Development of appropriate process for sprouting of soybeans

I.L. Pardeshi¹ and P.T. Tayade²

¹Associate Professor, ²M. Tech. Scholar, Department of Agricultural Process Engineering, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra), India - 444 104

Abstract

The wide spread use of soybeans can be ensured by the appropriate pre-processing on soybean by sprouting it. The soybean variety TAM-38 was used to establish the appropriate process for its sprouting. In order to optimize soaking time and number of rinsing, the experimentation was conducted using 4 levels of soaking time (2h, 4h, 6h and 8 h) and 7 rinsing (each at interval of 6 h) at room temperature of 28 ± 2°C. The responses like sprouting percentage, sprout length and overall acceptability found to be decreased with prolonged soaking time after 4 hours whereas the sprouting percentage, sprout length and overall acceptability were found to be increasing with number of rinsing upto 6 to 7 number of rinsing after 4 hours of soaking. The soybean seeds could be optimally sprouted by soaking in normal water for 4 h, followed by 6 to 7 numbers of rinsing at an interval of six hours.

Keywords: Soybean, processing, sprouting, rinsing, trypsin

Introduction

In India, on one hand, nutritional deficiency due to limited availability of pulses is prevailing while on another hand, soybean, the major and chief source of vegetable proteins, is having its utilization limited for oil purpose only. After appropriate processing like sprouting and converting into consumer friendly and health friendly sprouted soybean products, it would help to incorporate soybean in daily diet of Indian population. For this purpose, there is a need to establish an appropriate and foolproof process. This will help to ensure and adapt its routine use in the high soybean producing regions where malnutrition is still widely prevalent.

Soybean (Glycine max L.) described as “golden bean” has ensured its widespread consumption by strong evidence of low incident rate of breast, colon and prostate cancer or coronary diseases in the eastern countries (Plaza et al., 2003). Soybean is widely used in variety of food preparation (Sharma et al., 2001). The FDA (Food and Drug Administration) of United State confirms that soy protein, as part of a diet, low in saturated fat and cholesterol may significantly reduce the risk of coronary heart disease. The FDA recommends incorporating 25 g of soy protein in your daily meals (Anonymous, 2009a). Soybean is rich in sulphur containing amino acids, which make soy protein as most satisfying pulse protein as per FAO pattern (Manay and Shadaksharswamy, 2004). It is rich in minerals (calcium, phosphorus and iron) and vitamins (vitamin “A”, “D”, “E” and “K”) (Prasad et al., 2001). It plays important role in preventing and treating chronic diseases such as heart ailments, osteoporosis, cancer, kidney ailments and menopausal syndromes (Anonymous, 2009b).

On contrary to 50 g per head per day requirement of pulses recommended the ICMR, New Delhi (Singh, 2000) in Indian context, the per capita availability is merely 35 g per day per head and till declining for ever growing Indian
demography. In such circumstances, the pulse deficiency to the tune of 4 to 5 million tonnes per year, either should be met out by import of pulses or go without that. On other hand, soybean contains 40 % protein and 20 % oil, its 80 % utilization is limited to oil production only. This is due to anti nutritional factors associated with soybean. The incorporation of soybean, after proper processing, as vegetable protein source (pulse grain) in daily diets of Indians would help to combat the pulse deficiency and thereby, nutrition deficiencies at every stage of growth of human. Besides, farmers in Vidarbha region of Maharashtra State, India, are now switching over to soybean from cotton crops. In cotton districts of western Vidarbha, for instance, the cotton area in the 2007-08 kharif shows a decline to 10.7-lakh hectare from 11.5-lakh hectare last year, while that of soybean has jumped to 10.5-lakh hectare from 7-lakh hectare (Anonymous, 2008). This is being seen as hope of ray to overcome farmers’ suicide incidences in the region.

