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RESEARCH PAPER

Effect of Storage Conditions on Physio-chemical Characteristics of Tray and Solar Dehydrated Health Functionality Indigenous Fermented Soybean *Hawaijar*

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Abstract

A traditional fermented food made from soybean fermented with *Bacillus subtilis,* is most popular in Manipur, Nagaland, Arunachal Pradesh, Mizoram and Sikkim and is a means of livelihood in many regions of northeast India. Fermented soybean is considered as healthful food as claimed by medical researches but is perishable with a very low shelf-life. Nutritional properties of naturally fermented soybean as affected by the storage at ambient and refrigeration conditions was studied and reported here. The soybeans after fermentation were tray and solar dried and their nutritional properties were determined at varying time intervals (0, 30, 60 and 120 days). Their moisture, ash, protein, crude fibre and yeast and mold counts were determined on the successive days of storage to assess the suitability to consumers. The result showed that with the increase of storage period there was a considerable increase in moisture content (from 8.9% to 11.89%), significantly decrease in protein content (from 29.10% to 27.50%) and the amount of crude fiber (from 6.52% to 4.28%). However, there was a little change in ash content (from 1.30% to 1.28%). Samples that were stored in refrigerating conditions showed comparatively less loss than others. Moreover, higher changes were observed in the samples that were sun dried than dried mechanically. The same trend was observed in the samples stored at ambient conditions. The microbiological evaluation revealed even on the 120 days of storage the yeast and mold count was within the permissible limit (7.8×10^2 cfu/g) and the product was acceptable for consumption.

Keywords: Fermented soybeans, *Hawaijar, Bacillus subtilis,* storage, drying, nutrition, tray, solar

The soya bean (*Glycine max*) is a species of legume native to East Asia but is grown worldwide. The main producers of soybean are the United States (35%), Brazil (27%), Argentina (19%), China (6%) and India (4%). It is classified as an oilseed rather than a pulse. Fat-free (defatted) soybean meal is a significant and cheap source of protein for animal feeds and many prepackaged meals. Soybean oil is another product of processing the soybean crop. Besides, it is used as in textured vegetable protein (TVP) as an ingredients in many meat and dairy analogues.

It has been described as a miracle golden bean because of its nutritional composition. It is a rich pulse containing about 40% protein, 20% fat and 31% carbohydrate. Soybean proteins are a good source of essential amino acids such as lysine, tryptophan and threonine. Thus, addition of soybean to staple diets can improve the nutritional composition of stale crops. But like some other legumes, it contains some anti-nutrients such as trypsin inhibitor and phytic acid, but these can be destroyed by heat especially moist heat during processing. Soybean can be used as whole soybean, can be incorporated into cereals, legumes and root and tubers. The oil is used in many industrial applications.

Several fermented foods include soybean sauce, fermented bean paste, natto, and tempeh, among others have been made from it. North East India is treasure house of agricultural, horticultural crops and microbial resources. Indigenous fermented foods form a major role in the daily food intake of northeastern regions of health India. A traditional fermented food made from soybean *hawaijar* fermented with *Bacillus subtilis*, is most popular in Manipur, Nagaland, Arunachal Pradesh, Mizoram and Sikkim. Selling of fermented soybean is a means of livelihood in many regions of northeast India. A good quality fermented soybean has very strong ammoniacal smell. It produces lots of spider web like mucus strings when bean are pulled apart. Its moisture content is around 80% because of which its shelf-life is very short (2-3 days) at ambient conditions. However, the perceived flavour can differ from person to person.

After fermentation by microorganisms, the anti-nutritional factors in soybean or soymeal are totally degraded. Fermentation could also degrade large soybean protein into peptides and amino acids, therefore, removing the allergenic effect of soybean protein. Nutritional components are formed during fermentation such as functional peptides with ACE inhibitory activity are created by protein degradation, isoflavones are converted to their functional forms, the aglycones and while antioxidant activity is enhanced, contributed mainly by the increase of short chain peptides and phenolic compounds. Certain vitamins and bio-active compounds are also formed such as riboflavin, β-carotene, vitamin K2 and ergosterol. Total nutritional profiles of soybean and soy meal are greatly enhanced by fermentation.

