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Studies on pressing pressure and pressing time on qualities of Soypaneer

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Abstract
The experimental research work was carried out at the department of Agricultural Process Engineering, CAE & T, VNMKV, Parbhani (Maharashtra) to study the effect of varying pressing pressure and pressing time on moisture content, yield, colour values (L^*, $a^*$and b^*) and sensory qualities of soypaneer. Soypaneer was prepared using 0.2% citric acid as a coagulant. Four levels of pressing pressure (1, 2, 3, 4 bar) and three levels of pressing time (15, 20, 25 min) were taken and soypaneer samples were prepared. The study revealed that the values of moisture content of soypaneer were found to decrease with increase in pressing pressure and pressing time. The yield of soypaneer decreased with increase in pressing pressure and pressing time due to removal of water from the soybean curd during its preparation. The study also indicated that the colour values (L^*, $a^*$and b^*) of soypaneer were not significantly influenced either by pressing pressure or by pressing time. The process variables *viz*. varying pressing pressure and pressing time did not show significant effect on colour and flavour of soypaneer. However, taste, body and texture and overall acceptability of soypaneer were found to be significantly affected by varying pressing pressure and pressing time. The pressing pressure of 3 bar and pressing time of 25 min were found to get desired qualities of soypaneer.

Keywords: Soypaneer, coagulant, soybean curd

Introduction
Soypaneer is one of the most nutritional products made from soybean. It is known as tofu in the orient. It is a coagulated and pressed soy protein, and used as a vegetarian food ingredient. Soypaneer is an appropriate alternate to milk paneer and gives all the nutritional advantages and psychological satisfaction of eating a paneer-dish. Soypaneer is, therefore, has a great potential to replace costly milk-paneer in the near future and provides an opportunity to low and middle income population to enjoy the delicacy of paneer dish at an affordable price.
Preparation of soypaneer generally includes soaking soybean in water, simultaneous grinding and cooking of soaked soybean, deodorizing, filtering soymilk from okara, coagulation of soymilk at 80 ºC temperature of soymilk, filtering coagulated solids from whey, molding and pressing of solids. As the quality of soypaneer depends upon its texture and sensory qualities of soypaneer, there is a lot of scope to study the effect of various parameters *viz*. soaking time, grinding time, type of coagulant, concentration of coagulant, pressing pressure, pressing time, etc. The textural properties of soypaneer are highly affected by the pressing pressure and pressing time used during preparation of soypaneer. Soypaneer should preferably have optimum firmness along with desired moisture content, yield and sensory parameters of soypaneer. For achieving better quality of soypaneer, there is a great need to standardize pressing pressure applied over the soybean curd and pressing time during preparation of soypaneer.

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 115ºC 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 at 80ºC with citric acid as coagulant (0.2%). 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.

The effect of pressing pressure and pressing time was studied as these parameters affect the removal of whey from the soypaneer which in turn affects textural as well as sensory properties of soypaneer. Four levels of pressing pressure (1, 2, 3, 4 bar) and three levels of pressing time (15, 20, 25 min) were decided and soypaneer samples were prepared.

Moisture content of soypaneer

The moisture content of fresh soypaneer was determined by oven dry method suggested by Ranganna (2000).

The moisture percent was measured in the form of loss in weight of soypaneer.

$$\text{Moisture content, \% (wb)} = \frac{\text{Initial weight (g) - Final weight (g)}}{\text{Initial weight (g)}} \times 100$$

Yield of soypaneer

The soypaneer after removing from the chilled water was wrapped by a clean muslin cloth to remove surface water. The weight of fresh soypaneer was taken by using electronic weighing balance. The soypaneer yield was measured as kg of soypaneer per kg of dry soyadal used for the preparation of soypaneer.

Colour measurement

The colour of soypaneer samples were measured using a Hunter Colour Lab Colour- Flex Colorimeter. The instrument was calibrated as per the procedure given in the reference manual with standard black and white tiles before testing the samples. The sample (20 g) was placed in the sample cup and the colour readings were taken in terms of L^*, a^* and b^* values. The L^* value ranges between 0 and 100 and was used as a measure of lightness. A lower value of L^* indicates darkness and higher value indicates lightness. Positive a^* value denotes redness and a negative value represents greenness. Positive b^* value denotes yellowness and negative b^* value represents blueness. Three replications of a soypaneer sample were taken for determination of colour.

