J Food Sci Technol (May–June 2010) 47(3):290–294
DOI: 10.1007/s13197-010-0045-x

ORIGINAL ARTICLE

Effect of soy protein isolate incorporation on quality characteristics and shelf-life of buffalo meat emulsion sausage

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Revised: 16 July 2009 / Accepted: 22 July 2009

Abstract Incorporation of soy protein isolate (SPI) at 0, 15, and 25% levels in buffalo meat was investigated for production, quality and shelf life evaluation of emulsion sausage (ES). Quality of ES was evaluated by pH, moisture content, thiobarbituric acid (TBA) number, total plate count (TPC), and Yeast and mold count, sensory, characteristics and instrumental colour and texture measurements. It was found that pH and moisture content were slightly affected, TBA number remained unaffected. TPC of ES fresh sample was found in the range 3.7–4.3 log cfu/g. ES was acceptable to the panelists and incorporation of SPI did not affect the acceptability. SPI incorporation increased Hunter L and b values but decreased a value and instrumental hardness. During storage (0°C), L, a, b values fluctuated irregularly. It was concluded that incorporation of SPI slightly improved texture, juiciness and colour of emulsion sausage.

Keywords Buffalo meat · Soy protein isolate · Emulsion sausage · Thiobarbituric acid value · Total plate count · Shelf-life

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Introduction

A major goal of the meat industry in recent years has been to develop healthier meat products, containing low fat and incorporating health enhancing ingredients. Fat has a major influence on the binding properties, tenderness, juiciness, mouth feel and overall appearance of processed meats such as emulsion type products. Soy protein isolate (SPI) is a promising source of soluble protein (Sofos and Allen 1977, Hand et al. 1987, Claus et al. 1989, 1990, Claus and Hunt 1991, Covestany et al. 1994).

Replacement of greater part of fat by thickening agents/meat extenders such as SPI provides lubricity, solubility and swelling. A fat mimick system influences texture properties in low fat food. Modi et al. (2009) conducted studies on quality changes in low fat mutton *kofta* produced by carrageenan as fat replacer in cooked products. They reported that *kofta* containing carrageenan was softer, had lower free fatty acid and exhibited marginal changes in Hunter L, a, b value.

Moisture content is an important property of emulsion sausage (ES) and it is related to sensory and textural characteristics. Greene and Cumuze (1981) reported on the basis of panelists evaluation that range of thiobarbituric acid (TBA) number for which the panelists as a group first detected a difference in oxidized flavour was in the range of 0.6–2.0. Ranken and Kill (1993) described microbiological quality in terms of microbial count/g 10^2-excellent quality, 10^4-good commercial quality,10^6-rejection limit in many commercial conditions, 10^8-meat and meat products smell and 10^9-meat become slimy. Instrumental texture measurement quantifies physical textural changes. Sofos and Allen (1977) conducted studies on effects of lean meat source and levels of fat and soy protein on the properties of wiener-type products the effect of different meat sources (beef, pork, beef hearts) and of varying fat and textured soy protein (TSP) levels on properties of wiener-type products. Beef was found to give a more stable emulsion than pork and

beef hearts in high fat (30%) and TSP (25%) formulations. High levels (45%) of hydrated TSP did not adversely affect emulsion stability of formulations low in fat (10%). Toughness, caused by lowering the fat levels, was improved by inclusion of pork without causing adverse effects on emulsion stability when low levels (5%) of SPI were used. By lowering the fat and increasing the soy level, a high-protein-low-fat wiener was produced.

The objective of our study was to assess the effect of SPI on quality characteristics of low fat ES from buffalo meat.

Materials and methods

Buffalo meat 6 kg mainly from round portion of adult female buffalo (aged 4–5 years) carcass of good finish were obtained within 5 h of slaughter. Buffalo fat (2 kg) from brisket and back was procured along with buffalo meat. The meat and fat were chilled at 2°C for 20 h. Other non meat-ingredients like spices, salt, condiments, fibrous casing (35 mm dia) and SPI were procured from local market.

