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Optimization and Utilization of the Golden Bean (Soybean) in Different Category of Food

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Abstract: *Soybean is one of the most widely grown leguminous crops in the world grow in tropical, subtropical and temperate climates and provides abundant protein and oil for human diet and animal feeding. Fermented soybeans and their process products have attracted the attention in food manufactures due to the increase of health-promoting metabolites and pharmacological properties. Soybean can play a vital role in balancing the protein deficiency of our diet. Protein content of soybean is about 2 times of other pulses, 4 times of wheat, 6 times of rice grain, 4 times of egg; 12 times of milk. The present investigation was made with an attempt to utilize Soy bean in different forms of food for the production of Soy Nuts, Soy Milk, Soy Tofu, Soy Yoghurt and Soy Shrikhand. The by-product, Okara was used in the production of Soy fortified Gulab Jamun, Chakli and Cookies. The products were evaluated for physicochemical properties like sensory evaluation, moisture, titrable acidity, total solids, pH, total ash, acid insoluble ash, salt, brix and free fatty acids according to the standard analytical methods. The microbial parameters like Total Viable Count (TVC), Yeast and Mould, E. coli, E. coli and Coliforms, Mesophiles and Thermophiles were also tested according to the standard methods.*

Keywords: *Soybean, Soymilk, Tofu, Soy Yoghurt, Soy Shrikhand, Soy Cookies, Soy Gulab Jamun, Soy Nuts, Soy Chakli, Sensory analysis, Chemical and Microbial analysis.*

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I. Introduction

The Soybean (*Glycine max*), which is considered to be a miracle bean by many people, was first grown as a crop in China [14]. It is one of the best sources of Protein. Mahatma Gandhi introduced soya bean in India in 1935 in the form of cooked whole or split beans [8]**.** Soybean is one of the most widely grown leguminous crops in the world, grown in tropical, subtropical and temperate climates [17]. Its seeds contain more than 36% protein, 30% carbohydrates and appreciable amounts of dietary fiber, vitamins and minerals [2]. Soybean has 3% lecithin, which is helpful for brain development. It is also rich in Ca, Protein and Vitamins A, B, C and D [7]**.** Seeds of soybean have been used in Asia and other parts of the world to prepare a variety of fresh, fermented and dried foods. Besides its use for domestic purposes, soy oil has multifarious uses in related industries for the production of pharmaceuticals, plastics, papers, inks, paints, varnishes, pesticides and cosmetics. Recently, use of soy oil as biodiesel has opened up another possibility of renewable sources of energy for industrial uses. As a legume crop, soybean is capable of biological nitrogen fixation [2]**.** Its application is further established by the absence of cholesterol in the oil produced from soy beans [11].

The major soybean producing nations are the United States, Brazil and Argentina. Production of soybean in India is dominated by Maharashtra and Madhya Pradesh which contribute 89 per cent of the total production. Rajasthan, Andhra Pradesh, Karnataka, Chhattisgarh and Gujarat contribute the remaining 11 per cent production [20]. Soya products are increasingly becoming popular especially amongst health conscious people [15].

Soybean is one of the richest sources of isoflavones, which act as a phytoestrogen in humans [3]. Nowadays, soy isoflavones have undoubtedly become the most prevalent and potent xenoestrogens in human food [4]. Isoflavone aglycones are excellent metabolites due to their bioavailability, absorption and estrogenic properties against cancer and coronary heart diseases [5]. For several decades, soybean has been used as commercial crop in the world because of its valuable health benefits such as anticancer, anti-atherosclerotic, anti-inflammatory, and antioxidant [5]. Soy protein products contain isoflavones that exerts protective properties against breast, prostate, colon and lung cancers [9] [5].

The demand for alternatives to dairy products is growing due to problems with intolerance and allergy.

Hence the interest in soya-based foods has developed [19]. Fermented foods include soy sauce, fermented bean paste, natto, and tempeh, among others [13].

Soymilk is a water extract of whole soybean seed [21]. Soy milk (plain/flavored) is prepared to drink and applicable to all or any sections of individuals littered with lactase deficiency [12]. Tofu is now well accepted in Indian market to replace dairy milk paneer. Tofu is prepared from soy milk as soymilk curd by the addition of coagulants [21]. The most acceptable and commonly used starter strains are lactic acid bacteria (LAB), a well-known probiotic bacterium with several desired bioactivities [6]. Yogurt is one of the most popular fermented foods and traditionally consumed for a long time [21]. It is a semi solid food produced by fermenting milk with lactic acid bacteria [10]. Snack foods are nutritious when made from fruits, pulses or cereals. Legumes are high in protein especially in the essential amino acids, lysine and tryptophan, fats, oil, minerals, vitamins, phyto-chemicals and carbohydrates [1]. Today major challenges are being faced by industrialized countries to control the cost of health care and provide busy consumers more and more choice by healthy processed or ready to eat foods [16]. Indian fermented milk products utilize 7 per cent of total milk produced and mainly include three sweetened products i.e. dahi, Shrikhand and lassi. These products have enjoyed reputation for their nutritional and therapeutic value from time immemorial and play an important role in synthesis of vitamin B complex in human body. Shrikhand is popular dessert and forms part of a delicious supplement on religious functions [18].

II. Materials and Methods

Collection of Soybean Seed

The experiment was conducted at the Maiyas Beverages and Foods Pvt. Ltd., Bengaluru, during the period of 1st January to 30th May, 2020. High quality wholesome and mature soybean seeds were procured from the local market in Bengaluru. They were sorted and cleaned to remove stones and damaged seeds. After sun drying, seeds were kept in air tight container for further use.