In general, increase in human consumption of soy products is limited because of its contents such as trypsin inhibitors, saponin and unavailable sugars like non-digestible oligosaccharides (NDO, i.e. α-galactose such as raffinose, stachyose and verbiscose). Trypsin inhibitor inhibits trypsin/ chemotrypsin, thus pose difficulties during protein digestion and saponin causes nausea and vomiting. The NDO sugars are notoriously known for the flatulence production in man and animals. These sugars escape digestion, when they are ingested due to lack of α-galactosidase activity in the mammalian mucosa. Consequently, the oligosaccharides are not absorbed into the blood and are digested by the microflora of the lower intestinal tract resulting in the production of large amount of carbon dioxide and hydrogen and small amount of methane (Manay and Shadaksharswamy, 2004; Wang et al., 2007). Whereas, trypsin inhibitors can be reduced by sufficient hydrothermal treatment and saponin eliminated by soaking prior to cooking but, NDO cannot be eliminated by usual soy processing (Leske et al., 1993). Many researchers have been carried out to reduce the oligosaccharide content in legume seeds or in soybean products by processing techniques such as soaking, cooking, germination, fermentation, autoclaving and enzyme treatment (Wang et al., 2007). Soybeans after fermentation are being used in China and Japan for over years. However, in Indian context, better utilization of soybean can be ensured by sprouting of soybeans. The sprouting followed by cooking of soybeans ensure more than 60 % reduction in flatulence effect in human intestine (Ali et al., 1988) besides multifold increase in Vit C and Vit A in spray dried powder of sprouted soymilk over non-sprouted soybean milk powder (Tayade, 2010).

Sprouting is the practice of soaking, draining and then rinsing seeds at regular intervals until they germinate, or sprout (Anonymous, 2009c). Sprouted soybean prevent the disease like cancer, lowering the level of blood cholesterol and reducing the risk of coronary heart disease, modulating the immune response and stimulating the minerals absorption (Wang et al., 2007). It also works as an antihypertensive and anti-diabetic agent and prevents the diseases like hypertension and diabetes (MaCue et al., 2005). Therefore, the aim of the study is to develop the appropriate process for sprouting of soybeans for further preparation of different convenient sprouted soy products.

Materials and Methods

Selection of Materials: The soybean grain variety, namely, TAMS-38 (white flour yielding variety) was procured from the Seed Technology Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra), India. The grain mass was cleaned and graded before further study.

Germination test of soybean grains: The germination test was carried out in Seed Technology Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra), India for determining the viability of soybean grain by using the standard method followed for testing the viability of soybean seed (Aggarwal, 1999).

Preparation of sprouted soybean: For preparation of sprouted soybean, 2 to 3 times as
much cool (30-32°C) water was added in weighed sample of soybean and mixed up with soybean grains to assure even water contact for all. The seed was allowed to soak for requisite time. The soaked soybean seeds were covered into the wet cloth and soaked water was drained off. The soaked sample were set anywhere out of direct sunlight at a room temperature between rinses for optimal sprouting. The sprouted soybeans were cleaned with running tap water, known as rinsing. The rinsing of soybeans needs to be done at an interval of 4 to 6 h and repeat it till the better sprouting is ensured (Soy sprouts better with more frequent rinses). While rinsing, the sprouts were not disturbed. The rinsing at regular interval was done still desired sprouting was achieved (Anonymous, 2009d).

In order to optimize soaking time (2 to 8 h) and number of rinsing (at interval of 6 h), the experimentation was conducted using 4 levels of soaking time (2 h, 4 h, 6 h and 8 h) and 7 rinsing (each at interval of 6 h) using Factorial Completely Randomized Design (FCRD). The responses were taken as percent sprouting, sprout length and overall acceptability. The overall acceptability of soy sprouts was carried out for sprouted soymilk samples prepared (Tayade, 2010) and served to six numbers of untrained judges was determined using 9-point hedonic scale (BIS, 1971). The experimentation was replicated thrice. The data was analyzed statistically using ANOVA (Singh, et al., 2008) at 5 % level of significance.

Results and Discussion

Development of sprouted soybeans: In order to study process for sprouting of soybeans, the testing of viability of soybean seeds and the experimentation on effect of process variables like soaking time and number of rinsing of soaked soybeans on sprouting of soybeans was conducted as discussed in Materials and methods.

Germination test of soybean seed: The seeds rolled in germination paper and germinated seeds are shown in Fig. 1. The data of germination test was replicated six times. In above experiment, it was observed that germination percentage for the grain used for the experimentation was 80% (S.D. ± 7 %).

Optimization of process parameters for sprouting of soybean: The experimentation on optimization of process parameters like soaking period (2 to 8 h) and number of rinsing (1 to 7) at an interval of 6 h i.e. up to 42 h for preparation of sprouted soybean was conducted and the results were depicted below.

