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RESEARCH PAPER

Effect of packaging on shelf-life of soy fortified *Sattu*

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SUMMARY : The soy fortified *Sattu* was prepared with whole and sprouted soybean at 10 and 20 per cent level of fortification. Storage studies were conducted for soy fortified *Sattu* using three different packaging materials *i.e.* LDPE, HDPE and LAF at room temperature. In storage studies free fatty acid content and moisture content were observed for 90 days of storage period. Free fatty acid content of whole soybean supplemented sattu significantly increased from 0.31 to 1.16 per cent whereas for sprouted soybean supplemented *Sattu*, values of FFA increased from 0.30 to 1.05 per cent. However, moisture and FFA content of all samples were increased with increase in storage period. The laminated aluminium foil was proved to be best packaging material for storage of *Sattu*.

KEY **W**ORDS : *Sattu*, Fortification, Packaging materials, Free fatty acid content

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The soybean (*Glycine max*) is known as the "Golden Bean" of the 20th century. Soybean has great potential as an exceptionally nutritive and very rich protein food. It can supply the much needed protein to human diets, because it contains above 40 per cent protein of superior quality and all the essential amino acids particularly glycine, tryptophan and lysine, similar to cow milk and animal proteins. Soy sprouts have an advantage over other legume sprouts for not only being protein content but also for containing neutraceuticals ingredients which reduces the risk of range of hazardous diseases like breast cancer, uterus cancer, atherosclerosis and osteoporosis (Kumar *et al*., 2006).

Sattu, originally powdered roasted chickpeas, have evolved with time to include it with other flours also. The traditional *Sattu* has served humbly the people of Bihar and Jharkhand where the summer temperatures rose to unbearable heights even without global warming. In rural areas of Maharashtra, *Sattu*, a traditional weaning food, is consumed by all age groups. *Sattu* is prepared from the flour of roasted cereals or legumes or combination of cereal and legumes with added flavouring agents. Rohini *et al.* (1990) reported that traditional *Sattu* is a mixture of Bengal gram and wheat usually in a 1:3 proportion. It is better than any cold drink since it is nutritious and assimilated by the body easily. *Sattu* has its own benefits for all age groups. Deshpande and Bargale (2007) prepared *Sattu* which was packed in LDPE and metal container for storage period of 90 days in summer season (40^0C and 38 per cent RH) and rainy season (30^0C and 92 per cent RH). The soy fortified *Sattu* could be stored safely for 60 days in humid (30^0C and 92 per cent RH) and warm condition (40^0C and 38 per cent RH) of storage in metal container while the LDPE packages stored it safely for 30 days in warm conditions and 15 days in humid conditions of storage. The packaging materials *viz.*, low density polyethylene (LDPE), high density polyethylene (HDPE) and laminated aluminium foil (LAF) are known to be fairly good moisture and oxygen resistant and are being used commercially for packaging of snacks food.

The study was planned with the objectives of evaluating the effect of different packaging material substituting whole and sprouted soybean at 10 and 20 per cent in wheat and Bengal gram dhal to compare the shelf-life of product in different packages.

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EXPERIMENTAL METHODS

Production of sprouted soybean :

Soybean was cleaned by sorting and soaked in water at room temperature for 4 h. The soaked beans were drained, spread on cotton cloth and were kept in dark. The soybeans were watered every 6 h for 48 h. The sprouted soybeans were washed, drained and dried at 60°C in a tray dryer (Jideani and Felix, 2009).

Sample preparation :

Cleaned whole grains of soybean *(Glycine max.* variety: JS-335), wheat *(Triticum aestivum*) and Bengal gram dhal *(Cicer arietinum)* were separately conditioned to obtain 30 per cent moisture level in each of these samples. Samples were sprinkled with a predetermined quantity of water based on calculation of their respective initial moisture contents. The samples were then thoroughly mixed, sealed in double-layered low density polyethylene bags (200 gauges) and stored under refrigerated condition (10°C) for 48 h to facilitate the moisture equilibration. Each of these samples was then roasted on a pan with medium heat of gas. The roasted wheat, Bengal gram, whole or sprouted soybeans as per treatment were mixed in a required proportion to make *Sattu*. Samples thus prepared were ground and powdered and passed through 60 mesh (opening size 0.296 mm) sieve. control sample of traditional *Sattu* using wheat and Bengal gram (3:1 proportion) was also prepared by following similar procedure(Deshpande and Bargale, 2007).

