Food Chemistry **30** (1988) 181–190

Changes in the Quality of Soybean during Storage. Part 2—Effect of Soybean Storage on the Sensory Qualities of the Products made Therefrom*†

Ranjana Narayan, G. S. Chauhan & N. S. Verma

Department of Food Science and Technology,
G.B. Pant University of Agriculture and Technology, Pantnagar—263 145, India

(Received 2 September 1987; revised version received and accepted 20 January 1988)

ABSTRACT

The sensory qualities of products made from stored grains are directly related to the various physico-chemical and biological changes occurring in grains during storage. Three products—soymilk, tofu and soynuts—were prepared from soybeans of different storage periods and were evaluated for their sensory properties along with some chemical qualities. Total solids and protein in soymilk, as well as in tofu, decreased with the storage time, whereas colour, crispness and taste of soynuts were lost with increase in storage time of beans. Overall organoleptic score of all the products was found to decrease with increase in storage time of beans.

INTRODUCTION

With the increase in population and wide prevalence of protein malnutrition, attempts are being made to utilise protein from several unconventional sources (Liener, 1972). Soybeans, being nutritionally very important, are receiving priority in the field of production. However, with increasing production of soybeans, a proper technology for their storage is equally important in order to maintain quality and to reduce losses. The

* Research paper No. 5007 through the Experiment Station, G.B.P.U.A. & T., Pantnagar, Nainital U.P., India.

† Part 1 appeared in *Food Chemistry*, **27**, 13–23.

Food Chemistry 0308-8146/88/$03·50

importance of proper storage of this crop in India cannot be overlooked because proper storage serves as a flywheel between the demand and supply. Various physical, chemical and biological changes take place during storage depending on the storage conditions, storage time and condition of grains to be stored (Christensen & Kaufmann, 1969; Narayan *et al.*, 1987). These physical and chemical changes, when they reach a certain limit, cause the grains to deteriorate. The quality and acceptability of products made from these grains are also therefore affected. Biological changes are reflected in the physical, as well as in organoleptic, characteristics of the products. Thus the acceptability of products made out of stored grains directly relates to the various physico-chemical changes occurring in them during storage.

Since no information is available on the effect of storage on the sensory properties of products made from stored soybean, the present study was undertaken.

MATERIALS AND METHODS

Soybean seeds of the Bragg variety used in an earlier study by the authors (Narayan *et al.*, 1987) were employed for the preparation of the following products.

Soymilk

Cleaned soybeans were soaked in water overnight. After soaking, extra water was drained off and the soybeans were washed and rubbed to remove hulls. The cotyledons were then blanched with 0·5% sodium bicarbonate for 30 min with a cotyledons to water ratio of 1:5. Blanched splits were washed and ground with water (beans to water ratio of 1:8) followed by filtration through double layered cheese cloth. Soymilk, thus prepared, was boiled for 5–10 min without any loss in volume and treated with 7% sugar followed by cooling and flavouring with vanilla essence (Fig. 1). The soymilk was chilled and presented to a laboratory panel, consisting of nine members, for sensory evaluation. Soymilk samples were also subjected to analysis of protein and total solids.

Tofu (soy paneer)

Soybeans were soaked overnight and the hulls were removed by rubbing with hands. The dehulled cotyledons were ground with hot water and filtered through cheese cloth. The final volume was made up in the ratio of 1:6 (w/v) on a soybean weight basis. The soymilk was boiled and cooled