Effect of soaking period and number of rinsing on sprouting: The effect of soaking time and number of rinsing on sprouting of soybean was studied and observations were recorded at average temperature of 27.4 to 28.5°C. The ANOVA (conducted at 5 % level of significance) (Singh et al. 2008) given in Table 1, showed that the sprouting percentage increased significantly with soaking period from 2 h to 4 h, thereafter decreased non-significantly up to 6 h of soaking. The soaking period less than four hours may be too less to impart sufficient soaking, leading to reduced percent sprouting. The further increase in soaking time, after 6 h, showed significant decrease in sprouting percentage of soybean. This may be due to the fact that at temperature (27.4 to 28.6°C) under consideration, the soaking of soybeans for more than four to six hours may be leading to anaerobic fermentation.
The number of rinsing also had significant effect on sprouting percent of soybean. It could be seen that (Table 1, Fig. 2), the percent sprouting increased significantly with number of rinsing up to fifth rinsing. Thereafter, with the further rinsing, the increase in percent sprouting of soybean was not significant. This showed that maximum possible sprouting could be accomplished up to five rinsing. This may be due to the fact that all the viable seeds available might have got sprouted, by this time. The maximum percent sprouting achieved i.e., 74 % was less than observed germination percent i.e. 80 %. The remaining 6 % soybean seeds might have got germinated after 30 hours during germination test or may the viability of these 6% seeds be affected by initial soaking. The sample of sprouted soybean (Fig. 3) reveals the effect of soaking period on percent sprouting after five rinsing (30 hours after soaking).

Effect of soaking period and number of rinsing on length of soy sprouts: The effect of soaking time and number of rinsing on length of soy sprouts was studied. The ANOVA (conducted at 5 % level of significance) (Singh et al., 2008) given in Table 1, showed that the length of soy sprouts increased significantly with soaking period from 2 h to 4 h, thereafter decreased significantly upto 8 h of soaking. The soaking period less than four hours may be too less to impart sufficient soaking, leading to reduced sprouting length. The more soaking period may be resulting in anaerobic fermentation of soaked soybeans, leading to decreased sprout lengths due to limited availability of reserved foods.

The number of rinsing also had significant effect on length of soy sprouts. It could be seen that (Table 1, Fig. 4), the length of soy sprouts increased significantly up to seventh rinsing. This indicated that further rinsing would lead to further increase in sprout length.

The behavior of single grain with respect to sprout length increasing with number of rinsing is shown in Fig. 5. The Fig. 5 shows that the soybean seed takes up water and gets swelled during soaking indicating increase in volume and thereby increase in equivalent diameter (Fig. 6) by 14.66 %. The sufficiently increased equivalent diameter (22.21 %) upto 2nd rinsing (12 h after soaking) indicated signs of sprouting.

The gradual increase in equivalent diameter after 2nd rinsing indicated gradual development of sprout i.e., increased sprout length (Fig.4 and Fig. 5).

Effect of soaking period and number of rinsing on sensory acceptability of soy sprouts: The effect of soaking period and number of rinsing on sensory overall acceptability of soymilk prepared from soy sprouts (Tayade, 2010) was determined (BIS, 1971). The data obtained, was analyzed statistically (Table 1) and represented in Fig. 7, indicated that overall acceptability was highest for samples sprouted after 4 h soaking and it decreased significantly either by reduction in soaking time upto 2 h or increase in soaking time up to 8 h. This may be due to the fact that at 2 h soaking, there could be insufficient soaking and at more than 6 h soaking, there may be possibility of fermentation leading to development of off smell of sprouts. The significant increase in overall acceptability of soy sprouts was found at 4th rinsing (i.e., at 24 h after soaking) and it was observed to be increasing up to 6th rinsing followed by non-significant change thereafter upto seventh rinsing. The increase in overall acceptability with increase in number of rinsing
Fig 3: Effect of soaking condition on sprouting

Fig 4: Effect of soaking time and number of rinsing on sprout length

Fig 5: Behaviour of single grain during sprouting
Fig 6: Effect of soaking and rinsing on equivalent diameter of sprouting soybeans

Fig 7: Effect of soaking time and rinsing interval on sensory acceptability
may be attributed to reduction in antinutritional factors especially non digestible oligosaccharides and typical beany flavour.

