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%), CaSO₄ (0.4%), CaCl₂ (0.4%), MgSO₄ (0.4%), MgCl₂ (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, broken grains 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 °C at 19 psi pressure (1.33 kg/cm²) 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 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%), CaSO₄ (0.4%), CaCl₂ (0.4%), MgSO₄ (0.4%), MgCl₂ (0.4%), acetic acid (0.5%) and alum (2.5%) at 80°C.
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 soya paneer 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 soya paneer. The typical textural profile curve (force-time curve) given by texture analyzer for each sample was used to determine the textural properties of soya paneer.

### Results and Discussion

The textural properties like hardness, gumminess, chewiness, cohesiveness, springiness and adhesiveness of soya paneer 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 soya paneer 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        | CaSO₄       | 143.36       | 94.90         | 94.82         | 0.662        | 0.9991      | -0.160              |
| T3        | CaCl₂       | 160.69       | 107.82        | 107.73        | 0.671        | 0.9991      | -0.110              |
| T4        | MgSO₄       | 80.21        | 52.06         | 51.87         | 0.649        | 0.9965      | -0.160              |
| T5        | MgCl₂       | 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 ** Non significant

### Hardness

It is seen from the Table 1 that the values of hardness of soya paneer prepared by using different coagulants varied widely. The alum coagulated soya paneer had the highest hardness value (215.71 g) followed by the hardness value of calcium chloride coagulated soya paneer (160.69 g). The least hardness value (80.21 g) was noticed in magnesium sulphate coagulated soya paneer followed by magnesium chloride coagulated soya paneer (131.55 g). The hardness values of calcium sulphate and acetic acid coagulated soya paneer were found to be 143.36 g and 141.43 g, respectively. The hardness value of soya paneer 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 soya paneer coagulated with alum is due to ability of alum to create a more dense structure of the soya paneer by making protein molecules closer due to loss of water during coagulation process. The higher hardness of alum coagulated soya paneer was also associated with low water holding capacity. Cai (1998) [1], and Szczesniak (1998) [2], reported that the low water holding capacity of soya paneer has been associated with higher hardness in soya paneer. The least hardness of magnesium sulphate coagulated soya paneer 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 soya paneer is also due to high moisture content of this soya paneer. Similar observations of differences in textural characteristics as a result of coagulant were noted by Shen (1991) [3], and Szczesniak (1998) [2]. The variation in hardness values of soya paneer is probably due to the differences in gel network influenced by different coagulants. The similar results of variation in hardness of soya paneer using different coagulants were observed by Conrad O Perera (2006).

### Gumminess

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

### Chewiness

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

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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.

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 0.100 to 0.160. 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). Poya and Woodrow (2004) reported the variation in textural properties of soypaneer prepared by different coagulants. Veronica A. Obatolu (2008) stated that 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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