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Rutuja Mane
Department of Agricultural Process Engineering, Dr. ASCAE&T Mahatma Phule Agricultural University, Rahuri, Maharashtra, India

Kailash Kamble
Department of Agricultural Process Engineering, Dr. ASCAE&T Mahatma Phule Agricultural University, Rahuri, Maharashtra, India

Vikram Kad
Department of Agricultural Process Engineering, Dr. ASCAE&T Mahatma Phule Agricultural University, Rahuri, Maharashtra, India

Vilas Salve
Department of Agricultural Process Engineering, Dr. ASCAE&T Mahatma Phule Agricultural University, Rahuri, Maharashtra, India

Ritu Kukde
Department of Agricultural Process Engineering, Dr. ASCAE&T Mahatma Phule Agricultural University, Rahuri, Maharashtra, India

Corresponding Author:
Rutuja Mane
Department of Agricultural Process Engineering, Dr. ASCAE&T Mahatma Phule Agricultural University, Rahuri, Maharashtra, India

Effect of soaking temperature on water absorption of soybean grains, nutritional content and sensory quality of soymilk

Rutuja Mane, Kailash Kamble, Vikram Kad, Vilas Salve and Ritu Kukde

Abstract
Soybean is an excellent source of protein. However, off-flavor is the most serious issue with raw soybeans. The purpose of this study was to determine the effect of soaking temperature on the proximate composition and sensory properties of soymilk made from the soybean varieties DS-228, KDS-753, JS-93-05, JS-335, and KDS-726.Three soaking temperature 30, 40 and 50 °C and constant time of 12 hr were considered in the experiment. The study revealed that soaking temperature had significant effect on water absorption of grains. Soymilk protein content was significantly affected by soaking temperature. A higher value (was observed at 40 °C soaking temperature. Soymilk fat content was significantly affected by soaking temperature.

Keywords: Soaking temperature, proximate composition, soybean and soymilk

Introduction
The soybean (*Glycine max* (L) Merrill, Leguminosae family) evolved in Eastern Asia. It originated in China between 1100 and 1700 BC (IITA, 2009). Soybeans were introduced into Nigeria for the first time in 1908. (Fennel, 1966). Soybean is an excellent source of quality protein (35-42%) and fat (16-27%), as well as vitamins and minerals. This makes it one of the most valuable and widely grown crops. On a dry matte basis, soybean seeds have 5.6 - 11.5% moisture, 32 - 43.6% crude protein, 15.5 - 24.7% crude fat, 31.7 - 31.85% carbohydrate, 4.5 - 6.4% ash, 10 - 14.9% neutral detergent fibre (NDF), and 9 to 11.1% acid detergent fibre (ADF) (Goyal *et al*., 2012) [5]. Soymilk is one of the most affordable sources of high-quality protein and is commonly used as a dairy substitute. Whole soymilk is said to contain 90% moisture, 3.6% protein, 2.0% fat, 2.9% carbohydrate, and 0.5% ash. Soymilk contains 8% to 10% solids (Khursheed and Suthar, 2010) [6].

Materials and Methods
a. Materials
Whole soybean (Glycine max) seeds were used in the experiment. Clean and good-quality soybean grains obtained from the seed technology, MPKV, Rahuri. All chemicals used were of analytical grade.

b. Soybean Soaking Procedure
Sample of Soybeans were soaked in hot water of temperature 30 °C, 40 °C and 50 °C in hot water bath in the ratio of 1:3(w/v) for 12 hours. For each soaking temperature three replications were taken.