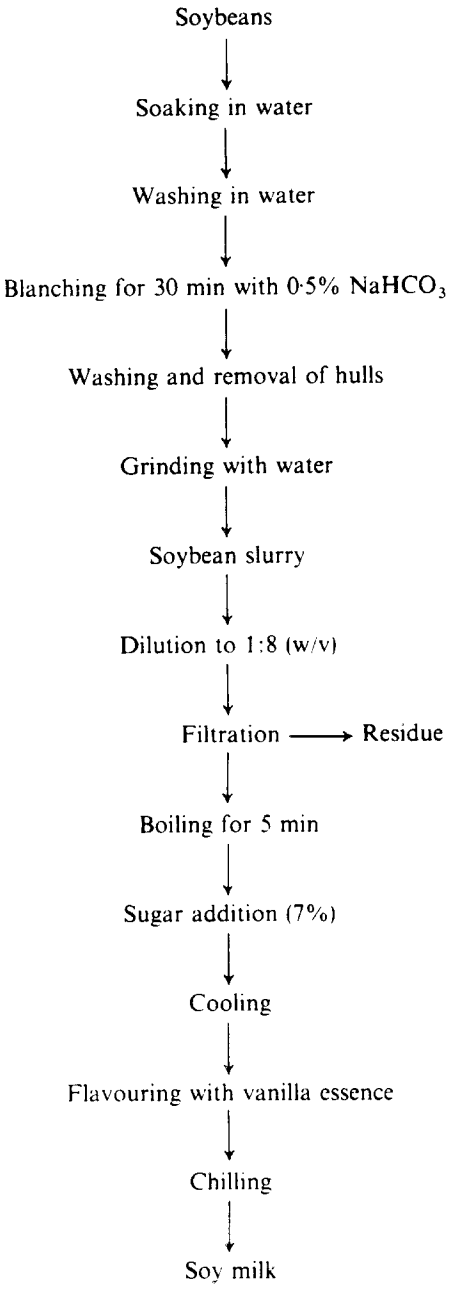

Fig. 1. Flow diagram for manufacturing soy milk.

down to 85–90°C. Then the coagulant ($CaCl_2$, 10%) was added until the whey became clear. Whey was removed and the coagulate was pressed for 5 min. The pressed cake was cut into cubes and these cubes were deep fat-fried (Fig. 2). The fried soy paneer was then subjected to laboratory panels for sensory evaluation. The yield, total solids and protein content of tofu were determined.

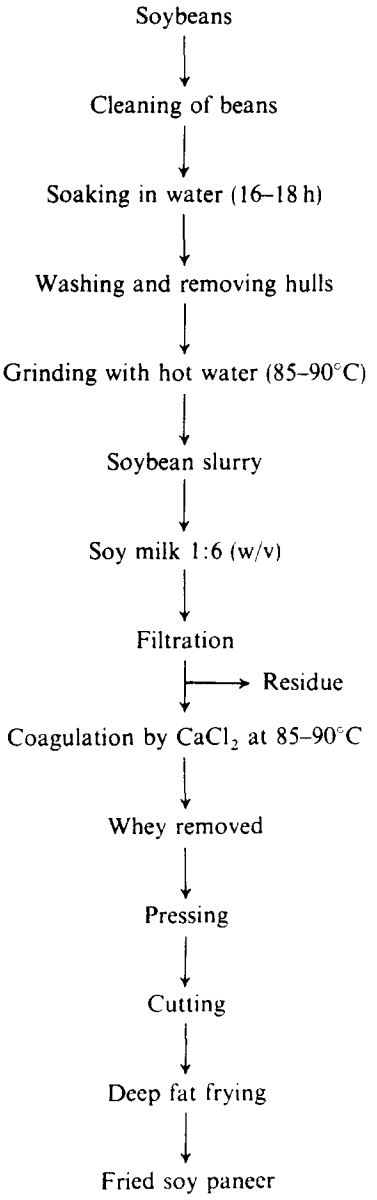

Fig. 2. Flow diagram for manufacturing tofu (soy paneer).

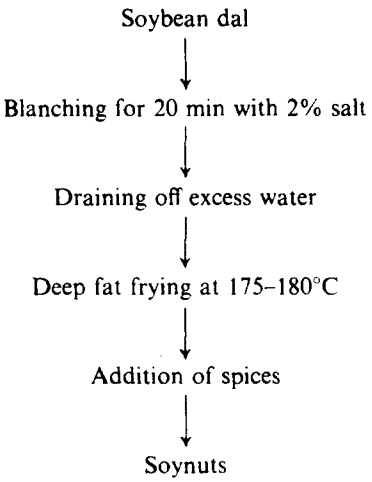

Fig. 3. Flow diagram for manufacturing soynuts.

Soynuts

Soybean dal was blanched for 20 min in water containing 2% salt. The extra water was drained and the blanched dal was deep fat-fried at a temperature of 175–180°C. Spices were added to taste and the soynuts were subjected to sensory evaluation (Fig. 3).

Analytical methods

Total solids and protein content of soymilk and tofu were analysed by using standard methods of the AOAC (1966) in duplicate.

Sensory evaluation

All three products, i.e. soymilk, tofu and soynuts, were presented to a laboratory panel consisting of nine members. The members were asked to record their degree of preference on an evaluation card using a hedonic scale as given below:

Hedonic scale

Liked extremely	9	Disliked slightly	4
Liked very much	8	Disliked moderately	3
Liked moderately	7	Disliked very much	2
Liked slightly	6	Disliked extremely	1
Neither liked nor disliked	5		

The data thus obtained for sensory characteristics were subjected to

statistical analysis by using a two way technique of analysis of variance described by Snedecor & Cochran (1967).