The ES was prepared from comminuted mixture of meat, fat, salt, condiments and SPI. The recipe was: meat (3 kg), fat (300 g.), spices mix (36 g), salt (75 g), garlic paste (60 g) and SPI (400 g). Buffalo meat and fat were ground in a grinder (Model TC12 E, PRS Technology, Bombay, India). The ground buffalo meat and fat were transferred to bowl cutter and chopped for 2 min, half quantity of ice cubes (250 g) were added to reduce the temperature, which encouraged emulsion formation. Spices, condiments and SPI and remaining part of ice cubes (250 g) were added at the end of chopping. After chopping, meat stuffing into casing was done firmly and carefully by stuffing machine (Model ZE 31, PRS Technology, Bombay, India). After stuffing the mix into casing, open end was tied. ES was packed in casing, stored at 0°C and evaluated for quality characteristics.

Analytical methods: pH of meat samples were determined by digital pH meter (Model XT 22, Metzer, New Delhi, India). The electrode of pH meter was calibrated with the help of 2 buffer solutions of pH 4 and 7. Ten g of finely ground sample were blended in 50 ml of distilled water in a test tube in a Cyclo Mixer (CM-101,Yorco, New Delhi, India). The extract was filtered through Whatman Nr 1 filter paper. Electrode of pH meter was dipped in the filtrate and the sample pH recorded.

Moisture content of sausage was evaluated as given in Food Industry Manual (Ranken and Kill 1993) by using hot air oven (Model ASO, Yorco, New Delhi, India) thermo statistically controlled at 150 ± 5°C.

TBA number: This was measured by the method as described by Strange et al. (1997). The absorbance of prepared samples were measured at 530 nm in a Spectrometer (Model 310E, Electronic corporation of India, Hyderabad, India).

The samples were analyzed for total plate count (TPC, 37°C, 48 h, nutrient agar) and yeast and mold count (Potato dextrose agar, 3°C, 48 h) according to standard procedures (APHA 1992). Nutrient agar and potato dextrose agar were procured from Hi-Media, Mumbai, India.

Sensory characteristics of ES were evaluated on 9-point Hedonic rating tests (Ranganna 1994) for colour, flavour, texture, taste, mouth feel, juiciness and overall acceptability using 5–10 judges of different age group having different eating habits.

Instrumental colour: The sample of ES was made flat by pressing. The tip of Hunter Lab (Mini scan XE plus, USA) instrument was kept over the samples at room temperature (25°C) and L, a, b values measured.

Instrumental texture analysis was performed by Texture Analyzer (Texture Analyzer Heavy Duty, TAHD, England) using Warner–Bratzler blade. The probe measured the hardness of ES. The setting conditions were pre test speed = 2 mm/sec, test speed = 1 mm/sec, post test speed = 5 mm/sec, rupture test = 1 mm/sec, Distance = 50 mm and Force = 50 g.

Statistical analysis: Data collected from six experiments on different characteristics were subjected to analysis of variance as described by Cochron and Cox (1992).

Results and discussion

Physicochemical and microbiological quality: The pH of ES samples ranged 5.7–6.8 in fresh condition. pH values of SPI sample were higher (6.7–6.8) (Table 1) than control samples because of buffalo meat being slightly acidic in nature. Cooking also cause increase by pH of 0.2- 0.7 unit (Polanne et al. 2001). During refrigerated storage, pH values decreased marginally.

The control ES had moisture content of 65.5%. Incorporation of SPI decreased moisture content significantly ($p < 0.05$) (Table 1). A gradual decrease in moisture content of ES was observed during refrigerated storage (0°C). Rate of moisture reduction was higher in control ES compared with SPI – ES. Linear regression equations ($Y = -3X + 64.13$, $Y = -2.22X + 62.64$, $Y = -3X + 61.55$, Y: Moisture content and X: Storage period in days) best fitted to the experimental data. It was indicated by correlation coefficient, which ranged from 0.8872 to 0.9996.