Sensory evaluation

Sensory evaluation is the way of knowing acceptability of product using the senses, *viz*. sight, smell, touch, test, and hearing. It is also a way of simulating the consumer response by a few experienced judges. Hence a panel of ten judges comprising of faculty and students of the institutes was formed based on the preliminary screening by consideration of motivation and willingness of judges to test sample. A consumer acceptability sensory trial was conducted at Department of Agricultural Process Engineering, College of Agricultural Engineering and Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. Sensory evaluations of all the prepared soypaneer samples were done by the testing panel. They were asked to evaluate color, flavour, taste, body & texture, and overall acceptability by scoring a rate on a 9 point hedonic scale (9 = Like extremely, 8 = Like very much, 7 = Like moderately, 6 = Like slightly, 5 = neither like nor dislike, 4 = Dislike slightly, 3 = Dislike moderately, 2 = Dislike very much and 1 = Dislike extremely).

Results and Discussion

Effect of pressing pressure and pressing time on moisture content (%, wb) of soypaneer

Variations in moisture content of soypaneer prepared by varying pressing pressure and pressing time were noted and tabulated in Table 1. These variations indicate that when pressing pressure increased moisture content of soypaneer decreased. The maximum moisture content value (75.60%) was observed in soypaneer pressed at 1 bar pressure for 15 min followed by the moisture content value (73.10%) of soypaneer pressed at 1 bar pressure for 20 min. Table 1 also shows that minimum moisture content value (66.20%) was observed in soypaneer when it was pressed at 4 bar pressure for 25 min.

It is revealed from the analysis of variance that there was significant effect of pressing pressure and pressing time on moisture content of soypaneer. The interaction effect of pressing pressure and pressing time on moisture content of soypaneer was also found to be significant.

Table 1: Effect of pressing pressure and pressing time on m.c. (%, wb) of soypaneer

Pressing pressure (bar)	Pressing time (min)			
	15	20	25	
1 bar	75.60	73.10	72.70	
2 bar	72.20	71.80	71.40	
3 bar	71.10	70.80	69.50	
4 bar	67.90	67.10	66.20	
Analysis of variance				
Source of variation	**MSS**	**F-value**	**S.E.**	**C.D.**
Pressing Pressure (P)	72.132	72.125	0.333	0.979*
Pressing Time (T)	9.233	9.232	0.289	0.848*
P x T	0.999	0.999 ^{NS}	0.577	N.S.

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

Fig.1 shows decreasing trend in moisture content values of soypaneer when pressing pressure was increased from 1 to 4 bar and pressing time was increased from 15 to 25 min during its preparation. The decreasing trend in moisture content of soypaneer was due to removal of water from the soypaneer with increase in pressing pressure and pressing time. Similar decreasing trend of moisture content of soypaneer with increasing pressing pressure and pressing time was reported by Beddows (1987) [1], Gandhi (1988) [3], Murdia (2010) [6], Rekha (2013) [7] and Swati (2015) [8].

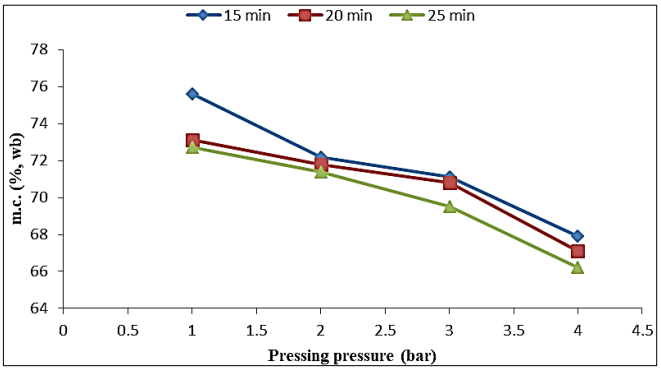

Fig 1: Effect of pressing pressure and pressing time on moisture content (%) of soypaneer

The following multiple regression equation was fitted with an R^2 value of 0.942.

$M = - 2.153X_1 - 0.175X_2 + 80.383$

where M is the moisture content and X_1 and X_2 are the pressing pressure in bar and pressing time in min, respectively.

The value of coefficient of pressing time was more as compared to the coefficient of pressing pressure which indicates that the effect of pressing time on moisture content of soypaneer was more than the effect of pressing pressure.

