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Effect of soaking and boiling soybean on quality parameters of soy flour

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Abstract
The evaluation of quality parameters of soy flour prepared from soaked and boiled soybean was carried out at the department of Agricultural Process Engineering, CAE & T, VNMKV, Parbhani (Maharashtra). Soybean variety JS -335 was selected for this study. Soybean was procured from Soybean Processing Center, VNMKV, Parbhani. Whole unbroken soybean free from infestations was selected for study purpose. The soaked and boiled soybeans were milled to obtain soy flour. Evaluation of quality parameters viz., moisture content, protein content, bulk density, dispersibility, water absorption capacity and color of soy flour samples was performed as per the standard procedures. It is revealed that increase in soaking and boiling time of soybean seeds did not show any significant effect on moisture content of soy flour samples. The significant difference in protein content was observed in soy flour samples. However, as soaking and boiling time increased bulk density of samples increased. The dispersibility of soy flour samples decreased significantly. The result also showed that water absorption capacity increased significantly with increase in soaking and boiling time. Also it is seen that there was non significant difference in colour values of soy flour samples prepared from soaked and boiled soybeans.

Keywords: soy flour, dispersability, water absorption capacity, soaked and boiled soybean

Introduction
Soybean plays a major role in the world food trade. It has about 42% and 56% of area and production, respectively of total oilseeds. The current global production of soybean is around 283.1 million MT with USA being the largest producer. Globally, in 2014-15. India ranks 5th in the area and production of soybean after USA, Brazil, Argentina and China. The contribution of India in world soybean area and production is about 7.8% and 4.2%, and is 108.834 lakh hectare and 104.366 lakh MT respectively. In India Madhya Pradesh state contributes about 55.462 lakh hectare in total area and 60.249 lakh MT production of soybean while Maharashtra state contributes about 38.008 lakh hectare in total area and 30.721 lakh MT production of soybean. The states like Madhya Pradesh, Maharashtra and Rajasthan together contributes about 97% total area and 96% production of soybean in the country (Anonymous, 2015).
Soy flour is most widely used in baked goods 2-15% is added to breads, crackers, muffins, donuts, cakes, rolls, cookies, tortillas, or chapattis. In baked goods, soy flour increases the storage life and nutritional value, while adding moisture as needed with little or no increase in cost. Also it is also used in pasta products, processed meats, gravies, sauces, soups, cereals, prepared mixes, dairy substitutes, candies, special diet foods and spice bases. In other products, it generally lowers the cost and improves the functional properties by serving as a conditioner, emulsifier, moisture retainer, antioxidant etc. (William *et al*, 2004). Hence the quality parameters viz., moisture content, protein content, bulk density, dispersibility, water absorption capacity and colour were evaluated for soy flour prepared from soaked and boiled soybean.

Materials and Methods
Procurement of Soybean
Soybean variety JS -335 was selected for the study on the basis of popularity and yield. Soybean was procured from Soybean processing center, VNMKV, Parbhani. Whole unbroken soybean free from infestations was selected for study purpose.

Preparation of soy flour from soaked and boiled soybean
1 kg clean soybeans which were free from dirt and other foreign material weighed and soaked

in water (seeds to water ratio 1:3) for one hour. Thereafter, 29 soybeans were boiled in water (seeds to water ratio 1:5) in a water bath at 100 ^{o}C temperature for 15 minutes and dried in tray dryer at 60 ^{o}C temperature till constant weight was obtained. During drying, soybeans were stirred at interval of 30 minutes to ensure uniform drying. The dried soybeans were milled to obtain soy flour. Soy flour obtained was finally packaged in packaging material due to hygroscopic nature of soy flour, then used for analysis. Similarly soybeans were soaked in water for 2, 3 and 4 hrs and boiled for 15, 30, 45 and 60 minutes respectively and dried in tray dryer at 60 ^{o}C temperature till constant weight was obtained. The soy flour was then prepared by milling dried soybeans.