TBA number: Increasing levels of SPI increased TBA number of ES (Table 1). Rate of increase of TBA number in control ES was lower when compared with SPI incorporated ES during refrigerated storage. During storage, TBA number increased. All samples were found to be in safe limit of TBA number till the end of storage. Previous reports indicated that meat products having TBA number from 0.5 to 1.0 possessed no off flavour (Tarladgis et al. 1960). Watts (1962) advocated that values of TBA number in the range 1 to 2 mg mA/kg was minimum detectable level for oxidized flavour in beef and its products.

Microbiological quality: The TPC (log cfu/g) of ES was in the range of 3.7–4.4 in fresh condition (Table 1). The TPC of ES did not differ significantly ($p < 0.05$) as a result of SPI incorporation. During refrigerated storage (0°C) the

TPC increased and was in the range 6.4–6.7 log cfu/g on 28th day of storage. Ranken and Kill (1993) described the spoilage condition at 10^7/g of bacteria. The results are also in an agreement with Hytiainen et al. (1975). Yeast and mold was not detected in sausage sample till 21 days of refrigerated storage (0°C). On 28th day, yeast and mold count was in the range 2.2 to 2.4 log cfu/g (results not shown).

Hunter colour measurement: The Hunter L and b values increased and a values decreased after incorporation of SPI (Table 1). It is clear that the addition of SPI improved brightness and reduced darkness. During storage, marginal fluctuations in L, a and b values were observed indicating no definite trend.

Instrumental hardness: SPI decreased hardness and improved tenderness (Table 1). During refrigerated storage (0^0C), hardness increased till 14 days followed by decline on further storage. The increase in force was due to increase in compactness during ripening of sausage during 14 days of storage (Rizawi et al. 2008) and decline in hardness after 14 days could be due to bacterial activity.

Table 1 Changes in physico-chemical, microbiological and textural quality characteristics of buffalo meat emulsion sausage containing different levels of soy protein isolate (SPI) during storage at 0°C

