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Comparative investigation on spray dried powder from soymilk and sprouted soybean milk

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ABSTRACT : In order to study the comparative investigation on spray dried soymilk and sprouted soybean milk powder, TAMS-38 variety of soybean was used. The sprouted soybean prepared by soaking it in normal water for 4 h, followed by six number of rinsings at an interval of six hours at room temperature of 28 (± 2^0 C). The soymilk and sprouted soybean milk prepared were dried using laboratory spray drier at 178 -182^0 C and feed rate of 350-375 mL/h keeping other machine parameters constant. The difference between ash (7.5 to 7.75 %), fat (10.8 to 11.5 %) and moisture content (0.066 to 0.076 kg/kg dm) of the soymilk powder and sprouted soybean milk powder were non-significantly differed from each other while protein content of sprouted soybean milk powder (27.44 %) was significantly low as compared to that in soymilk powder (37.48 %). Vitamin C and vitamin A of sprouted soybean milk powder (21.15 mg and 1.4 µg per 100g), was significantly high as compared to that in soymilk powder (8.99 mg and 0.09 µg per 100 g), respectively. The sensory qualities of reconstituted soymilk and sprouted soybean milk were higher than soymilk and spouted soybean milk, respectively. The shelf life of spray dried soymilk powder was 46 days (about 1.5 months), and that of spray dried powder of spouted soybean milk was 49 days (about 1.5 months) if stored at 30^0 C temperature and 95 per cent RH and packed in metalized polyester (140 gauge).

KEY WORDS : Soymilk, Soymilk powder, Sprouted soybean, Spray drying, Milk powder, Vitamin A, Vitamin C, Shelf life

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Soybean (*Glycine max* L.) described as "golden bean" is known to be native crop of eastern Asia, where it has served as an important part of diet for centuries. At present, the importance of soybean and its processed products is focused on the strong evidence that the low incident rate of breast, colon and prostate cancer or coronary diseases in the eastern countries related to a consumption of the soybean products (Plaza *et al.*, 2003). Soybean is widely used in variety of food preparation (Sharma *et al.*, 2001). It contains 38-42 per cent protein, which is more than that in other sources and also a cheapest and best source of high quality vegetable protein. 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. 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).

In general, increase in human consumption of soy products has limited due to trypsin inhibitors, saponin contents and unavailable sugars like non-digestible oligosaccharides (NDO, *i.e.* ~-*galactose* such as raffinose, stachyose and verbiscose) in soybean. 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). However, in order to overcome above difficulty, the sprouting of soybean can be a good option.

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 antidiabetec agent and prevents the diseases like hypertension and diabetes (MaCue *et al.*, 2005). Trypsin inhibitor inhibits trypsin/chemotrypsin, thus, pose difficulties during protein digestion and saponin causes nausea and omitting. 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 ~-*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). Therefore, the aim of the study is to prepare the spray dried powder from soymilk and sprouted soybean milk and estimate the proximate composition of spray dried soymilk powder and sprouted soybean milk powder.

METHODOLOGY

The experimentation was carried out at Post Harvest Technology Scheme, Dr. P.D.K.V., Akola (Maharashtra). The soybean seed variety, namely, TAMS-38 was procured from the Seed Technology Research Unit, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Preparation of spray dried soymilk powder :

Soybean grains were cleaned and washed and the process parameters like soaking time (8 h) of beans and heating time (20 min) of slurry for preparation of soymilk were optimized. The slurry was prepared by pouring wet ground paste using domestic mixer by adding three times water and boiled it, 1 per cent sodium bicarbonate (Verma and Jain, 2003; Singh *et al.*, 1988; Ewan *et al.*, 1992) was added in sample during heating to minimize beany flavour. Sample was filtered through muslin cloth and okara was separated. The laboratory model of spray drier (Labultima – 222 Advanced) was used for spray drying of soymilk at 180°C inlet air temperature, 99°C outlet temperature, with feed rate at 350 mL/h keeping other machine parameters *viz.*, atomizer air pressure, vacuum, drying cycle time, log interval as constant (Anonymous, 2009d, Tayade, 2010).