c. Production of soymilk

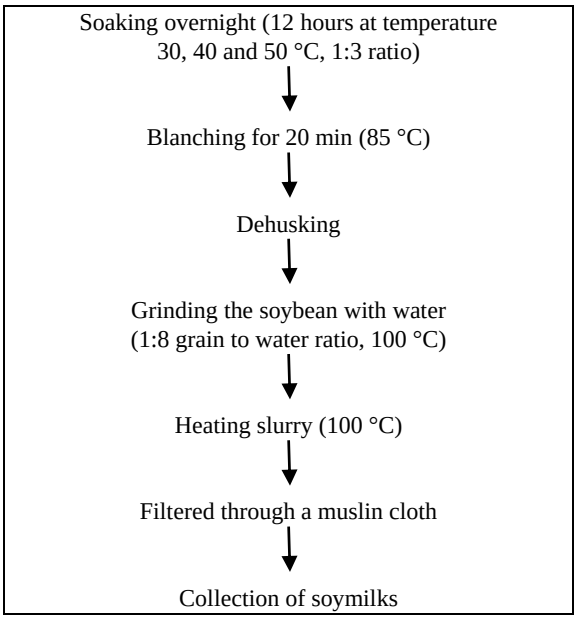

Fig 2: Flowchart for processing of soybeans into soymilk.

d. Determination of proximate composition

All the samples were subjected to (AOAC, 1995) method of analysis for crude protein, fat, pH and total ash at laboratory of animal husbandry and dairy science and laboratory of Agricultural Process Engineering, MPKV, Rahuri. As per the procedure recommended in I.S.I. Hand Book of Food Analysis, Dairy Products, Part 1 (1980). The proximate composition of the samples was carried out by the methods described by (AOAC 2012) while the Protein Content was determined by means of a micro-Kjedhal method which comprises distillation, titration and wet digestion. Fat (%) Percentage of fat was determined as per the procedure recommended in I.S.I. Hand Book of Food Analysis, Dairy Products, Part 1 (1980). This was determined using a hand-held pH/mV/Temperature meter (Model 1Q240, San Diego, USA) attached to a stainless steel.

Results and Discussion

a. Effect of soaking temperature on water absorption

Table 1. shows water absorption by the grains of soybean at 30 °C increased from 65% to 129.68% after 12 hours of soaking for variety DS-228. Water absorption by the grains of DS-228 at 40 °C found increased from 79% to 133.26% after 12 hours of soaking and grain soaking at 50 °C found increased 84% to 134.12% after 12 hrs of soaking.

Table 2. shows water absorption by the grains of soybean variety KDS- 753 at 30 °C found increased from 52% to 131.86% after 12 hours of soaking. Water absorption by the grains at 40 °C found increased from 62% to 133.58% after 12 hours of soaking and grain soaking at 50 °C found increased from 75% to 135.34% after 12 hrs of soaking.

Table 3 shows water absorption by the grains of soybean variety JS-93-05 at 30 °C found increased from 40% to 135% after 12 hours of soaking. Water absorption by the grains at 40 °C found increased from 67% to 136.81% after 12 hours of soaking and grain soaking at 50 °C found increased from84% to 138.25% for 12 hours.

Table 4. shows that water absorption by the grains of soybean variety JS-335 at 30 °C found increased from 50% to 129.58% after 12 hours of soaking. Water absorption by the grains at 40 °C found increased from 62% to 130.76% after 12 hours of soaking and grain soaking at 50 °C found increased from 78% to 134.14% after 12 hrs of soaking.

Table 5. shows that water absorption by the grains of soybean variety KDS-726 at 30 °C found increased from 40% to 114.55% after 12 hours of soaking. Water absorption by the grains at 40 °C found increased from 45% to 115% after 12 hours of soaking and water absorption soaking at 50 °C found increased from 60% to 115% after 12 hrs of soaking.

It was found that water absorption by the grains at soaking temperature 50 °C found maximum than 30, 40 °C soaking temperature. Similar results find by yang *et al.*, 2016.

Table 1: Effect of soaking temperature and variety DS-228 on water absorption of grains.

Time(hr)	30 °C	40 °C	50 °C
1	65.75	79.6	84.35
2	79.7	85.68	92.1
3	92.8	94.7	107.19
4	99.95	103.35	107.9
5	106.9	105.10	108.30
6	108.3	108.69	109.99
7	109.5	110.9	111.75
8	112.8	113.6	113.65
9	114.3	116.09	115.2
10	117.45	118.65	119.9
11	122.28	124.42	129.03
12	129.68	133.26	134.12

Table 2: Effect of soaking temperature and variety KDS-753 on water absorption of grains.