	Storage period, days				
	0	7	14	21	28
		pH			
S1	5.7 ± 0.02 ap	5. 7 ± 0.06 ap	5.6 ± 0.04 ap	5.6 ± 0.03ap	5.6 ± 0.02 ap
S2	6.7 ± 0.02 bp	6.7 ± 0.02 bp	6. 7 ± 0.12 bp	6.6 ± 0.01bp	6.6 ± 0.01 bq
S3	6.8 ± 0.30 bp	6.7 ± 0.05 bp	6.7 ± 0.07 bp	6. 7 ± 0.07 bp	6.6 ± 0.04 bq
Moisture content %					
S1	65.5 ± 0.02 ap	63.9 ± 0.03 aq	60.1 ± 0.02 bq	57.4 ± 0.01cr	55.5 ± 0.03 cr
S2	62.5 ± 0.01 bp	60.2 ± 0.02 bp	58.3 ± 0.02 cp	55.4 ± 0.02 cr	52.3 ± 0.02 cr
S3	59.6 ± 0.02 cp	58.5 ± 0.02 cp	56.3 ± 0.02 dq	55.5 ± 0.03 dq	50 ± 0.02 dr
TBA number, mg MA/kg					
S1	0.26 ± 0.02 ap	0.28 ± 0.03 ap	0.30 ± 0.02 bp	0.34 ± 0.01 bq	0.38 ± 0.03 bq
S2	0.28 ± 0.01 ap	0.29 ± 0.02 ap	0.32 ± 0.02 bp	0.35 ± 0.02 bp	0.39 ± 0.02 bq
S3	0.28 ± 0.02 ap	0.31 ± 0.02 aq	0.33 ± 0.02 aq	0.37 ± 0.03bq	0.40 ± 0.02 cq
Peak force (+ve) measured as hardness, g					
S1	3150.5	3225.4	3250.2	3200.3	3155.1
S2	3100.4	3115.5	3200.4	3150.5	3100.3
S3	3025.3	3100.3	3155.3	3145.3	3050.2
Hunter colour L					
S1	39.6 ± 0.47 ap	40.1 ± 0.63 ap	37.0 ± 0.56 aq	39.6 ± 0.56 aq	41.1 ± 0.64 aq
S2	42.3 ± 0.35 bp	38.9 ± 0.54 b	45.5 ± 90.49 bq	47.9 ± 0.44 bq	54.1 ± 0.67 cr
S3	50.2 ± 0.28 cp	47.5 ± 0.71cp	47.8 ± 0.61cp	49.5 ± 0.59 cp	52.1 ± 0.55 cq
Hunter colour a					
S1	14.7 ± 0.37 ap	11.3 ± 0.53 aq	16.2 ± 0.45 ap	11.4 ± 0.27 bq	10.2 ± 0.39 bq
S2	10.7 ± 0.31 bp	13.4 ± 0.44 bq	10.6 ± 0.38 bp	11.1 ± 0.29 bp	12.1 ± 0.52 bq
S3	8.7 ± 0.49 cp	11.1 ± 0.63 cq	9.3 ± 0.62 cr	9.2 ± 0.32 cr	7.6 ± 0.37cr
		Hunter colour b			
S1	18.4 ± 0.27ap	16.9 ± 0.28 aq	16.9 ± 0.19 aq	16.2 ± 0.22 aq	13.1 ± 0.28 br
S2	18.9 ± 0.34 ap	19.9 ± 0.39 aq	12.9 ± 0.25 cr	13.2 ± 0.31 cr	14.1 ± 0.37 cr
S3	21.1 ± 0.33 bp	20.7 ± 0.24 bp	15.0 ± 0.35 cq	13.1 ± 0.27 cq	10.2 ± 0.26 dr
Standard plate count, cfu/g					
S1	3.7 ± 0.30 ap	4.4 ± 0.05 ap	5.3 ± 0.07 aq	6.24 ± 0.07aq	6.7 ± 0.19 aq
S2	4.2 ± 0.02 ap	5.1 ± 0.02 ap	6.2 ± 0.12 bq	6.4 ± 0.01bq	6.4 ± 0.01 bq
S3	4.4 ± 0.08 ap	5.2 ± 0.01 ap	6.3 ± 0.01 bq	6.4 ± 0.02 bq	6.5 ± 0.01 bq

S1- control emulsion sausage; S2-emulsion sausage with 15% SPI, S3-emulsion sausage with 25% SPI.
Values followed by different letters in a row (a,b,c ---) and in a column (p,q,r) differ significantly ($p < 0.05$) (n = 6).

Table 2 Changes in sensory characteristics of buffalo meat emulsion sausage containing different levels of soy protein isolate