RESULTS AND DISCUSSION

Soymilk

Prepared soymilk was analysed for total solids and protein content and the results are presented in Table 1. The recovery of both total solids and protein, in soymilk decreased with the increase in storage period of the soybeans. This decrease was due to degradation of the cellular membrane of

TABLE 1
Total Solids and Protein Content of Soy Milk Samples prepared from Soybeans stored for Different Periods

Storage period (years)	*Total solids (%) (±SD)*	*Protein (%) (±SD)*	*Protein (g/100 of solids) (±SD)*
1	11·1 (±0·26)	2·84 (±0·02)	25·6 (±0·05)
2	10·5 (±0·33)	2·60 (±0·03)	24·8 (±0·08)
3	9·8 (±0·16)	2·31 (±0·04)	23·6 (±0·06)
9	8·3 (±0·29)	1·80 (±0·02)	23·7 (±0·09)

the soybeans by various phospholipases. The membrane degradation causes leaching out of various constituents into the soaking water (Narayan *et al.*, 1987). These observations are in accordance with earlier findings of Yoshino *et al.* (1977) and Saio *et al.* (1980), who reported a rapid decrease in NSI and extractability of proteins and solids into soymilk at high temperature and high relative humidity conditions. The soymilk samples were subjected to taste panels for organoleptic evaluation and the results of statistical analysis of the organoleptic data for the samples are presented in Table 2. The soymilk samples prepared from the soybeans stored for one and two years were acceptable and those prepared from the soybeans stored for three and nine years were unacceptable. The sensory quality of soymilk was found to decrease significantly with the increase in storage period, i.e. the sensory properties of soymilk prepared from the beans stored for different periods differed significantly from each other.

TABLE 2
Effect of Storage Period on Overall Organoleptic Score of Soymilk

Panelist	*Samples (years of storage)*			
	R_1 *(1)*	R_2 *(2)*	R_3 *(3)*	R_4 *(9)*
1	7·75	5·75	5·25	3·75
2	8·50	6·50	6·00	5·50
3	7·00	6·00	4·00	2·50
4	7·75	6·00	6·00	5·50
5	8·50	7·75	6·75	5·25
6	7·50	5·25	4·75	3·25
7	7·00	6·50	5·75	4·50
8	7·75	7·00	6·00	4·50
9	8·00	7·75	6·75	6·50
Mean	7·75	6·50	5·69	4·58

Statistical Analysis

Treatment pairs	*Actual mean difference*
R_1 R_2	1·25[a]
R_1 R_3	2·06[a]
R_1 R_4	3·17[a]
R_2 R_3	0·81[a]
R_2 R_4	1·92[a]
R_3 R_4	1·11[a]

Critical difference = 0·7716.
[a] Differ significantly at the 5% level.

TABLE 3
Yield, Total Solids and Protein Content (as it is basis) of Tofu Samples prepared from Soybeans stored for Different Periods

Storage period (years)	*Yield (%) (±SD)*	*Total solids (%) (±SD)*	*Protein (%) (±SD)*	*Protein (g/100 g of solids) (±SD)*
1	18·7 (±0·08)	25·10 (±0·04)	16·2 (±0·05)	64·5 (±0·07)
2	18·2 (±0·14)	24·47 (±0·08)	14·4 (±0·08)	59·0 (±0·08)
3	16·9 (±0·12)	22·15 (±0·04)	12·8 (±0·04)	57·6 (±0·05)
9	11·4 (±0·11)	19·83 (±0·06)	10·5 (±0·02)	52·9 (±0·12)

Tofu

The extraction of total solids and protein content decreased in tofu with the increase in storage period of the soybeans (Table 3). These observations compared favourably with the earlier findings of Yoshino *et al.* (1977) and Saio *et al.* (1980). The results, showing the statistical analysis of sensory evaluation data for all samples, are summarised in Table 4. It was observed that tofu prepared from soybeans stored for one and two years was acceptable and the differences in the sensory properties were non-significant. However, the tofu prepared from the beans stored for one year differed significantly in sensory properties from that prepared from beans stored for three and nine years. The tofu prepared from the beans stored for three and nine years was found to be unacceptable.