Effect of pressing pressure and pressing time on yield of soypaneer

The yields of soypaneer prepared by varying pressing pressure and pressing time were determined as kg of soypaneer per kg of dry soyadal used for preparation of soypaneer. The results are presented in Table 2. It is revealed from the table 2 that yields of prepared soypaneer decreased with increase in pressing pressure and pressing time. The maximum yield (1.437 kg) was observed in soypaneer pressed at 1 bar pressure for 15 min followed by the yield (1.401 kg) of soypaneer pressed at 1 bar pressure for 20min. Table 2 also indicates that minimum yield (0.922 kg) was noted in soypaneer when it was pressed at 4 bar pressure for 25 min. Decrease in yield of soypaneer with increase in pressing pressure and pressing time is due to removal of water from the soybean curd during its preparation. Similar findings were noted by Beddows (1987) [1], Gandhi (1988) [3], Murdia (2010) [6], Rekha (2013) [7] and Swati (2015) [8].

Table 2: Effect of pressing pressure and pressing time on yield (kg) of soypaneer

Pressing pressure (bar)	Pressing time (min)			
	15	20	25	
1 bar	1.437	1.401	1.377	
2 bar	1.360	1.325	1.257	
3 bar	1.241	1.159	1.032	
4 bar	0.971	0.941	0.922	
Analysis of variance				
Source of variation	**MSS**	**F-value**	**S.E.**	**C.D.**
Pressing Pressure (P)	0.370	146.539	0.017	0.049*
Pressing Time (T)	0.033	13.236	0.015	0.043*
P x T	0.004	1.669 ^{NS}	0.029	N.S.

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

The analysis of variance shows that yield of soypaneer was significantly influenced by pressing pressure and pressing time. However, the interaction effect of pressing pressure and pressing time on yield of soypaneer was found to be insignificant.

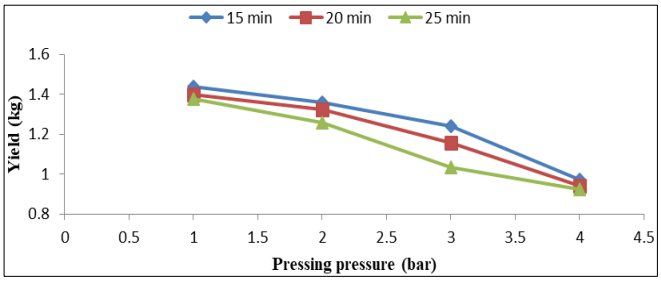

Fig 2: Effect of pressing pressure and pressing time on yield (kg) of soypaneer

The following multiple regression equation (R^2 = 0.956) showed that pressing pressure (X_1) and pressing time (X_2) had significant effect on yield of soypaneer. However, yield of soypaneer was more affected by pressing pressure than pressing time.

$Y = - 0.155X_1 - 0.011X_2 + 1.844$

where Y is the yield of soypaneer in kg, X_1 and X_2 are the pressing pressure in bar and pressing time in min, respectively.

Effect of pressing pressure and pressing time on colour values (L^*, a^*, b^*) of soypaneer

a) Colour value (L^*)

The colour values (L^*) of soypaneer prepared by varying pressing pressure and pressing time were measured by a Hunter Colour Lab Colour- Flex Colorimeter and are tabulated in Table 3. The colour values (L^*) of soypaneer varied from 77.07 to 77.91. An ANOVA was carried out to study the effect of varying pressing pressure and pressing time on colour values (L^*) of soypaneer. It is revealed from the ANOVA that the colour values (L^*) of soypaneer were not significantly influenced either by pressing pressure or by pressing time. The interaction effect of pressing pressure and pressing time on colour values (L^*) of soypaneer was also found to be nonsignificant. As the other process parameters *viz*. soyadal to water ratio (1:3 w/v), soaking time (4 h), grinding time (5 min), coagulant (citric acid 0.2%), coagulation temperature (80°C) were constant, nonsignificant effect of varying pressing pressure and pressing time was found on colour values (L^*) of soypaneer.

Table 3: Effect of pressing pressure and pressing time on colour value (L^*) of soypaneer

Pressing pressure (bar)	Pressing time (min)			
	15	20	25	
1 bar	77.41	77.84	77.67	
2 bar	77.53	77.47	77.07	
3 bar	77.26	77.91	77.51	
4 bar	77.41	77.53	77.26	
Analysis of variance				
Source of variation	**MSS**	**F-value**	**S.E.**	**C.D.**
Pressing Pressure (P)	0.179	0.179	0.333	N.S.
Pressing Time (T)	0.384	0.384	0.289	N.S.
P x T	0.108	0.108	0.577	N.S.