	Storage period, days				
	0	7	14	21	28
Colour					
S1	7.8 ± 0.52 ap	7.3 ± 0.22 ap	7.1 ± 0.12 ap	7.0 ± 0.12 aq	6.8 ± 0.52 aq
S2	8.1 ± 0.52 bp	7.8 ± 0.52 bp	7.6 ± 0.42 bp	7.3 ± 0.22 bp	7.1 ± 0.52 bq
S3	8.2 ± 0.52 bp	8.0 ± 0.22 bp	7.8 ± 0.52 bp	7.6 ± 0.52 bq	7.4 ± 0.22 bq
Flavour					
S1	7.6 ± 0.23 ap	7.2 ± 0.12 ap	7.0 ± 0.52 ap	6.8 ± 0.22 ap	6.6 ± 0.12 bq
S2	7.8 ± 0.52 ap	7.6 ± 0.12ap	7.3 ± 0.32 ap	7.2 ± 0.22 bp	7.0 ± 0.12 bq
S3	7.9 ± 0.42 ap	7.8 ± 0.12 ap	7.6 ± 0.12 ap	7.4 ± 0.52 bp	7.2 ± 0.32 bq
Texture					
S1	7.8 ± 0.12 ap	7.7 ± 0.32 ap	7.4 ± 0.22 ap	7.10 ± 0.12 bp	6.8 ± 0.22 bq
S2	7.9 ± 0.42 ap	7.7 ± 0.22 ap	7.5 ± 0.52 bp	7.4 ± 0.12 bq	7.3 ± 0.42 bq
S3	7.8 ± 0.52 ap	7.6 ± 0.52 ap	7.4 ± 0.12 ap	7.3 ± 0.22 bp	7.2 ± 0.52 bq
Taste					
S1	7.9 ± 0.32 ap	7.8 ± 0.52 ap	7.6 ± 0.12 ap	7.3 ± 0.50 bp	7.0 ± 0.52 bq
S2	8.0 ± 0.12 bp	7.8 ± 0.52 bp	7.7 ± 0.22 bp	7.6 ± 0.12 cp	7.5 ± 0.52 cp
S3	8.1 ± 0.22 bp	8.0 ± 0.42 bp	7.8 ± 0.52 cp	7.7 ± 0.32 cp	7.6 ± 0.52 cp
Mouth feel					
S1	7.1 ± 0.20 ap	6.7 ± 0.42 bp	6.5 ± 0.32 bp	6.2 ± 0.52 bp	6.2 ± 0.12 bp
S2	7.1 ± 0.20 ap	6.7 ± 0.42 bp	6.5 ± 0.32 bp	6.2 ± 0.52 bp	6.2 ± 0.12 bp
S3	7.1 ± 0.20 ap	6.8 ± 0.42 bp	6.5 ± 0.32 bp	6.2 ± 0.52 bp	6.2 ± 0.12 bp
Juiciness					
S1	7.6 ± 0.13 ap	7.5 ± 0.12 ap	7.3 ± 0.52 ap	7.0 ± 0.32 bq	6.8 ± 0.52 bq
S2	7.8 ± 0.52 ap	7.6 ± 0.12 ap	7.5 ± 0.52 ap	7.4 ± 0.22 ap	7.2 ± 0.52 bq
S3	7.8 ± 0.52 ap	7.7 ± 0.22 ap	7.6 ± 0.52 ap	7.5 ± 0.12 ap	7.3 ± 0.52 bq
Overall acceptability					
S1	7.7 ± 0.23 ap	7.6 ± 0.52 ap	7.4 ± 0.12 ap	7.1 ± 0.12 bq	7.0 ± 0.32 bq
S2	8.0 ± 0.52 bp	7.9 ± 0.12 bp	7.8 ± 0.22 bp	7.6 ± 0.52 bp	7.5 ± 0.32 bq
S3	8.2 ± 0.52 bp	8.0 ± 0.32 bp	7.9 ± 0.52 bp	7.8 ± 0.32 bp	7.7 ± 0.52 bp

Sensory characteristics: In most of the cases, the sensory scores were between 8 and 7, which represented the condition between liked very much and liked moderately (Table 2). Colour, texture, juiciness and taste had higher score as a result of SPI incorporation. Soy fiber incorporation also improved texture, juiciness and mouth feel of the products (Todd et al. 1989, Pszcola 1991, Troutt et al. 1992, Thebaudin et al. 1997, Desmond et al. 1998, Mansoor and Khalil 1999). Scores of different attributes decreased during refrigerated storage (0°C). The products were sensorily acceptable up to 28 days of storage.

Conclusion

Incorporation of SPI brought considerable change in physico-chemical, microbiological, sensory and textural characteristics of low fat emulsion sausage. In sensory characteristics, colour, texture and juiciness quality improved. In instrumental colour measurement, L and b values increased while a value decreased after incorporation of SPI. Instrumental hardness decreased due to addition of SPI.

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