Preparation of spray dried sprouted soybean milk powder :

The optimally sprouted soybeans were used for preparation of sprouted soymilk. For development of sprouted soybean seeds, 2 to 3 times as much cool (30-32°C) water was added to cleaned soybeans and mixed up seed to assure even water contact for all and allowed the seed to soak for 4 h, draining it and followed by gentle rinsing with clean water at regular interval of 6 h till the good sprouts are seen (Pardeshi and Tayade, 2013). While rinsing, the sprouts should not be disturbed and the rinsing at regular interval be done still desired sprouting is achieved (Anonymous, 2009e). The soy sprouts were wet ground with requisite hot water and sprouted soybean milk was obtained as per procedure discussed above. The sprouted soybean milk spray dried as above to obtain sprouted soybean milk powder.

Proximate composition :

The proximate composition of spray dried soymilk powder and sprouted soybean milk powder was carried out according to the method by AOAC (1965). This includes determination of moisture content, ash content, crude fat. Protein content was determined by using Bradford reagent method (Bradford, 1976). The amount of vitamin A (Shrivastava and Kumar, 2006) and vitamin C (Thimmaiah, 2006) of spray dried soymilk powder and sprouted soybean milk powder was determined by titration method.

Per cent reconstitution :

The per cent reconstitution of spray dried soymilk powder and sprouted soybean milk powder was obtained by determining the amount of powder emulsified in the water. For this purpose, 7 g of powder was taken in empty beaker. Four to five teaspoons of luke warm water was added to it and stirred to mix homogenously. Further the luke warm water was added to make up 100 ml volume and stirred well. This was further heated on sim flame for 5 to 6 minutes. This method was adopted after trying different ways to reconstitute the powder (Anonymous, 2009d).

Sensory evaluation :

The sensory evaluation of soymilk and sprouted soybean milk as compared to cow milk and reconstituted milks from soymilk powder, sprouted soymilk powder and commercially available cow milk powder was carried out by a panel of six members of untrained judges (BIS, 1971). Each sample was categorized as sample with sugar and sample without sugar. The panelists were asked to indicate their preference for each sample based on the quality attributes of colour, flavour, texture, and overall acceptability (OAA) using a nine point hedonic scale.

Shelf - life study :

Water activity (a_w) of the product was measured instantly by the water activity meter (Powkit model, Aqualab). In order

to estimate shelf life of spray dried soymilk powder and sprouted soybean milk powder, initial water activity (a_w) and initial moisture content (Mi), critical water activity (a_{wc}) and critical moisture content (Mc), were determined. Spray dried soymilk powder and sprouted soybean milk powder were having the initial moisture content of 0.066 to 0.075 kg/kg dm, respectively. The packets of 70 mm wide and 120 mm long metalized polyester were prepared. About 10 g of product sample was filled in each packet and was closed by heat sealing, taking care that minimum possible air space remained in the packet. The sealing was carefully inspected to avoid any possibility of leakage. The packets containing soymilk powder and sprouted soybean milk powder were placed in desiccators and the relative humidity of 95 per cent was maintained inside desiccators maintained at the temperature of 30°C, which was the room temperature. The storage studies were conducted for a period of 42 days (6 weeks). One packet at each condition was taken out from the desiccators, at an interval of 7 days. The quality of the stored product was determined in terms of change in moisture content and water activity.

Statistical analysis :

The composition of spray dried soymilk powder and sprouted soybean milk powder was statistically analyzed using paired t – test. The data on the sensory attributes were analyzed by ANOVA (Singh *et al.*, 2008).

RESULTS AND DISCUSSION

The white flour yielding variety of soybean (Anonymous, 2009e) was selected for the present study. The grains were cleaned for impurities, broken, damaged and immature seeds, which accounted to be 17 to 20 per cent.