Time (hr)	30 °C	40 °C	50 °C
1	52.47	62.25	75.15
2	67.5	79.29	88.13
3	78.11	75.51	97.72
4	86.45	92.26	104.33
5	92.503	100.37	106.25
6	96.95	104.9	107.32
7	104.35	109.32	112.7
8	110.65	113.5	112.85
9	112.85	114.9	115.5
10	117.86	117.3	118.53
11	123.23	126.13	125.90
12	131.86	133.58	135.34

Table 3: Effect of soaking temperature and variety JS-93-05 on water absorption of grains.

Time (hr)	30 °C	40 °C	50 °C
1	40.4	67.89	84.13
2	52.55	84.35	94.44
3	68.63	94.033	98.6
4	85.85	102.3	100.6
5	95.45	107.95	106.12
6	104.85	109.45	110.26
7	110.6	112.8	115.74
8	114.7	114.95	118.3
9	116.4	118.55	119.09
10	120.62	121.38	123.35
11	128.21	130.86	130.33
12	135	136.81	138.25

Table 4: Effect of soaking temperature and variety JS-335 on water absorption of grains.

Time(hr)	30 °C	40 °C	50 °C
1	51.033	62.50	78.4
2	68.23	74.3	93.1
3	82.95	89.7	96.4
4	93.75	97.61	101.85
5	102.15	103.06	103.6
6	104.6	107.35	109.95
7	110.48	111.44	110.1
8	113.15	112.6	116
9	113.35	114.05	116.45
10	115.466	115.866	118.55
11	120.35	122.69	126.06
12	129.58	130.76	134.14

Table 5: Effect of soaking temperature and variety KDS-726 on water absorption of grains.

Time (hr)	30 °C	40 °C	50 °C
1	40.45	45.05	59.6
2	54.67	64.6	80.97
3	70.51	79.6	87.19
4	81.27	85.93	102.24
5	95.59	95.25	103.25
6	103.05	104.65	105.6
7	104.94	106.23	106.25
8	110.08	111.7	109.96
9	110.66	112.95	112.5
10	114.55	115.7	116.04
11	119.4	120.72	122.93
12	127.26	128.2	132.82

b. The effect of variety and temperature on nutritional component of soymilk

The effect of five different varieties on nutritional component of soymilk is depected in the Table 6 It shows that for protein content of soyben variety KDS-753 (3.87 gm) is significantly superior than all varieties at par with soyben variety JS-335 (3.77 gm) and JS-93-05(3.75 gm). Ash content of soyben variety JS-93-05(0.725 gm) showes significantly superior than all varieties at par with soyben varieties KDS-753(0.71 gm), JS-335(0.70 gm) and KDS-726 (0.68 gm). pH of soybean variety JS-93-05 (6.783 gm) showes significantly superior than all varieties at par with JS-335 (6.762 gm) and KDS-753 (6.729 gm). Fat content of soyben variety KDS-726 (2.414 gm) shower significantly superior than all vaieties at par with DS-228 (2.199 gm). Also effect of variety was significant on TSS of soymilk.

The effect of three temperature on nutritional component of soymilk is depected in Table 7 It shows that for protein content at soaking temperature 30 °C (4.059 gm) is significantly superior than other temperature. Ash content at soaking temperature 30 °C (0.784 gm) shows significantly superior than other temperature. The pH at soaking temperature 40 °C (6.783) shows significantly superior than other temperature at par with 30 °C (6.541) and for fat 50 °C (2.535 gm) shows significantly superior than other temperature. The effect of soaking temperature was significant on TSS of soymilk.

The interaction effect of varieties and temperature on nutritional component of soymilk shows non-significant effect. Similar results found by Zeritu Shashego, 2019 [15].

Table 6: Effect of variety on nutritional component of soymilk

Variety	Protein	Ash	pH	Fat	TSS
V1(DS-228)	3.67	0.618	6.39	2.20	6.60
V2(KDS-753)	3.88	0.710	6.729	2.17	7.13
V3(JS-93-05)	3.76	0.725	6.783	2.17	6.72
V4(JS-335)	3.78	0.705	6.762	2.08	6.32
V5(KDS-726)	3.55	0.68	6.02	2.41	7.46
CD @5%	0.16	0.05	0.348	0.19	0.11
SE(m)	0.06	0.017	0.093	0.075	0.04

Table 7: Effect of temperature on nutritional component of soymilk.