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

b) Colour value (a^*)

The measured colour values (a^*) of soypaneer prepared by varying pressing pressure and pressing time are tabulated in Table 4. The colour values (a^*) indicating redness of soypaneer were in the range of 2.68 to 3.25. It is revealed from the ANOVA that the pressing pressure and pressing time

had nonsignificant effect on colour values (a^*) of soypaneer. The interaction effect of pressing pressure and pressing time on colour values (a^*) of soypaneer was also found to be nonsignificant. As all other process parameters affecting colour of soypaneer were constant, the effect of pressing pressure, pressing time and their interaction was found to be nonsignificant.

Table 4: Effect of pressing pressure and pressing time on colour value (a^*) of soypaneer

Pressing pressure (bar)	Pressing time (min)			
	15	20	25	
1 bar	2.98	2.78	2.92	
2 bar	2.81	2.78	2.68	
3 bar	3.25	3.03	2.93	
4 bar	2.98	2.81	3.25	
Analysis of variance				
Source of variation	**MSS**	**F-value**	**S.E.**	**C.D.**
Pressing Pressure (P)	0.174	0.174	0.333	N.S.
Pressing Time (T)	0.073	0.073	0.289	N.S.
P x T	0.067	0.067	0.577	N.S.

* 5% level of significance NS Non significant

c) Colour value (b^*)

The effect of varying pressing pressure and pressing time on colour values (b^*) of soypaneer is presented in Table 5. The colour values (b^*) indicating yellowness of soypaneer were found to be in the range of 14.19 to 15.71. It is revealed from the ANOVA that the colour values (b^*) of soypaneer were not significantly influenced either by pressing pressure or by pressing time. The interaction effect of pressing pressure and pressing time on colour values (b^*) of soypaneer was also found to be nonsignificant.

Table 5: Effect of pressing pressure and pressing time on colour value (b^*) of soypaneer

Pressing pressure (bar)	Pressing time (min)			
	15	20	25	
1 bar	15.21	14.58	15.57	
2 bar	15.61	15.71	15.03	
3 bar	14.74	14.19	15.25	
4 bar	15.21	15.61	14.74	
Analysis of variance				
Source of variation	**MSS**	**F-value**	**S.E.**	**C.D.**
Pressing Pressure (P)	0.805	0.805	0.333	N.S.
Pressing Time (T)	0.094	0.094	0.289	N.S.
P x T	0.825	0.825	0.577	N.S.

* 5% level of significance NS Non significant

Effect of different pressing pressure and pressing time on sensory evaluation of soypaneer

Table 6 shows the results of sensory evaluation of soypaneer prepared by varying pressing pressure and pressing time for quality attributes such as colour, flavour, taste, body & texture and overall acceptability. The results were expressed on a 9-point hedonic scale. The highest score for overall acceptability (8.9) was observed in T9 treatment (3 bar, 25 min) followed by T8 treatment (3 bar, 20 min) having score 7.9. The lowest score for overall acceptability (3.1) was noted in T1 treatment (1 bar, 15 min) followed by T2 treatment (1 bar, 20 min) having score 3.2. The data in Table 6 indicates that the process variables *viz.* varying pressing pressure and pressing time did not show significant effect on colour and flavour of soypaneer. However, taste, body and texture and overall acceptability of soypaneer were found to be significantly affected by varying pressing pressure and pressing time.

Table 6: Effect of different pressing pressure and pressing time on sensory evaluation of soypaneer

Treatment	Colour	Flavour	Taste	Body and texture	Overall acceptability
T1(1bar,15min)	8.5	8.1	6.1^a	3.1^a	3.1^a
T2(1bar,20min)	8.3	8.2	6.4^a	3.3^a	3.2^a
T3(1bar,25min)	8.3	8.3	6.9^a	3.5^a	3.3^a
T4(2bar,15min)	8.4	8.3	7.1^b	3.7^a	3.5^a
T5(2bar,20min)	8.6	8.5	7.3^b	3.9^a	3.8^a
T6(2bar,25min)	8.6	8.6	7.5^b	4.2^b	4.1^b
T7(3bar,15min)	8.7	8.7	7.4^b	5.1^b	5.1^c
T8(3bar,20min)	8.8	8.7	8.5^c	7.8^c	7.9^d
T9(3bar,25min)	8.9	8.8	8.9^c	8.8^c	8.9^e
T10(4bar,15min)	8.8	8.7	8.5^c	7.8^c	7.2^d
T11(4bar,20min)	8.8	8.7	8.4^c	5.2^b	7.1^d
T12(4bar,25min)	8.7	8.6	8.3^c	4.1^b	4.3^b
C.D.	N.S.	N.S.	1.248*	0.997*	0.823*
S.E.	0.281	0.330	0.425	0.340	0.280