Germination of soybean seed :

Germination of soybean seed was measured for testing the viability of seeds. It was observed that germination percentage for the grain used for the experimentation was 80 per cent (S.D. ± 7 %).

Preparation of sprouted soybean milk :

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. Optimally prepared soy sprouts were used for preparation of sprouted soybean milk. It could be seen that cow milk was white in colour while soymilk had a little yellowish white colour. The sprouted soybean milk was having more yellowish white colour.

Preparation of spray dried soymilk and sprouted soybean milk powder :

Laboratory model of spray dryer was used to carry out spray drying of soymilk as discussed earlier. The optimized level of feed rate and drying temperature as 350 to 375 g/h and 178 to 180°C, respectively were used to prepare spray dried sprouted soybean milk powder (Anonymous, 2009d, Tayade, 2010). The other machine parameters as aspiration (50 % of total capacity; giving vacuum of - 80 mm of water column), outlet air temperature (100°C), and pressure for operation of solenoid system for nozzle cleaning (2 kg/cm^2) were kept constant as suggested by Anonymous (2009d). Similarly, spray drying of sprouted soybean milk was carried out at the conditions required for spray drying of soymilk.

Proximate composition :

The fat, protein, ash, vitamin C, vitamin A, moisture contents were determined and given in Table 1. The protein content in sprouted soybean milk powder (SSMP) was found significantly reduced upto 27.44 per cent as compared to that of 37.48 per cent in soymilk powder (SMP). This may be due to the fact that protein content might have been decreased

Table 1 : Composition of spray dried powders of soymilk and sprouted soybean milk

Particulars		R_1	R_2	Mean	l tc_{al} l	$(tt_{able})^*$
FAT (% wet basis)	SMP	12.78	10.37	11.575		
	SSMP	11.58	10.04	10.810	1.76	
Ash (% wet basis)	SMP	7.51	7.64	7.575		
	SSMP	7.65	7.65	7.745	1.06	
Protein (% wet basis)	SMP	37.31	37.65	37.48		
	SSMP	27.21	27.67	27.44	167.33	
Vit. C (mg/ 100 g)	SMP	9.49	8.49	8.99		
	SSMP	21.22	21.08	21.15	28.28	
Vit. A (mg/ 100 g)	SMP	9.531×10^{-5}	8.61×10^{-5}	9.0705×10^{-5}		
	SSMP	1.400×10^{-3}	1.408×10^{-3}	1.4041×10^{-3}	151.76	
Moisture content, kg/kg dm	SMP	0.0662	0.0653	0.0658		
	SSMP	0.0756	0.0765	0.0760	11.25	12.70

* 5 % level of significance using paired t-test

SMP- Soymilk powder, SSMP- Sprouted soybean milk powder

during sprouting itself (Nsofer *et al*., 1995) as might have been used as the reserve food during sprouting. Vitamin C in soymilk powder (8.99 mg/ 100 g) was found to be 5 fold more than that in raw soybean (2 mg/ 100g) (Bates and Mathews, 1975). However, the vitamin C content in sprouted soybean milk powder (21.15 mg/100 g) was observed to be increased significantly *i.e.*, by 3 times as compared to soymilk powder and 10.5 times as compared to that in raw soybeans (Table 1). This might be accredited to increase in vitamin C during sprouting itself, as may be due to biosynthesis of vitamin C during sprouting of soybean (Plaza *et al*., 1995). Vitamin A in sprouted soybean milk (1.4 µg) was found to be significantly high (nearly by 1450 %) as compared to that in soymilk powder (0.09 µg) (Table 1). This may be due to biosynthesis of vitamin A during sprouting itself (Plaza *et al.*, 2003). This indicates that the sprouting of soybeans certainly improves the quality of spray dried powder obtained from sprouted soybean milk. Nutritional composition of sprouted soybean milk powder was compared with commercial cow milk powder (MP) (Table 2). The moisture content in both the cases was similar. Ash content in sprouted soybean milk powder was more as compared to that of commercial milk powder. Though fat content in sprouted soymilk powder was less as compared to soymilk powder, it is still very high as compared to that in cow milk powder. Protein content in sprouted soybean milk was more than that in commercially available cow milk powder. Therefore, the sprouted soybean milk powder can be used as a supplementary food and help to avoid protein deficiency problem. Carbohydrates obtained in above sample were almost similar. Moreover, the additional benefit of sprouted soybean milk powder was accounted to availability of vitamin A and vitamin C. Moreover, the lactose free nature of sprouted soybean milk powder would account special status amongst the lactose intolerant population. As compared to soymilk powder, the sprouted soymilk powder would carry additional benefits of having reduced levels of non digestible oligosaccharides, thus, leading to reduced flatulence effect after its consumption (Ali *et al.*, 1988).