Drying is a mass transfer process consisting of the removal of water or other solvent by evaporation from a solid, semi-solid or liquid. This process is often used as a final production step before selling or packaging products like *hawaijar.*

Traditional sun drying takes place by storing the product under a direct sunlight and is low cost process calling for little expertise but is possible only in areas where, on an average year, the weather allows foods to be dried immediately after harvest. But it also results in contamination, damage by birds, rats or insects; slow or intermittent drying with no protection from rain or dew that wets the product, mould growth with relatively high final moisture content; low and variable quality of products. A solar or electric food dehydrator on the other hand can greatly speed up the drying process and ensure more consistent results. Such drying effectively prevents the growth of micro organisms and their survival in the food.

India experienced rapid increase in production of soybean in the state of Madhya Pradesh, Uttar Pradesh and Maharashtra the production of soybean is increasing while its utilization remains low, calling for its utilization in large quantities. Keeping these factors in view, the present study was conducted to study the effect of drying methods on physic-chemical characteristics of fermented soybean (*hawaijar*), determine the storage behavior of fermented soybean (*hawaijar*) and to find out its shelf-life.

Materials and Methods

Procurement of raw material

Fresh and healthy soybean was purchased from the local market of Allahabad, and brought to the laboratory in sterile polythene bags for use during the period of investigation. Pure and clean water was taken from the laboratory and the soybean was soaked overnight in clean steel utensil. High density polyethylene was used as packaging material for storing the sample in ambient and refrigerated conditions.

Preparation of fermented soybean product

The fermented soybean product (*hawaijar*) was prepared as per the flow-sheet depicted in Fig. 1.

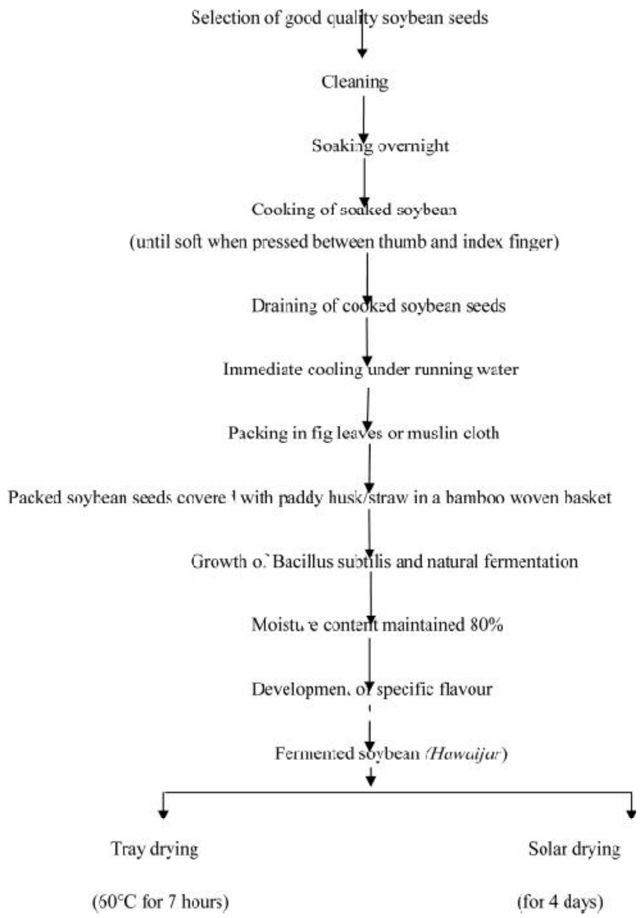

Fig. 1: Process Flow chart for preparation of fermented soybean (*Hawaijar*)

Af er the soya beans were fermented, they were dried and stored. The solar and tray dryer used are shown in plate 1 and 2 while the fermented and dried soya bean is shown in plate 3. Treatments used were, T1= Fermented soybean tray dried stored at ambient temperature, T2 = Fermented soybean tray dried stored at refrigeration temperature (10^{O}C), T3 = Fermented soybean solar dried and stored at ambient temperature, T4 = Fermented soybean solar dried stored at refrigeration temperature (10^{O}C).