Moisture content

A 5 gm sample was taken in a tare moisture box and was weighed accurately using a single pan digital balance of 0.0001 g sensitivity to get the exact weight of the sample. It was kept in hot air electric oven maintained at temperature of 105 ± 1 ^{o}C for 4 hours. The sample was taken out of oven, cooled in desiccators and weighed to determine the moisture content.

$$\text{Moisture content (\%)} = \frac{\text{Wt. of original sample} - \text{Wt. of dried sample}}{\text{Wt. of original sample}} \times 100$$

Protein content

The protein content was determined by Micro- Kjeldahl's apparatus.

Bulk density

The bulk density of soy flour was determined by the method of (Wang *et al.*, 1976) [12]. 5 g of the sample was weighed into 50 ml graduated measuring cylinder. The samples were packed by gently tapping the cylinder on the bench top 10 times from height of 5cm. The volume of the sample was recorded.

$$\text{Bulk density (g/ml)} = \frac{\text{Weight of the sample}}{\text{Volume of the sample after tapping}}$$

Dispersibility

Dispersibility was determined using the method described by (Kulkarni *et al.*, 1991). Ten grams of the flour sample was weighed into 100 ml measuring cylinder, water was added to each volume of 100 ml. The set up stirred vigorously and allowed to stand for three hours. The volume of settled particles was recorded and subtracted from 100. The differences reported as percentage dispersibility.

% Dispersibility = 100 - volume of settled particle

Water absorption capacity

In a weighed centrifuge tube 5 gm of sample and 30 ml of distilled water was added and material was suspended in water by mixing with a thin glass rod taking care to see that no sample adhered to the side of centrifuge tube. After holding for a period of 30 min, 10 ml of distill water was used to wash the sample adhering to the stirring rod and centrifuge tube if any. The suspension was then centrifuged at 3000 rpm for 15 min. The supernant liquid was discarded and the tube kept mouth down at an angle of 15-20 in forced draught air oven at 50 ^{o}C. It was placed in desiccators at the room temperature and subsequently weighed. Water absorption capacity was calculated as the amount of water retained by 100 g of sample and expressed in percent. (Bodhankar, 1992).

$$\text{WAC} = \frac{\text{V1-V2)} \square \text{þ}}{\text{Weight of sample}} \text{ x } 100$$

V1 = Initial volume of water used
V2 = Volume of water remaining (not absorbed)
þ = Density of water (1 g/cm3)

Colour

Colour (L, a, b values) of the samples were determined by using colour flex EZ colorimeter, which gave values of: a) Luminosity (L) or sample whiteness which was the total reflection of light in a scale (0 to100), where 0 represents perfect black and 100 perfect white; b) Shade or "a" parameter, known as the predominant wave length, where negative values shows a tendency to red colour, and c) the colour intensity or "b" parameter where negative values show a tendency to blue colour and positive values a tendency to yellow colour. The a*, b* were converted into hue angle (tan-1 b*/ a*) and chroma ((a*2+ b*2)1/2) (Agrahar and Jha, 2010).

Results and Discussion

The results of quality parameters viz., moisture content, protein content, bulk density, dispersibility, water absorption capacity and color of soy flour prepared from roasted soybean are presented in table 1.

Moisture content

The results pertaining to analysis of variance of soy flour samples prepared from soaked and boiled soybean for moisture content are given in table 1. A maximum moisture content was obtained 5.97% for soy flour prepared from 4 hr soaked and 60 min boiled soybeans and minimum moisture content was obtained for soy flour prepared from1 hr soaked and 15 min boiled soybeans i.e. 5.32%. From the data, it is also revealed that increase in soaking and boiling time of soybean seeds did not show any significant effect on moisture content of soy flour samples. It may be attributed to high cell damage due to long boiling time that resulted in high moisture retention. The results of the present study regarding moisture content are in line with the results of the previous study done by Mubarak (2005) for mungbean flour.