Per cent reconstitution :

Soybean fats have good emulsifying ability and are an excellent source of palmitic acid (Linden and Lorient, 1999). It was seen that the spray dried sprouted soybean milk powder was having less reconstitution per cent (94.47 %) as compared

Table 2 : Proximate composition of sprouted soybean milk powder and milk powder

Sr. No.	Product	g per 100g dm					mg per 100g dm		Cal / 100g
Contents		MC	Ash	Fat	Protein	Carbohydrate	Vit.-A	Vit.-C	Energy
1.	MP	5.50	5.85	20.0	20.00	50.05	–	–	460
2.	SSMP	7.60	7.74	10.8	27.44	46.94	0.0014	21.15	395

Table 3 : Properties of soymilk powder and sprouted soybean milk powder

Sr. No.	Particulars	% reconstitution	Bulk density (g/cm^3)
1.	SMP	96.50	0.65
2.	SSMP	94.47	0.54

Table 4 : Encoding of the product considered for sensory evaluation

Code No.	Notation
Without sugar	
1.	Cow milk
2.	Soymilk
3.	Sprouted soybean milk
4.	Reconstituted cow milk from powder
5.	Reconstituted soymilk from powder
6.	Reconstituted sprouted soybean milk from powder
With sugar	
1.	Cow milk
2.	Soymilk
3.	Sprouted soybean milk
4.	Reconstituted cow milk from powder
5.	Reconstituted soymilk from powder
6.	Reconstituted sprouted soybean milk from powder

to that of soymilk powder (96.50 %) (Table 3) (Anonymous, 2009d), may be due to little reduction in fat content (Table 1). From Table 3, the bulk density of sprouted soybean milk powder was found to be less than that of soymilk powder.

Sensory evaluation :

The quality attributes considered for sensory evaluation were colour, flavour, texture and overall acceptability (OAA). Twelve samples as coded as shown in Table 4 were served to the judges and they were asked to evaluate those samples as guided in score sheet provided. The scores given for various sensory quality attributes by 6 judges were statistically analyzed by using analysis of variance (Singh *et al.*, 2008) as given in Table 5.

The Table 5 shows that samples with sugar (B) were liked significantly higher than those without sugar (B). The samples of cow milk (01) were attributed highest sensory scores, but sensory scores of soymilk (02) and sprouted soybean milk (03) were significantly less than that for cow milk. However, the sensory attributes of reconstituted milk obtained from spray dried soymilk powder and spray dried sprouted soybean milk powder were at par to that of reconstituted cow milk powder.

Shelf - life study :

The sorption isotherms for soymilk powder (Fig. 1) and for sprouted soybean milk powder (Fig. 2) were used to estimate a_{Wc} and Mc. Where, a_W increases more rapidly even with small increase in moisture content, water activity is called critical water activity (a_{Wc}) and corresponding moisture content is termed as critical moisture content (Mc). In order to determine equilibrium moisture content of spray dried soymilk powder and sprouted soybean milk powder, the open samples were subjected to saturated environment *i.e.* 95 % RH at 30°C and maximum attainable moisture was determined and termed as equilibrium moisture content (EMC).