Temperature	Protein	Ash	pH	Fat	TSS
T1(30 °C)	4.059	0.784	6.541	1.948	7.47
T2(40 °C)	3.700	0.655	6.783	2.137	7.08
T3(50 °C)	3.417	0.626	6.281	2.535	5.99
CD@ 5%	0.143	0.045	0.270	0.168	0.10
SE(m)	0.049	0.015	0.093	0.058	0.03

c. The Effect of Soaking Temperature on the Sensory Attributes of Soymilk

a. Colour

Temperature had a significant (p<0.05) effect on soymilk acceptability. Soymilk from DS-228 was found to have a significantly higher score 8 at 40 °C than at 30 and 50 °C. Consumer panellists preferred the product obtained at 40 °C. Based on the scale used on the evaluation sheet, the colour of the soybean milk obtained from the three soaking temperatures was above average. Heat treatment (blanching and hot water soaking) was known to reduce lipoxygenase enzyme, which deteriorate colour, allowing the soy milk to retain its natural colour. Soybean contained lipoxygenase enzyme, which oxidised carotenoid and chlorophyll piercements, according to Cauvain and Young (2001). Because the soybean was blanched prior to soaking, enzyme activation or colour oxidation may have been inhibited.

b. Flavour

There was no significant difference in flavour acceptance of soy milk between the three soaking temperatures 30 °C, 40 °C and 50 °C. All products had good flavour, which could be attributed to optimal blanching, which stopped the enzymatic activity that contributed to acceptable flavour. Blanching and soaking were found to be effective in preventing the development of rancid flavour in soy milk extracted with hot water.

The result shows that blanching and soaking reduced the beany flavour of soy milk to a greater extent.

c. Taste

There was no significant difference in taste acceptance of soy milk between the three soaking temperatures 30 °C, 40 °C and 50 °C. Variety had a significant influence (p<0.05) on soymilk taste, with a significantly higher score 7 at 40 °C and for the DS-228 variety.

d. Overall acceptability

Soaking temperature influenced the overall acceptability of soy milk, which was expressed as the sum of the effects of the selected parameters. Soybean treated at 40 °C with the DS-228 variety yielded a more acceptable product. Soy milk made from soaked soybeans was found to have lower acceptance at 30 °C and 50 °C. This demonstrated that soaking temperature had a significant impact on the overall acceptability of soy milk.

Table 8: Sensory analysis of soymilk.

Treatment	Description	Colour	Flavour	Taste	Overall acceptability
T1	DS-228, Soaking at 30 °C	6.67	7.33	6.00	6.67
T2	DS-228, Soaking at 40 °C	8.67	7.67	7.00	7.78
T3	DS-228, Soaking at 50 °C	7.00	6.67	5.67	6.44
T4	KDS-753, Soaking at 30 °C	6.33	7.33	5.67	6.44
T5	KDS-753, Soaking at 40 °C	8.00	7.33	5.33	6.89
T6	KDS-753, Soaking at 50 °C	6.00	7.00	5.67	6.22
T7	JS-93-05, Soaking 30 °C	6.33	6.67	6.33	6.44
T8	JS-93-05, Soaking at 40 °C	7.33	6.33	5.67	6.44
T9	JS-93-05, Soaking at 50 °C	5.00	6.67	7.00	6.22
T10	JS-335, Soaking at 30 °C	5.33	6.67	6.67	6.22
T11	JS-335, Soaking at 40 °C	8.33	6.00	5.67	6.67
T12	JS-335, Soaking at 50 °C	5.67	5.67	5.67	5.67
T13	KDS-726, Soaking at 30 °C	5.00	6.67	6.67	6.11
T14	KDS-726, Soaking at 40 °C	7.67	6.33	6.67	6.89
T15	KDS-726, Soaking at 50 °C	4.67	6.67	6.33	5.89

Conclusion

Approximately 95 percent of the water was absorbed in soybean grains in the first six hours of soaking. After 12 hrs, the water absorption reached maximum of 136 percent of original weight of soybean grains. When hot water was used, soaking time of soybean grains can be reduced.

Soaking of soybean grains of variety DS-228 at 40 °C of water, yield most acceptable soymilk.

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