Physico-chemical analysis

The hot air oven was used for moisture determination by method (AOAC, 1995). The ash was determined by standard method (Ranganna, 1986) af er the organic mat er was burnt away. The protein content (%) of samples was determined by Micro kjeldahl method (AOAC, 1980). Determination of crude fiber was carried out by the standard method (AOAC, 1980). Yeast and Mold Count was determined by the standard procedure prescribed (Rangana, 1986) and was expressed as colony forming units (cfu/g)

Results and Discussion

Af er fermentation, the moisture content (%) of the product was found to be 55%, and its amount was reduced as the drying of that product was carried out for enhancing the shelf-life of products.

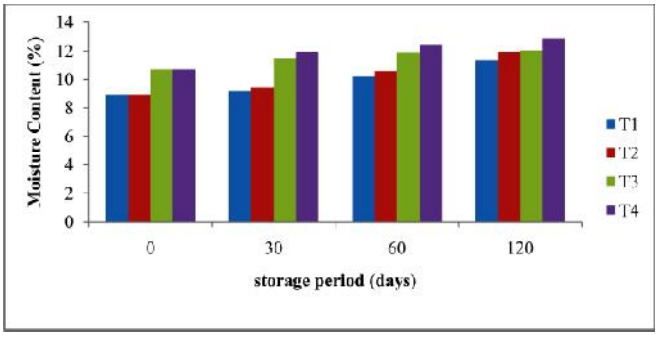

Fig. 2: Effect of storage condition on moisture content (%) of dried fermented soybean (*hawaijar*) during storage

T1= Fermented soybean tray dried stored at ambient temperature, T2 = Fermented soybean tray dried stored at refrigeration temperature (10^{O}C), T3 = Fermented soybean solar dried and stored at ambient temperature, T4 = Fermented soybean solar dried stored at refrigeration temperature (10^{O}C).

The results showed that the moisture content of product increased considerably during the storage period. The maximum moisture content was found in T_4 (sun dried and kept in the Refrigerated condition) 10.74% (Fig. 2). The increase in moisture content with the increase in storage period was comparatively more in the products in refrigerated condition rather than ambient condition might be due to hygroscopic nature of the fermented products. However, the increase in the moisture was in specified range. Those results are in confirmation to those obtained by Blandino *et al*. (2003). The increase in moisture content is mainly because of the ingress of water from atmosphere during storage.

The effect of storage period and different drying methods on ash content (%) of fermented soybean products packed in HDPE is presented in Fig. 3. It was found that the ash content varied very lit le during the storage period. It is contrary to the results obtained by Premarani and Chhetry (2011).

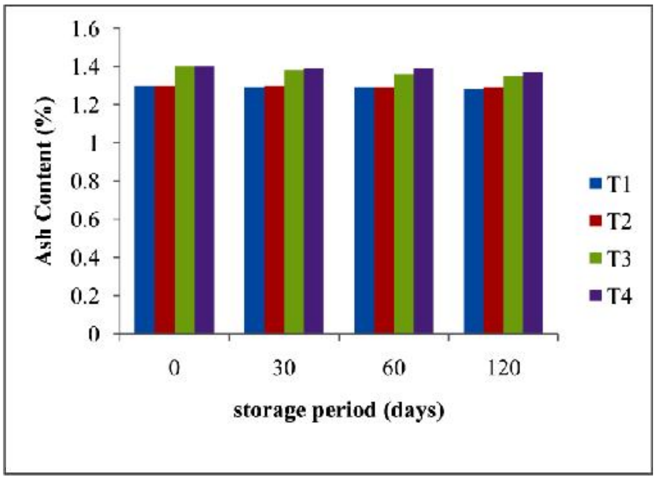

Fig. 3: Effect of storage condition on ash content (%) of dried fermented soybean (*hawaijar*) during storage