The data obtained was plotted as shown in Fig. 3 and values of EMC were read out and mentioned in Table 6. From

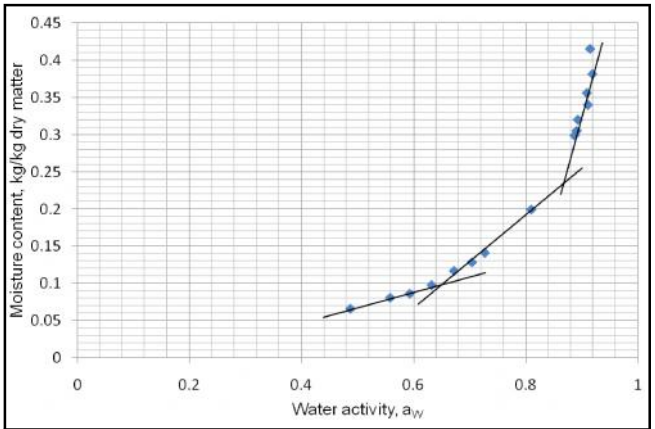

Fig. 1 : Determination of critical water activity of spray dried soymilk powder

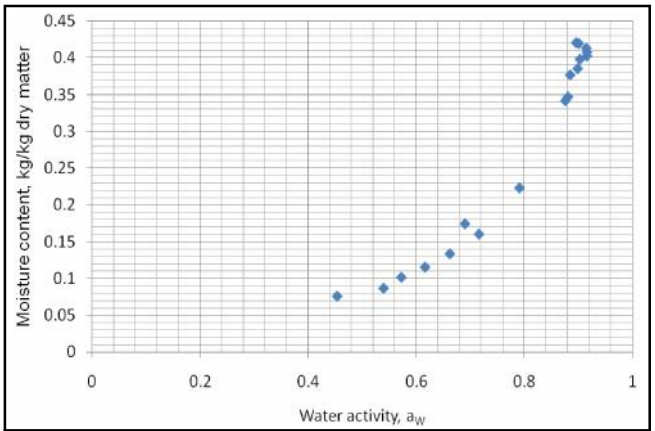

Fig. 2 : Determination of critical water activity of spray dried sprouted soybean milk powder

Fig. 3, the EMC of sprouted soymilk powder was read as 0.410 kg/kg dm whereas that of soymilk powder was read as 0.375 kg/kg dm, because beyond this moisture content, there was sudden increase in weight of sample, which may be due to occurrence of fungal growth. The water activity of the product

Table 5 : ANOVA (Analysis of variance) of sensory evaluation

Addition of sugar	WS*(A)	S**(B)					C.D. (P=0.05)
Factor means	7.30[a]	7.76[b]					0.11
Product code	01	02	03	04	05	06	
Factor means	8.10[a$]	7.04[b]	6.79[c]	7.79[d]	7.81[d]	7.87[d]	0.19

[$]The row wise values superscripted by similar letters differ non-significantly from each other

Table 6 : Properties of spray dried soymilk powder and sprouted soybean milk powder

Property	Initial moisture content, Mi (kg/ kg dm)	Initial water activity, a_W	Critical moisture content, Mc (kg/kg dm)	Critical water activity, a_{Wc}	Equilibrium moisture content, EMC, kg/ kg dm
Soymilk powder	0.0657	0.487	0.10	0.65	0.375
Sprouted soybean milk powder	0.0760	0.453	0.12	0.60	0.410

was considered as an index of shelf life of materials as reported by earlier researchers (Labuza and Medellin, 1981; Katz and Labuza, 1981; Tubert and Iglesius, 1986). The samples packed in standard packaging were kept in 95 per cent RH at 30°C.