Protein content

From table 1, it was observed that protein content of soy flour prepared from 1 hr soaked and 15 min boiled soybean to 4 hr soaked and 60 min boiled soybean was found to be decreased with increase in soaking and boiling time. The protein content of raw soy flour was observed to be 38.82%. The protein content of soy flour prepared from 1 hr soaked and 15 min boiled soybean to 4 hr soaked and 60 min boiled soybean ranged from 38.51% to 37.45%. The significant difference in protein content was observed in soy flour samples. These observations are in agreement with those reported by Mubarak (2004) for mungbean, Alajaji *et al.*, (2006) [2] for chickpea and Nwaoguikpe *et al.*, (2011) [10] for mucuna pruriens seeds (velvet beans).

Table 1: Quality parameters of soy flour prepared from soaked and boiled soybean

Parameters	Moisture content (%)				Protein content (%)				Bulk density (g/cm^3)			
Treatment	B1	B2	B3	B4	B1	B2	B3	B4	B1	B2	B3	B4
S1	5.32	5.43	5.55	5.63	38.51	38.34	38.4	37.76	0.56	0.62	0.66	0.69
S2	5.41	5.52	5.67	5.76	38.37	38.23	37.94	37.64	0.57	0.63	0.67	0.70
S3	5.57	5.65	5.79	5.86	38.21	38.13	37.81	37.53	0.58	0.64	0.68	0.72
S4	5.68	5.73	5.89	5.97	38.10	37.92	37.74	37.45	0.60	0.65	0.70	0.74
Source	SE		CD		SE		CD		SE		CD	
Soaking (S)	0.199		NS		0.189		0.545		0.011		0.011	
Boiling (B)	0.199		NS		0.189		0.545		0.011		0.031	
S x B	0.397		NS		0.376		1.090		0.022		NS	

***** Significant at 5% level
NS Non significant
Where,
S1B1 = Soy flour prepared from 1 hr soaked and 15 min boiled soybean
S2B2 = Soy flour prepared from 2 hr soaked and 30 min boiled soybean
S3B3 = Soy flour prepared from 3 hr soaked and 45 min boiled soybean
S4B4 = Soy flour prepared from 4 hr soaked and 60 min boiled soybean

Table 2: Quality parameters of soy flour prepared from soaked and boiled soybean

Parameters	Dispersibility (%)				Water absorption capacity (%)				L* value			
Treatment	B1	B2	B3	B4	B1	B2	B3	B4	B1	B2	B3	B4
S1	60.19	58.42	57.94	55.03	238.28	241.32	245.84	249.46	83.68	83.39	83.18	82.83
S2	59.45	57.13	55.64	54.26	240.35	243.69	247.94	250.19	83.63	83.31	83.11	82.77
S3	58.74	56.38	54.05	53.57	242.36	244.18	249.79	253.43	83.57	83.26	83.05	82.68
S4	57.64	55.38	52.87	51.31	243.82	246.28	251.55	255.47	83.54	83.17	82.92	82.60
Source	SE		CD		SE		CD		SE		CD	
Soaking (S)	0.165		0.478		1.607		NS		0.257		NS	
Boiling (B)	0.165		0.478		1.607		4.662		0.257		NS	
S x B	0.329		0.955		3.213		NS		0.514		NS	

