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Effect of different coagulants on textural properties of soypaneer

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Abstract
The experimental research work was conducted at the Department of Agricultural Process Engineering, CAE & T, VNMKV, Parbhani (Maharashtra) to study the effect of different coagulants viz. citric acid (0.2%), $CaSO_4$ (0.4%), $CaCl_2$ (0.4%), $MgSO_4$ (0.4%), $MgCl_2$ (0.4%), acetic acid (0.5%) and alum (2.5%) on textural properties of soypaneer. It is revealed from the study that the values of hardness, gumminess and chewiness of soypaneer prepared by using different coagulants varied widely due to differences in gel network influenced by different coagulants. The alum coagulated soypaneer having highest hardness value gives hard textured soypaneer with high value of cohesiveness (0.69). Similarly the magnesium coagulated soypaneer having the least value of hardness gives loose textured soypaneer with least value of cohesiveness (0.65). The type of coagulant had nonsignificant effect on the springiness values of soypaneer. The data also revealed that the effect of different coagulants on the adhesiveness values of soypaneer was found to be nonsignificant.

Keywords: soypaneer, coagulant, hardness, cohesiveness, adhesiveness

Introduction
Soypaneer is a gel-like food made by adding coagulants to soybean milk. Different coagulants like citric acid, calcium sulphate, calcium chloride, magnesium sulphate, magnesium chloride, acetic acid and alum are used to prepare soypaneer. Each of these coagulants produces soypaneer having different textural properties of soypaneer. For identification of best coagulant in terms of textural properties of soypaneer the study was carried out and the textural properties viz. hardness, gumminess, chewiness, cohesiveness, springiness and adhesiveness were evaluated through TPA (Texture Profile Analysis).

Materials and Methods
Procurement of Soybean
Well graded soybean (*JS-335)* was obtained from Seed Processing Plant, VNMKV, Parbhani (Maharashtra). The soybean grains were manually cleaned to remove foreign matter, dust, dirt, brokens and immature grains. Soybean was dehulled and soyadal was prepared in a dehuller.

Preparation of Soypaneer
Soymilk plant (Model: SC-20) was used for preparation of soymilk. 2 kg clean soyadal was soaked in water in the ratio of 1:3 (w/v) for 4 h. After soaking, the soaked water was decanted and the soyadal was washed manually by using clean water and the water was drained. Washed soyadal was ground with 12 lit water in the ratio of 1:6 (w/v) in the grinder. The ground slurry was boiled at 115 ºC at 19 psi pressure (1.33 kg/cm^2) by passing steam from the boiler into the grinder for 15-20 min. The cooked slurry was again stirred for 30 sec in the grinder. The slurry was released slowly from the grinder to the flashing chamber by switching on the vacuum pump and creating 280 to 300 mm of Hg vacuum inside the flashing chamber. The water flow of 2 lit/min was ensured at the vacuum pump. The water supply and power supply was closed when the pressure inside the grinder became zero. The slurry was drained from the flashing chamber to a filter press. The soymilk was squeezed and taken out through the outlet of filter press and the okara was retrieved from the filter bag of filter press. The soymilk was then coagulated using different coagulants viz. citric acid (0.2%), $CaSO_4$ (0.4%), $CaCl_2$ (0.4%), $MgSO_4$ (0.4%), $MgCl_2$ (0.4%), acetic acid (0.5%) and alum (2.5%) at 80ºC.

The coagulated mixture was left undisturbed for about 15 minutes. The coagulum was filtered with a muslin cloth and whey was separated from the solid. The solid was gently transferred and pressed in a pneumatic paneer press (3 bar pressure for 25 min). The textural properties (Hardness, Cohesiveness, Springiness, Gumminess, Chewiness and Adhesiveness) of soypaneer samples were evaluated using texture analyzer (TA. XT. Plus Texture Analyzer, Stable Micro System, UK). Ten replicate tests were carried out for each type of soypaneer. The typical textural profile curve (force-time curve) given by texture analyzer for each sample was used to determine the textural properties of soypaneer.

Results and Discussion

The textural properties like hardness, gumminess, chewiness, cohesiveness, springiness and adhesiveness of soypaneer prepared by using different coagulants were measured by Texture Analyzer (TA. XT. Plus Texture Analyzer, Stable Micro System, UK) and presented in Table 1.