TABLE 4
Effect of Storage Period on Overall Organoleptic Score of Tofu

Panelist	*Samples (years of storage)*			
	R_1 *(1)*	R_2 *(2)*	R_3 *(3)*	R_4 *(9)*
1	7·75	6·50	6·00	5·25
2	5·50	3·50	3·50	3·25
3	7·25	6·75	5·50	5·25
4	7·75	6·75	5·25	2·25
5	6·00	5·75	5·50	4·75
6	8·00	7·75	7·25	4·00
7	7·50	7·35	4·75	4·25
8	5·00	4·75	4·25	3·50
9	7·25	6·75	5·50	4·50
Mean	6·89	6·29	5·27	4·11

Statistical Analysis

Treatment pairs	*Actual mean difference*
R_1 R_2	0·60
R_1 R_3	1·62[a]
R_1 R_4	2·78[a]
R_2 R_3	1·02
R_2 R_4	2·18[a]
R_3 R_4	1·16[a]

Critical difference = 1·023.
[a] Differ significantly at the 5% level.

TABLE 5
Physical Characteristics of Soynut Samples prepared from Soybeans Stored for Different Periods

Storage period (years)	*Colour*	*Crispness*	*Taste*
1	Bright yellowish	Crisp	Good
2	Slightly yellowish	Crisp	Good
3	Slightly brownish	Crisp	Very slightly bitter
9	Brownish	Comparatively less crisp	Bitter

TABLE 6
Effect of Storage Period on Overall Organoleptic Score of Soynuts

Panelist	*Samples (years of storage)*			
	R_1 *(1)*	R_2 *(2)*	R_3 *(3)*	R_4 *(9)*
1	6·75	6·25	5·50	5·00
2	8·50	8·00	6·75	6·50
3	8·25	7·25	6·75	2·50
4	8·00	7·00	7·00	6·25
5	8·00	7·00	4·50	2·75
6	8·25	6·75	5·50	3·50
7	7·50	7·25	6·50	6·25
8	6·00	5·75	5·50	4·00
9	8·00	6·50	5·75	5·00
Mean	7·694	6·86	5·97	4·638

Statistical Analysis

Treatment pairs	*Actual mean difference*
R_1 R_2	0·834
R_1 R_3	1·724[a]
R_1 R_4	3·056[a]
R_2 R_3	0·89
R_2 R_4	1·222[a]
R_3 R_4	1·332[a]

Critical difference = 1·224.
[a] Differ significantly at the 5% level.

Soynuts

Soynuts were examined for colour, crispness and taste and the results are presented in Table 5. With the increase in storage period of soybeans, the colour of soynuts prepared therefrom changed from creamish yellow to brown. Crispness of nuts decreased and the taste changed to bitter, thus making it unacceptable. Soynuts were evaluated for sensory properties and the statistical analysis of the data showed that the soynut samples prepared from soybeans stored for one, two and three years were acceptable and those prepared from soybeans stored for nine years were unacceptable (Table 6). However, the sensory properties of soynuts prepared from the beans stored for one year differed significantly from those prepared from soybeans stored for three and nine years and non-significantly from those prepared from beans stored for two years.

Thus the results of this investigation indicate that, for preparing various soy products such as soymilk, tofu, soynuts etc., soybeans stored for two years at the most can be used, and not beyond that. However, the quality of soymilk is lowered significantly if beans are stored for more than a year.

REFERENCES

AOAC, Association of Official Analytical Chemists (1966). *Official Methods of Analysis.* (10th edn), Washington, DC.

Christensen, C. M. & Kaufmann, H. H. (1969). *Grain Storage. The Role of Fungi in Quality Loss.* Univ. Minn. Press. Minneapolis.

Liener, I. E. (1972). Nutritional value of food protein products. In *Soybean. Chemistry and Technology*, ed. A. K. Smith and S. J. Circle. The AVI Publishing Company, Inc., Westport, Connecticut.

Narayan, R., Chauhan, G. S. & Verna, N. S. (1987). Changes in the quality of soybean during storage. I. Effect of storage on some physico-chemical properties of soybean. *Food Chemistry*, **27**, 13–23.

Saio, K., Nikkuni, I., Ando, Y., Ofsuru, M., Ferauchi, Y. & Kito, M. (1980). Soybean quality changes during model storage studies. *Cereal Chem.*, **57**(2) 77–82.

Snedecor, G. W. & Cochran, W. G. (1967). *Statistical Methods* (6th edn). The Iowa State University Press.

Yoshino, U., Iwasaki., Y. Okubo, M. & Okuyama, T. (1977). Effect of storage conditions on soybean protein. *J. Jap. Soc. Fd. Sci. Tech.*, **24**(10), 526–9.