE 6
Mean values of % cooking loss of soy-beef burgers of five formulation stored for nine weeks at −18°C

Storage time (weeks)	Textured soy protein (%)					*Overall mean (effect of storage)
	0	20	30	40	50	
0	18.7	18.1	20.0	19.8	18.7	19.1 c
3	35.8	28.2	26.9	24.2	23.9	27.8 a
6	35.0	26.0	22.5	21.4	21.8	25.3 b
9	31.3	25.6	22.1	21.4	20.9	24.3 b
*Overall mean (effect of soy-beef mixture)	30.2a	24.5b	22.9b, c	21.7c	21.3c	

*Mean values within the same row with different superscript are significantly different ($P< 05$)

TABLE 7

F-values for taste panel evaluation on burger products containing five levels of soy protein[1] stored for four different times[2]

Souce of variation	Flavour	Appearance	Colour	Texture	Taste (soy bean/meat)	Taste (saltiness)	Taste (hotness)	Juiciness
Formulation	7.77*	1.73	39.86*	8.06*	68.44*	5.47	4.98	2.56
Storage (week)	3.50	4.67	5.56	3.13	2.12	0.28	1.45	5.46
Formulation x storage	4.09*	1.74	6.73*	1.67	1.63	3.04	0.65	1.17

*$P < 0.05$

[1] Levels of soy protein added at 0%, 20%, 30%, 40% and 50%.

[2] Storage times at 0, 3, 6 and 9 weeks.

detect significant differences. For appearance, the formulation with 50% TSP scored the lowest (2.92) compared to others. The effect of varying soy protein content on the appearance of soy beef burger was not significant. However, the addition of soy protein at 30, 40 and 50% resulted in very poor score (2.86, 2.68 and 2.21 respectively), for colour attribute. This is largely due to the dilution effect of the soy protein on the original colour of beef meat. No artificial colour was added in the soy-beef formulation, thus permitting panels to differentiate the products. In commercial meat processing in Malaysia, it is common practice to add artificial colour to the beef burger formulation. The effect of varying soy protein content on the texture of soy-beef burger was not significantly different. Similar findings on the texture attribute was reported earlier by Drake *et al.* (1975):

Saltiness, hotness/spiciness and beany taste attributes. In general, the increase in soy protein content from 0% up to 50% did not significantly affect the salt level as well as the hotness/spiciness of the soy-beef burgers. However, the score for hotness was higher with 40% and 50% soy protein addition. This may be due to the bland taste of soy protein, which consequently could intensify the strong taste of the spices that were not absorbed by the soy protein. The mean values for juiciness of burger products are also shown in Table 8. Additional soy protein showed no significant differences on this attribute. Although the physical tests carried out on WHC and cooking showed a significant increase in water retention, trained taste panels were not able to detect differences in juiciness among the five formulations. The different levels of soy protein significantly influenced the beany taste of the soy-beef product. An increase in the percentage of soy protein resulted in an increase in the beany taste, while also decreasing the meaty taste of the product. Levels of 30%, 40% and 50% soy protein received mean scores approaching the beany taste. Drake *et al.* (1975) reported similar findings in his experiments with soy-beef products.

Consumer acceptance. The mean values for acceptance of soy-beef burgers evaluated by sixty people are shown in Table 8. The acceptance of soy-beef burger was significantly higher when

TABLE 8

Mean values of various sensory evaluation attributes of soy-beef burgers at five levels of soy protein *1

Attributes	Content of soy protein (%)				
	0	20	30	40	50
Flavour	3.35 [a]	3.00 [b]	3.13 [a,b]	3.31 [a,b]	2.59 [c]
Appearance	3.11 [a,b]	3.21 [a]	3.15 [a,b]	3.21 [a]	2.92 [b]
Colour	3.58 [a]	3.22 [b]	2.86 [c]	2.68 [c]	2.21 [d]
Texture	2.78 [c,d]	3.04 [a,b]	2.88 [b,c]	3.21 [a]	2.56 [d]
Saltiness	3.21 [b]	3.28 [b,c]	3.06 [a,b]	3.32 [a,b]	3.36 [a]
Hotness/Spiciness	2.84 [a]	2.69 [b]	2.75 [b]	2.86 [b]	3.31 [a]
Juiciness	2.79 [b]	2.86 [b]	3.11 [a]	2.88 [b]	2.88 [b]
Beany taste	3.82 [a]	3.53 [b]	2.94 [c]	2.71 [c]	1.83 [d]
Overall	3.38 [a]	3.23 [a]	3.23 [a]	2.88 [b]	2.75 [b]

*Mean values with different superscripts are significantly different ($P < 05$).

[1] Overall mean; (effect of soy protein formulation).

[2] Mean value from 60 untrained panels, after 9 weeks storage.

less soy protein was formulated. Product formulation with 0%, 20% and 30% soy protein was acceptable but with those at 40% and 50% soy protein, the product was unacceptable to most consumers. However, the consumers were not able to differentiate between the three acceptable products. The maximum acceptable level of 30% addition of soy protein falls within the maximum limit of soy protein allowed by USDA (1973) on meat products.

CONCLUSION

This study on the blending of TSP into beef burgers indicates that there are many advantages of using soy protein in combination with meat products. Soy protein can serve as a functional ingredient in increasing water holding capacity and decreasing cooking loss thus yielding a product that is more juicy. Soy protein also serves as a partial replacement for conventional proteins such as beef and chicken which are expensive.

Sensory evaluation and acceptance test carried out from this study indicate that soy protein can be added up to 30% of the soy-beef formulation, without adversely affecting the overall acceptability of such products.

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