Table 1: Textural properties of soypaneer prepared by different coagulants

Treatment	Coagulant	Hardness (g)	Gumminess (g)	Chewiness (g)	Cohesiveness	Springiness	Adhesiveness (g.s)
T1	Citric Acid	151.96	101.05	100.78	0.665	0.9973	- 0.140
T2	$CaSO_4$	143.36	94.90	94.82	0.662	0.9991	- 0.160
T3	$CaCl_2$	160.69	107.82	107.73	0.671	0.9991	- 0.110
T4	$MgSO_4$	80.21	52.06	51.87	0.649	0.9965	- 0.160
T5	$MgCl_2$	131.55	88.53	88.29	0.673	0.9973	- 0.160
T6	Acetic Acid	141.43	94.48	94.31	0.668	0.9982	- 0.150
T7	Alum	215.71	149.70	149.57	0.694	0.9991	- 0.100
	C.D.	9.380*	12.645*	10.546*	N.S.	N.S.	N.S.
	S.E.	3.063	4.129	3.443	0.058	0.048	0.018

* 5% level of significance ^{NS} Non significant

Hardness

It is seen from the Table 1 that the values of hardness of soypaneer prepared by using different coagulants varied widely. The alum coagulated soypaneer had the highest hardness value (215.71 g) followed by the hardness value of calcium chloride coagulated soypaneer (160.69 g). The least hardness value (80.21 g) was noticed in magnesium sulphate coagulated soypaneer followed by magnesium chloride coagulated soypaneer (131.55 g). The hardness values of calcium sulphate and acetic acid coagulated soypaneer were found to be 143.36 g and 141.43 g, respectively. The hardness value of soypaneer prepared by citric acid as a coagulant was found to be 151.96 g which was close to the hardness value of milk paneer (153.76 g).

The highest hardness value of soypaneer coagulated with alum is due to ability of alum to create a more dense structure of the soypaneer by making protein molecules closer due to loss of water during coagulation process. The higher hardness of alum coagulated soypaneer was also associated with low water holding capacity. Cai (1998) [1]. and Szczesniak (1998) [7]. reported that the low water holding capacity of soypaneer has been associated with higher hardness in soypaneer. The least hardness of magnesium sulphate coagulated soypaneer is due to incomplete precipitation of soy proteins resulting in less compact protein network containing many air gaps within it. The least hardness value of magnesium sulphate coagulated soypaneer is also due to high moisture content of this soypaneer. Similar observations of differences in textural characteristics as a result of coagulant were noted by Shen (1991) [6]. and Szczesniak (1998) [7]. The variation in hardness values of soypaneer is probably due to the differences in gel network influenced by different coagulants. The similar results of variation in hardness of soypaneer using different coagulants were observed by Conrad O Perera (2006).

Gumminess

Table 1 reveals that the value of gumminess of soypaneer was found to be highest in alum coagulated tofu (149.70 g) followed by the gumminess value of calcium chloride coagulated soypaneer (107.82 g) prepared in this experiment. The gumminess value of citric acid coagulated soypaneer was found to be 101.05 g. The least value of gumminess (52.06 g) was noticed in soypaneer prepared by magnesium sulphate coagulated soypaneer followed by magnesium chloride coagulated soypaneer (88.53 g). The gumminess values of calcium sulphate and acetic acid coagulated soypaneer were found to be 94.90 g and 94.31 g, respectively. As gumminess is defined as the product of hardness and cohesiveness, the gumminess values of soypaneer prepared by different coagulants showed the same trend as that of hardness values of soypaneer. The variation in gumminess values of soypaneer is due to the differences in gel network influenced by different coagulants. The similar results of variation in gumminess of soypaneer using different coagulants were observed by Conrad O Perera (2006).

Chewiness

It is seen from the Table 1 that the chewiness values of soypaneer prepared by using different coagulants showed the same trend as the trends shown by hardness and gumminess values of soypaneer prepared by the same coagulants. The least value of chewiness (51.87 g) was noticed in soypaneer prepared by magnesium sulphate coagulated soypaneer followed by magnesium chloride coagulated soypaneer (88.29 g). The highest value of chewiness of soypaneer was noticed in alum coagulated soypaneer (149.57 g) followed by calcium chloride coagulated soypaneer (107.73 g). The least value of chewiness of magnesium coagulated soypaneer is due to its least values of gumminess and springiness. Conversely the highest value of chewiness of alum coagulated soypaneer is due to its highest values of gumminess and springiness. The differences in textural characteristics as a result of coagulant could be attributed to the differences in gel network influenced by different coagulants. deMan (1986) reported that the texture and microstructure of soypaneer were greatly influenced by the type of coagulant used. Conrad O Perera (2006) also reported the similar observations of variation in textural properties of soypaneer prepared by different coagulants. The results of variation in textural properties of

soypaneer coagulated with different coagulants were also in agreement with Shen (1991) [6]. and Szczesniak (1998) [7].