T1= Fermented soybean tray dried stored at ambient temperature, T2 = Fermented soybean tray dried stored at refrigeration temperature (10^{O}C), T3 = Fermented soybean solar dried and stored at ambient temperature, T4 = Fermented soybean solar dried stored at refrigeration temperature (10^{O}C).

The protein retention properties of tray dried product were bet er than solar dried product because the protein content reduces considerably due to photochemical reactions during sun drying of the product. The effect of storage period and different drying methods on protein content of the *hawaijar* packed in HDPE is presented in Fig 4. It was found that the protein content of *hawaijar* packed in HDPE decreased with increase in storage period. Overall, the results revealed that the protein content decreased during storage period.

Crude fiber content (%) of raw soybean was 3.8%, lowest in boiled unfermented beans (2.5%) but was the highest in three days fermented *hawaijar* (8.2%) and then, decreased during the storage period.

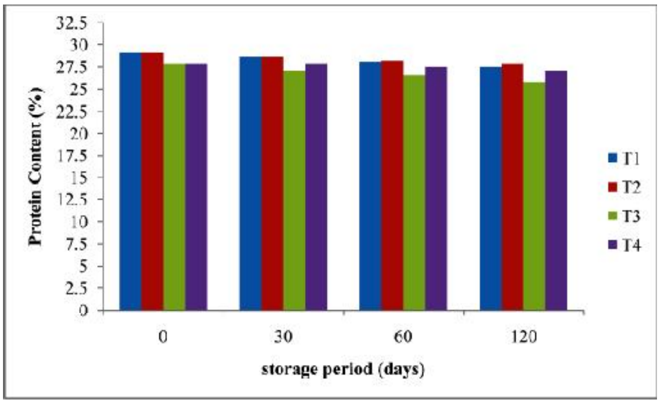

Fig. 4: Effect of storage condition on protein content (%) of dried fermented soybean (*hawaijar*) during storage

T1= Fermented soybean tray dried stored at ambient temperature, T2 = Fermented soybean tray dried stored at refrigeration temperature (10^{O}C), T3 = Fermented soybean solar dried and stored at ambient temperature, T4 = Fermented soybean solar dried stored at refrigeration temperature (10^{O}C).

On comparison of the results obtained with the data obtained by Premarani and Chhetry (2011), our results to be in confirmation of those reported earlier.

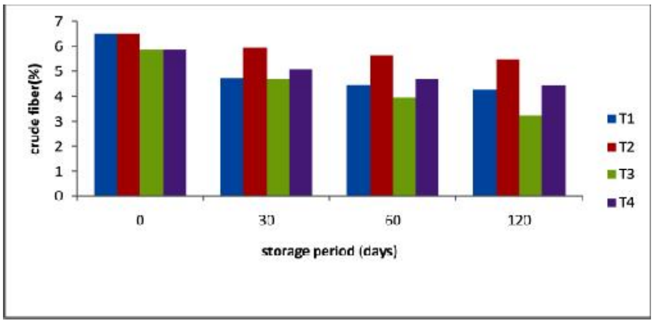

Fig. 5: Effect of storage condition on crude fiber content (%) of dried fermented soybean (*hawaijar*) during storage

T1= Fermented soybean tray dried stored at ambient temperature, T2 = Fermented soybean tray dried stored at refrigeration temperature (10^{O}C), T3 = Fermented soybean solar dried and stored at ambient temperature, T4 = Fermented soybean solar dried stored at refrigeration temperature (10^{O}C).

On critical evaluation, it was found that the sample T3 was having maximum loss which may be due to the sun drying and storage at ambient conditions. Minimum loss was observed in T2 as it was tray dried and stored at refrigeration condition.