***** Significant at 5 percent level
NS Non significant

Table 3: Quality parameters of soy flour prepared from soaked and boiled soybean

Parameter	a* value				b * value				Hue angle				Chroma			
Treatment	B1	B2	B3	B4	B1	B2	B3	B4	B1	B2	B3	B4	B1	B2	B3	B4
S_1	0.67	0.94	1.22	1.29	25.58	25.29	24.66	24.25	88.49	87.87	87.16	86.95	25.58	25.30	24.68	24.28
S_2	0.72	0.99	1.27	1.35	25.51	25.22	24.53	24.13	88.38	87.75	87.03	86.79	25.52	25.23	24.56	24.16
S_3	0.79	1.03	1.31	1.42	25.45	25.16	24.46	24.04	88.22	87.65	86.93	86.61	25.46	25.18	24.49	24.08
S_4	0.83	1.11	1.35	1.49	25.38	25.07	24.33	23.88	88.12	87.64	86.82	86.42	25.39	25.09	24.35	23.92
Source	SE		CD		SE		CD		SE		CD		SE		CD	
Soaking (S)	0.029		NS		0.233		NS		0.482		NS		0.259		NS	
Boiling (B)	0.029		NS		0.233		NS		0.482		NS		0.259		NS	
SxB	0.049		NS		0.466		NS		0.865		NS		0.418		NS	

NS Non significant

Bulk density

From table 1, it reveals that bulk density of soy flour increased from 0.56 g/cm3 for soy flour prepared from1 hr soaked and 15 min boiled soybeans to 0.74 g/cm3 for soy flour prepared from 4 hr soaked and 60 min boiled soybeans. As soaking and boiling time increased bulk density of samples increased. Similar results observed by Kajihausd *et al*., (2014) for sesame seed flour.

Dispersibility

From table 2, the dispersibility of soy flour sample ranged from 60.19% for soy flour prepared from 1 hr soaked and 15 min boiled soybeans to 51.13% for soy flour prepared from 4 hr soaked and 60 min boiled soybeans. The dispersibility of soy flour samples decreased significantly. These observations were in agreement with those reported by Kajihausd *et al*., (2014) sesame seed flour.

Water absorption capacity

From table 2, it reveals that water absorption capacity of soy flour prepared from soaked and boiled soybean ranged 238.28% for soy flour prepared from 1 hr soaked and 15 min boiled soybean to 255.47% for soy flour prepared from 4 hr soaked and 60 min boiled soybeans. The result shows that water absorption capacity increased significantly with increase in soaking and boiling time.

Colour

The results of analysis of color parameters viz., lightness, redness, yellowness, hue and chroma of raw and soy flour samples prepared from soaked and boiled soybeans are shown in table 1. From table 1, it is seen that there was non significant difference in colour values of soy flour samples prepared from soaked and boiled soybeans.

Soy flour prepared from 1hr soaked and 15 min boiled soybean has higher L* value i.e. 83.68 and lower for soy flour prepared from 4 hr soaked and 60 min 57 boiled soybean i.e. 82.60. The lightness of soy flour was decreased further with increasing soaking and boiling time. The redness of soy flour varied from 0.67 to 1.49 for soy flour prepared from 1 hr

soaked and 15 min boiled soybeans to soy flour prepared from 4hr soaked and 60 min boiled soybeans. The increase in redness of soy flour was observed. The yellowness of soy flour ranged from 25.58 to 23.88 for soy flour prepared from 1 hr soaked and 15 min boiled to 4hr soaked and 60 min boiled soybean. From the data it was observed that yellowness of soy flour samples decreased as soaking and boiling time increased. Hue angle was largest in soy flour prepared from 1 hr soaked and 15 min boiled soybeans i.e. 88.49 and smallest for soy flour prepared from 4hr soaked and 60 min boiled soybeans i.e. 86.42. Hue angle was found to be decreased in soy flour samples with increase in soaking and boiling time. Similarly chroma values were found to be decreased from 25.58 to 23.92 for soy flour samples prepared from 1 hr soaked and 15 min boiled to 4hr soaked and 60 min boiled soybean.

Conclusion

It is revealed that increase in soaking and boiling time of soybean seeds did not show any significant effect on moisture content of soy flour samples. The significant difference in protein content was observed in soy flour samples. However, as soaking and boiling time increased bulk density of samples increased. The dispersibility of soy flour samples decreased significantly. The result also showed that water absorption capacity increased significantly with increase in soaking and boiling time. Also it is seen that there was non significant difference in colour values of soy flour samples prepared from soaked and boiled soybeans.

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