The results of data analysis showed that the use of different coagulants had significant effect on hardness, gumminess and chewiness values of soypaneer coagulated with different coagulants.

Fig.1 shows the effect of using different coagulants on hardness, gumminess and chewiness values of soypaneer coagulated with different coagulants.

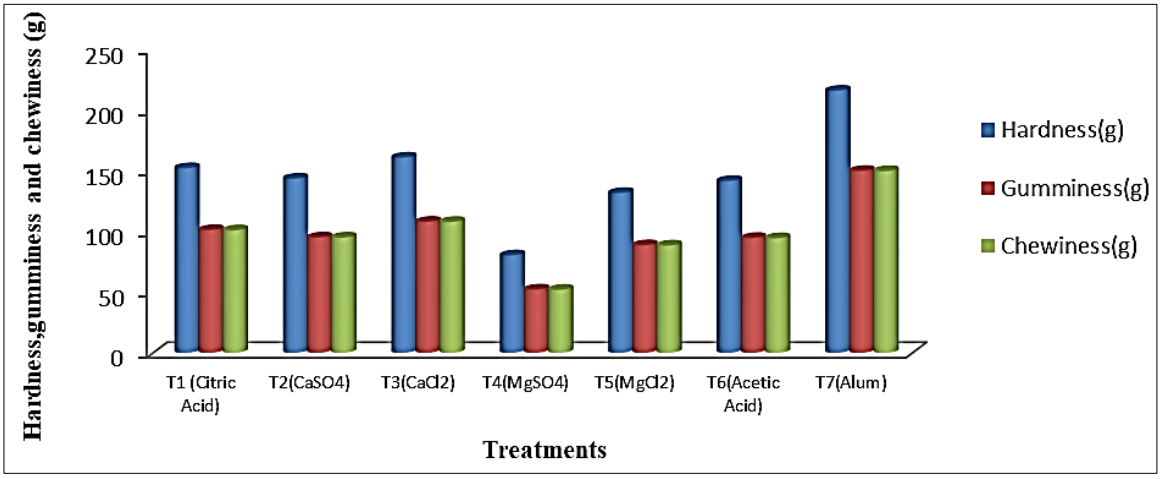

Fig 1: Effect of different coagulants on hardness, gumminess and chewiness of soypaneer

Cohesiveness

Cohesiveness values of soypaneer measured by Texture Analyzer (TA. XT. Plus Texture Analyzer, Stable Micro System, UK) are tabulated in Table 1. The values of cohesiveness of soypaneer were in the range of 0.65 to 0.69. The alum coagulated soypaneer having highest hardness value gives hard textured soypaneer with high value of cohesiveness (0.69). Similarly the magnesium coagulated soypaneer having the least value of hardness gives loose textured soypaneer with least value of cohesiveness (0.65). The highest value of cohesiveness of soypaneer coagulated with alum was due to more intensive protein network. Wang and Hesseltine (1982) noticed that the soypaneer with less intensive protein network had less cohesiveness. Hence the magnesium coagulated soypaneer showed the least value of cohesiveness. The variation in cohesiveness values of soypaneer may be due to different nature of protein matrix formed by different coagulants. However, the analysis of data indicates that the use of different coagulants in preparation of soypaneer had no significant effect on the values of cohesiveness of soypaneer in this study.

Springiness

The computed values of springiness of soypaneer prepared by different coagulants are presented in Table 1. The values of springiness of soypaneer were in the range of 0.9965 to 0.9991. From the analysis of data it is revealed that the type of coagulant had nonsignificant effect on the springiness values of soypaneer.

Adhesiveness

Measured values of adhesiveness are shown in Table 1. The values of adhesiveness of soypaneer were in the range of - 0.160 to - 0.100. The analysis of data revealed that the effect of different coagulants on the adhesiveness values of soypaneer was found to be insignificant.

The variation in textural properties of soypaneer is probably due to the differences in gel network influenced by different coagulants. The similar results of variation in textural properties of soypaneer using different coagulants were observed by Hou (1997) [4], Oboh (2005) and Conrad O Perera (2006). Poysa and Woodrow (2004) reported the variation in textural properties of soypaneer prepared by different coagulants. Veronica A. Obatolu (2008) stated that the the textural properties were significantly affected by different sources of coagulation.

Conclusions

The experimental research work revealed that the use of different coagulants had significant effect on hardness, gumminess and chewiness values of soypaneer. The higher hardness of alum coagulated soypaneer was associated with low water holding capacity. The use of different coagulants in preparation of soypaneer had no significant effect on the cohesiveness values of soypaneer. The type of coagulant had nonsignificant effect on the springiness and adhesiveness values of soypaneer.

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