Yeast and mold count (cfu/g) of dried fermented soybean (*hawaijar*) was nil after drying but it increased during the time of storage (Fig. 6). The minimum count was found to be nil in dried zero day sample and maximum count was observed in T1 after 120 days which was equal to 7.8×10^2 cfu/g.

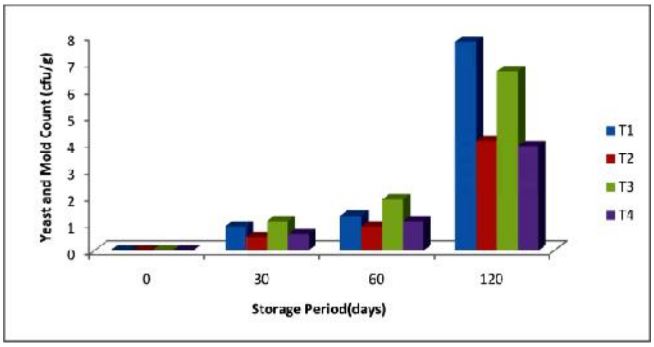

Fig. 6: Effect of storage condition on yeast and mold count (cfu/g) of dried fermented soybean (*hawaijar*) during storage

T1= Fermented soybean tray dried stored at ambient temperature, T2 = Fermented soybean tray dried stored at refrigeration temperature (10°C), T3 = Fermented soybean solar dried and stored at ambient temperature, T4 = Fermented soybean solar dried stored at refrigeration temperature (10°C).

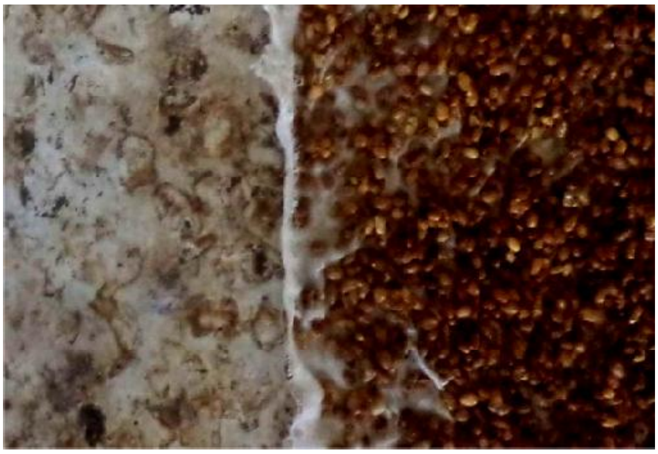

Plate 1: Tray drying of fermented soybean (*hawaijar*)

On comparison of the results obtained during the present study with that of Gernah *et al.* (2012), our results were dissimilar. It could be due to the fact that the soybean does not have the required carbohydrate to support yeast and mold growth due to which very less number of contents were observed. Also through Fig. 6, it was found that maximum number of colonies were observed in T_1 and T_3 which were stored in ambient conditions while T_2 and T_4 had the least growth having been stored at refrigeration conditions. It was thus, concluded that the refrigeration has a detrimental effect on the growth of yeast and mold count which can be an active method of storage.

Plate 2: Solar drying of fermented soybean (*hawaijar*)

Plate 3: Dried fermented soybean, *hawaijar* after 120 days of storage

Conclusion

The critical evaluation of drying of fermented soybean *Hawaijar* revealed that tray drying is bet er drying method as compared to sun drying as far as retention of physico-chemical at ributes is concerned. It was observed that there were not much differences in physico-chemical properties of dehydrated fermented soybean product *Hawaijar* stored in ambient temperature and refrigerated temperature during storage for a period of 120 days but distinct differences for yeast and mold counts were evident. *Hawaijar*, if properly made have a strong potential of increasing food production, improving the nutritional status of the rural population and provide income to rural masses of north eastern region of India.

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