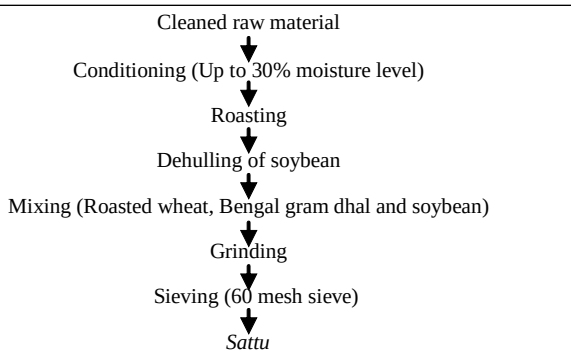

Fig.A: Flow chart of preparation of soy fortified *Sattu* with whole soybean

Storage studies :

Samples of soy fortified *Sattu* were stored at room temperature using different packaging materials of 200 gauges *viz.*, low density polyethylene (LDPE), high density polyethylene and laminated aluminium foil (LAF). The packets of 12 cm wide and 7 cm long of each packaging material (LDPE, HDPE and LAF) were prepared by heat sealing. About 30 g of product was filled in each packet and the sealing was carefully inspected to avoid any possibility of leakage. The storage studies were conducted for a period of 90 days. One packet each of different packaging materials was taken out at an interval of 15 days and quality of stored product was determined in terms of change in moisture content and free fatty acid content.

EXPERIMENTAL FINDINGS AND ANALYSIS

The results of the present study as well as relevant discussions have been presented under following heads:

Changes in free fatty acid content of sattu during storage :

It was observed from Table 1 that, there was significant difference within the treatments. FFA values increased throughout the storage period of 90 days for all *Sattu* samples. The FFA values varied from 0.29 per cent to 1.16 per cent during storage. The highest value was recorded for TW_2 sample *i.e.* 0.32 per cent and lowest for T sample *i.e.* 0.29 per cent on the day of preparation.

The FFA values of *Sattu* prepared from sprouted soybean (TS_1 and TS_2) were less than whole soybean (TW_1 and TW_2). This is due to decrease in free fatty acid content during sprouting and it is probably due to the greater rate of metabolism of fatty acids relative to their libration (McKinney *et al.*, 1958). Low FFA content in sprouted soybean than whole soybean was responsible for extending its shelf-life. The similar results were reported by Agrahar and Jha (2009).

A value of 0.99 per cent FFA (% of oleic acid) was used as the cut off value for acceptability of soy fortified sattu during storage in accordance with recommendation of Mustaka and Griffin (1964) for soy based products. The FFA of *Sattu* prepared from whole (TW_1 and TW_2) and sprouted soybean (TS_1 and TS_2) was increased with the level of fortification from 10 to 20 per cent for all packaging material *i.e.* LDPE, HDPE and LAF. The increase in the level of fortification resulted increase in FFA values of both the samples. Similar trend for increasing FFA values was supported by work done by Deshpande and Bargale (2007). The rate of increase in FFA of soy fortified *Sattu* was lower in LAF package followed by HDPE and LDPE. This is due to the LAF has low oxygen transmission property that helps in reducing oxidative rancidity in the product (Bargale and Bargale, 1993).

Changes in moisture content of sattu during storage :

The measured value of moisture content of *Sattu* varied from 5.82 per cent to 6.79 per cent during 90 days of storage. Table 2 shows that there was significant difference within the treatments at 5 per cent level of significance. The rate of increase in moisture content of the entire sample was varied significantly with packaging material.

The moisture content of all soy fortified sattu samples stored in different packaging material at room temperature was found to be increasing during storage period. The increasing

Table 1: Changes in free fatty acid content of sattu during storage

Days treatments	0 Day	15 Day	30 Day	45 Day	60 Day	75 Day	90 Day
TA	0.29	0.37	0.46	0.58	0.68	0.76	0.87
TB	0.29	0.36	0.44	0.51	0.59	0.62	0.71
TC	0.29	0.36	0.42	0.47	0.54	0.61	0.69
TW_1A	0.31	0.47	0.65	0.90	1.01	-	-
TW_1B	0.31	0.46	0.61	0.75	0.90	-	-
TW_1C	0.31	0.46	0.60	0.74	0.87	0.99	-
TW_2A	0.32	0.54	0.83	1.14	-	-	-
TW_2B	0.32	0.51	0.71	0.91	1.12	-	-
TW_2C	0.32	0.49	0.65	0.81	0.97	1.16	-
TS_1A	0.30	0.44	0.59	0.74	0.88	1.04	-
TS_1B	0.30	0.44	0.58	0.71	0.85	0.99	-
TS_1C	0.30	0.41	0.52	0.63	0.74	0.85	0.97
TS_2A	0.31	0.47	0.63	0.82	1.01	-	-
TS_2B	0.31	0.45	0.59	0.74	0.90	1.06	-
TS_2C	0.31	0.43	0.54	0.66	0.79	0.92	1.05
S.E.±	0.001	0.001	0.001	0.001	0.002	0.001	0.009
C.D. at 5%	0.004	0.005	0.005	0.005	0.006	0.004	0.002
F	62.722*	903.03*	3703.8*	8064.8*	15920*	93061*	18654*