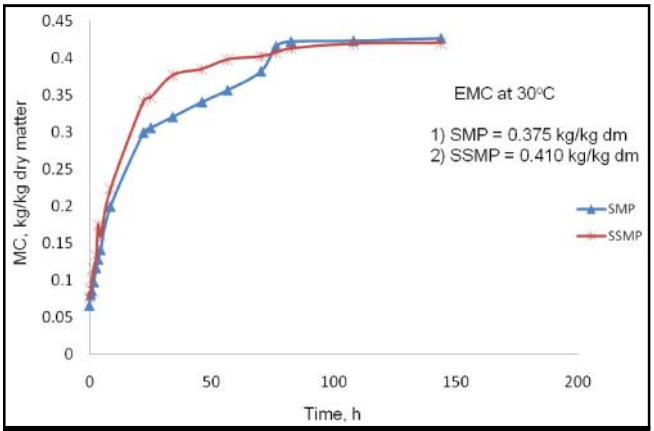

Fig. 3 : Variation in moisture content (MC) of spray dried soymilk powder and sprouted soybean milk powder with time at saturated condition

The observations on variation in moisture content and water activity were recorded during storage period of 42 days, at an interval of 7 days. Fig. 4 showed the increasing trend of moisture content and water activity of soymilk powder and sprouted soybean milk powder with storage period. The soymilk powder and sprouted soybean milk powder packed in metalized polyester and kept in 95 per cent RH and 30°C temperature could predicted to be stored safely for 46 and 49 days, respectively on the basis of time required to attain critical moisture by the samples packed in metalized polyester packets kept at 95 per cent RH and 30 °C temperature.

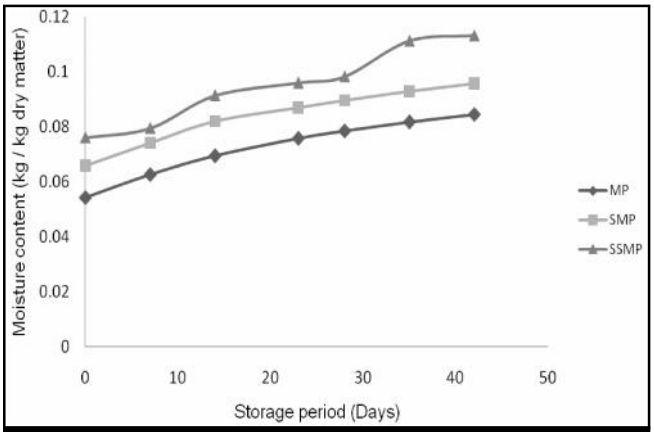

Fig. 4 : Variation in moisture content of spray dried soymilk powder (SMP) and sprouted soybean milk powder (SSMP) with atorage period

Conclusion :

The soybean seeds were sprouted by soaking it in normal water for 4 h, followed by six numbers of rinsings at an interval of six hours at room temperature of (28 ± 2°C). The sprouted soybean milk could be prepared well by following established method for preparing soymilk from soaked soybeans. The soymilk and sprouted soybean milk could be dried using laboratory spray drier at 178-182°C and feed rate of 350-375 ml/h keeping other machine parameters constant. The difference between ash, fat and moisture content of soymilk powder and sprouted soybean milk powder was non-significant. The ash, fat and moisture content of spray dried soymilk and sprouted soybean milk powder was 7.57 and 7.74; 11.57 and 10.81; and 6.66 and 7.6 g per 100 g dm, respectively. The difference between protein, vitamin C and vitamin A of soymilk powder and sprouted soybean milk powder was significant. The protein, vitamin C and vitamin A of spray dried soymilk and sprouted soybean milk powder was 37.48 and 27.44 g, 8.99 and 21.15 mg and 0.09 and 1.4 µg per 100g, respectively. Though the protein content of sprouted soybean milk powder was less as compared to that in soymilk powder, sprouted soymilk powder was found richer in vitamin C and vitamin A contents. The sensory qualities of reconstituted soymilk and sprouted soybean milk were better than soymilk and sprouted soybean milk, respectively. The shelf life of spray dried soymilk powder was 46 days (about 1.5 months), and that of spray dried powder of sprouted soybean milk was 49 days (about 1.5 months) if stored at 30°C temperature and 95 per cent RH and packed in metalized polyester (140 gauge).

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