* 5% level of significance NS Non significant

Figures in the same column with same superscript do not vary significantly.

Fig.3 shows that quality attributes of soypaneer pressed at 3 bar pressure for 25 min (T9 treatment) were found to be most acceptable due to highest average scores in terms of colour, flavour, taste, body and texture and overall acceptability followed by soypaneer pressed at 3 bar pressure for 20 min (T8 treatment). The soypaneer prepared at 3 bar pressure for 25 min achieved the highest score (8.9) for taste followed by the score of soypaneers (8.5) prepared at 3 bar and 4 bar pressures for 20 min and 15 min, respectively. The taste of the soypaneer was significantly affected by varying pressing pressure and pressing time. Kohyama (1993) [5] reported that the taste of soypaneer is significantly affected by its final texture. The lower average scores for taste and overall acceptability for soypaneer were attributed to either loose or hard texture of soypaneer.

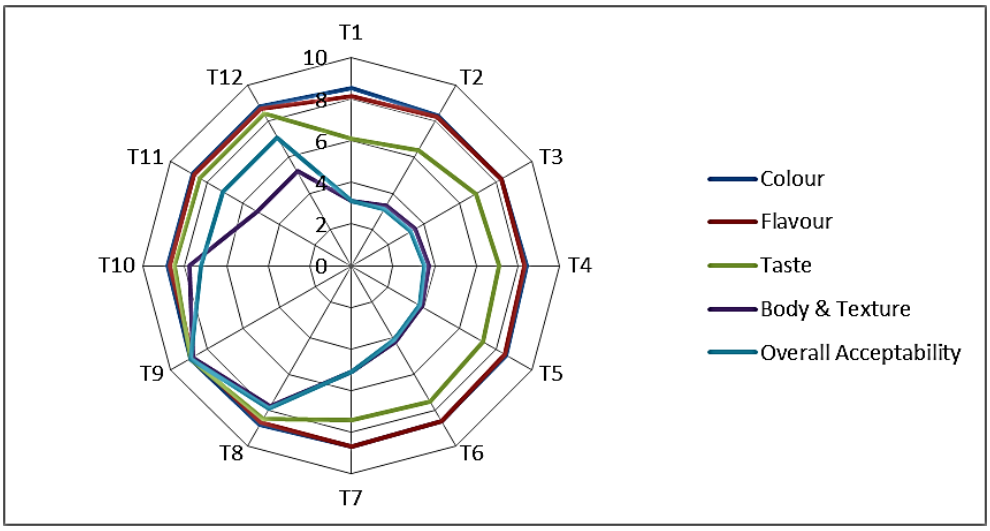

Fig 3: Effect of pressing pressure and pressing time on sensory evaluation of soypaneer

Conclusions

It is revealed from the study that the moisture content of soypaneer was found to decrease with increase in pressing pressure and pressing time due to removal of water from the soybean curd during its preparation. The yield of soypaneer was significantly influenced by pressing pressure and pressing time. However, the interaction effect of pressing pressure and pressing time on yield of soypaneer was found to be insignificant. The yield of soypaneer was more affected by pressing pressure than pressing time. The colour values (L^*, a^*, b^*) of soypaneer were not significantly influenced either by pressing pressure or by pressing time. The interaction effect of pressing pressure and pressing time on colour values (L^*, a^*, b^*) of soypaneer was also found to be nonsignificant. The process variables *viz*. varying pressing pressure and pressing time did not show significant effect on colour and flavour of soypaneer. However, taste, body and texture and overall acceptability of soypaneer were found to be significantly affected by varying pressing pressure and pressing time. The soypaneer prepared at 3 bar pressure for 25 min achieved the highest score (8.9) for taste followed by the score of soypaneers (8.5) prepared at 3 bar and 4 bar pressures for 20 min and 15 min, respectively.

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