**Optimization of process for sprouting of soybeans:** The experimentation for determining effect process parameters i.e. soaking period and number of rinsing for preparation of sprouted soybean was conducted. The responses considered were percent sprouting, sprout length and overall acceptability. The observations recorded were statistically analyzed by using Analysis of Variance (ANOVA) as given in Table 1 (Singh et al., 2008). From Table 1, it is clear that the maximum percent sprouting, maximum sprout length and maximum overall acceptability was found in case of samples sprouted after 4h of soaking.

The percent sprouting was maximum after 5th rinsing and remained unchanged (statistically non significant increase) after 5th rinsing i.e., after 6th and 7th rinsing. The sprout length, mm was found to increase significantly even up to 7th rinsing. The overall acceptability found to be increasing significantly up to 5th rinsing and later on, the increase in overall acceptability was non-significant. In order to ensure, highest possible percent sprouting, highest possible sprout length and highest possible overall acceptability of soy sprouts, the 6 to 7 number of rinsing, after 4h of soaking, were considered to be optimum.

The optimal process followed for sprouting of soybean i.e., 4 h soaking and six to seven numbers of rinsing at an interval of 6 h is depicted in Fig. 8. The total weight gain during soaking for 4 h was about 121.70 %. Thereafter, steady increase in weight i.e. 4 to 5 % after each rinsing was observed up to 5th rinsing. After 5th rinsing, the weight gain by the sprouts was about 1.36 % only. The weight gain may be attributed to water uptake during rinsing. The variation in dry matter of sprouting sample was not tested; therefore, other possible reasons could not be explored. The rinsing and cleaning is most important factor for better sprouting. Regular rinsing and cleaning avoids stickiness developed on sprouting grains and off smell development (Wang et al., 2007) during sprouting and also helps for developing more sprouts.

**Table 1: ANOVA table showing the process parameter on soaking period and rinsing interval of sprouted soybean**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Soaking period</th>
<th>2h</th>
<th>4h</th>
<th>6h</th>
<th>8h</th>
<th>CD (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>% Sprouting</td>
<td>44.68&lt;sup&gt;a&lt;/sup&gt;</td>
<td>46.79&lt;sup&gt;b&lt;/sup&gt;</td>
<td>46.58&lt;sup&gt;b&lt;/sup&gt;</td>
<td>43.14&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.30</td>
</tr>
<tr>
<td>2.</td>
<td>Sprout length, mm</td>
<td>8.21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.89&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8.24&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.35&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.62</td>
</tr>
<tr>
<td>3.</td>
<td>Sensory acceptability</td>
<td>6.57&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.61&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.67&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.42&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Rinsing interval</th>
<th>6h</th>
<th>12h</th>
<th>18h</th>
<th>24h</th>
<th>30h</th>
<th>36h</th>
<th>40h</th>
<th>CD (5%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>% Sprouting</td>
<td>2.69&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>39.95&lt;sup&gt;b&lt;/sup&gt;</td>
<td>61.71&lt;sup&gt;c&lt;/sup&gt;</td>
<td>67.96&lt;sup&gt;d&lt;/sup&gt;</td>
<td>69.61&lt;sup&gt;d&lt;/sup&gt;</td>
<td>70.13&lt;sup&gt;d&lt;/sup&gt;</td>
<td>3.04</td>
</tr>
<tr>
<td>2.</td>
<td>Sprout length, mm</td>
<td>0.70&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.19&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.93&lt;sup&gt;b&lt;/sup&gt;</td>
<td>6.75&lt;sup&gt;c&lt;/sup&gt;</td>
<td>12.92&lt;sup&gt;d&lt;/sup&gt;</td>
<td>15.92&lt;sup&gt;d&lt;/sup&gt;</td>
<td>16.83&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.81</td>
</tr>
<tr>
<td>3.</td>
<td>Sensory acceptability</td>
<td>6.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.25&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.33&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.00&lt;sup&gt;b&lt;/sup&gt;</td>
<td>7.25&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.33&lt;sup&gt;c&lt;/sup&gt;</td>
<td>7.33&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.15</td>
</tr>
</tbody>
</table>

* Row wise value superscripted by similar letters differ non-significantly from each other.
Fig 8: Effect of soaking and rinsing interval on weight gain of soybean seeds during sprouting

Conclusions
For the present study soybean variety TAMS-38 was used. On the basis of the results obtained, it could be concluded that soybean seeds could be optimally sprouted by soaking it in normal water for 4 h, followed by six to seven numbers of rinsing at an interval of six hours at room temperature of (28 ± 2°C).

References
Development of appropriate process for sprouting of soybeans