* indicates significance of value at P= 0.05, A- Low density polyethylene (200 gauges), B- High density polyethylene(200 gauges) , C- Laminated aluminum foil (200 gauges) T- Control (wheat Bengal gram dhal)

Table 2 : Changes in moisture content of acceptable soy fortified sattu during storage

Days treatments	0 Day	15 Day	30 Day	45 Day	60 Day	75 Day	90 Day
TA	6.07	6.09	6.11	6.14	6.17	6.21	6.26
TB	6.07	6.07	6.09	6.11	6.14	6.17	6.21
TC	6.07	6.07	6.08	6.10	6.12	6.15	6.18
TW_1A	5.90	5.93	5.96	5.99	6.04	6.10	6.18
TW_1B	5.90	5.92	5.94	5.97	6.01	6.06	6.13
TW_1C	5.90	5.91	5.93	5.95	5.97	6.02	6.08
TW_2A	5.82	5.85	5.88	5.93	5.99	6.05	6.12
TW_2B	5.82	5.83	5.86	5.90	5.96	6.03	6.10
TW_2C	5.82	5.83	5.85	5.87	5.90	5.95	6.01
TS_1A	6.49	6.51	6.54	6.58	6.64	6.71	6.79
TS_1B	6.49	6.51	6.53	6.57	6.62	6.68	6.75
TS_1C	6.49	6.50	6.52	6.55	6.58	6.62	6.68
TS_2A	6.41	6.44	6.47	6.52	6.57	6.64	6.72
TS_2B	6.41	6.42	6.44	6.47	6.52	6.57	6.66
TS_2C	6.41	6.42	6.44	6.46	6.49	6.52	6.58
S.E. ±	0.007	0.006	0.008	0.009	0.008	0.008	0.008
C.D. at 5%	0.02	0.02	0.02	0.02	0.02	0.02	0.02
F	1377.8*	1904.6*	1035*	878.33*	1178*	1268.5*	1471*

* indicates significance of value at P=0.05, TW_1- Soy fortified sattu with 10 per cent whole soybean, TW_2- Soy fortified sattu with 20 per cent whole soybean, TS_1- Soy fortified sattu with 10 per cent sprouted soybean, TS_2- Soy fortified sattu with 20 per cent sprouted soybean

in moisture content was due to hygroscopic properties of flours. The moisture content was found to be highest in treatment TS_1A *i.e.* 6.79 per cent and lowest moisture content was observed TW_2C *i.e.* 6.01 per cent.

The variation in moisture content of these samples was directly related to the water vapour transmission rate (WVTR) of packaging materials. It was observed that the LAF packages were most effective and least moisture could migrate through them. This was mainly due to the fact that LAF package is considered to have a very low WVTR (Bargale *et al*., 1993). The main reason for excessive increase in moisture content of LDPE package may be the fact that WVTR of LDPE is much higher than that of HDPE and LAF packages.

These moisture content values are within the range specified by the Bureau of Indian Standards of 9 per cent moisture content maximum (IS: 7837-1975) for flours.

Conclusion :

- The soy fortified *Sattu* prepared from sprouted soybean (TS_1 and TS_2) was stored safely in LAF packages for 90 days and 75 days. Similarly for whole soybean (TW_1 and TW_2) it was stored for 75 days and 60 days of storage for 10 per cent and 20 per cent level of fortification, respectively.
- In HDPE packages sprouted soybean supplemented *Sattu* samples were stored for 75 days and 60 days and in case of whole soybean supplemented *Sattu* for 60 and 45 days at 10 per cent and 20 per cent level of fortification, respectively.
- In LDPE packages *Sattu* remained safe for 60 days and 45 days for sprouted soybean and 45 days and 30 days for whole soybean supplemented *Sattu* at 10 per cent and 20 per cent level of fortification, respectively.

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