Production of Soy Nuts

The soybeans were cleaned and soaked in potable water for 6 hours. After soaking, they were blanched for 20 minutes with the addition of Sodium bi- Carbonate and salt. Then they were strained and sundried. Spices were added and mixed. Oven roasting was done for 20 minutes at 160^{o}C and it was cooled to room temperature. Nuts were packed in multilayer packaging material. 1 kg of soybeans will yield 800 g of soy nuts.

Production of Soy Milk

Split soy beans were soaked in 3-liter water for 6 hours, dehulled manually and cleaned with continuous flow of fresh water, which was then grinded with 7 liters of water. It was then boiled with constant stirring till the temperature of the milk reached 95^{o}C, later blanching of milk was done for 20 minutes. The homogenized mass was strained through a muslin cloth to separate milk from residue (okara). Soy milk was blended by adding 4 different flavors (i.e. Elaichi, Banana, Kesar Badam and Choco Coffee) and homogenized. The flavored milk was packed in cans and retort was done. Then the cans were dried and stored. 1 kg of soybeans will yield 5.04 liters of soy milk.

Production of Soy Tofu

Cleaned soy beans were soaked in 3 liters of water for 6 hours and it was grinded with 7 liters of water and boiled till it reaches 95^{o}C, following blanching for 20 minutes. The mass was strained through a muslin cloth to separate milk from residue (Okara). The soy milk was heated to a temperature of 75°C and citric acid (2.2 g/l) was added and gradually mixed for uniform distribution and it was kept until coagulated. After coagulation the mixture was poured into muslin cloth and weights were placed for about 20-30 minutes on it. After the removal of liquid, a firm tofu is obtained which is then cut into cube shapes and immersed in potable cold water for 30 minutes. Excess water was drained and it was packed and stored at 4^{o}C and used for further studies. The input of 9.3 liters soy milk will yield 1.8 kg soy tofu.

Production of Soy Yoghurt

Soy milk was homogenized with dairy milk with the ratio of 1:1 and it was heated to 85^{o}C for 15 min and then cooled to 40^{o}C. The lactobacillus culture was added (0.04 g/L) and mixed gently. The inoculated milk was distributed in cups & incubated at 42°C for 5-6 hours until pH reached 4.6 after the fermentation the samples were stored at 4°C.

Production of Soy Shrikhand

Soy beans were soaked in 3-liter water for 10-12 hours, manually dehulled and cleaned with continuous flow of fresh water. The soaked soy beans were grinded with 7 liters of water and boiled with constant stirring till it reached 95^{o}C and was blanched for 20 minutes. Homogenized mass was strained through a muslin cloth

and the milk was separated from residue. Lactobacillus culture was added (0.04 g/L) when the temperature of milk reached 45^{o}C and the inoculated milk was incubated for 5-6 hours at room temperature until pH reached 4.6. Curd was poured in to a clean muslin cloth to drain the whey from curd and it was suspended for 8-10 hours. Sugar was added to the content and mixed well. This mixture was then force rubbed and strained on the muslin cloth tied to the top opening of stainless-steel utensil. This is done to get homogenized consistency. Then the Shrikhand was cooled to a temperature below 10^{o}C and was packed.

Production of Cookies

Salt and Sweet Soy cookies

All the required ingredients were weighed. Butter and sugar were mixed until creamed and to this mixture dry ingredients (Maida, okara, salt, baking soda, baking powder and cardamom) were added and mixed to prepare dough. This dough was rolled out in a baking tray and was cut into desired shapes and was placed in aluminum trays and baked in preheated oven at 160°C for 20 minutes. The cookies were cooled to room temperature, packed under MAP conditions and stored.

Spicy Soy cookies

All the required ingredients were weighed. Butter and sugar were mixed until creamed then for this mixture dry ingredients (Maida, wheat, okara, salt, baking soda, baking powder, Green Chilli, Coriander leaves, Pepper powder, Dhaniya powder, Jeera powder, Ginger, Curry leaves, Hing) were added and mixed to prepare dough. This dough was rolled out in a baking tray and was cut into desired shapes and was placed in aluminum trays and baked in preheated oven at 160°C for 20 minutes. The cookies were cooled to room temperature and packed under MAP conditions and stored.

Production of Soy Fortified Gulab Jamun

Refined wheat flour, okara (10%), milk solid (10.8%), edible vegetable fat, semolina, raising agent – INS 500(ii), acidity regulator (INS 296) and cardamom were added and kneaded to make a smooth dough using water and the dough was kept aside for 2 minutes. To prepare sugar syrup, equal parts of sugar and water was boiled for 5 minutes and cardamom powder was added. The dough was fed into divider machine and cut into equal sized balls and deep fried until golden brown. The fried jamun balls were soaked in the hot sugar syrup for 20 minutes and transferred into clean tins and hot sugar syrup was filled. Tins were seamed, sterilized and stored.

Production of Soy Fortified Chakli

All the required ingredients (Rice flour (36.4%), Refined palmolein oil, Black gram flour, Butter, Salt and Okara (20%)) were weighed and the dry ingredients were mixed with butter for about 4 – 5 minutes till dough gets smooth appearance. The dough was fed into hoper of chakli machine and it was adjusted to get chakli shape of 3 or 4 rounds. It was fried in oil with temperature (160^{o}C). After frying the chakli was spread on the vessel for proper cooling, after cooling it was packed and stored.

Sensory Parameters

The samples were subjected to sensory evaluation was by 10 trained panelists. The sensory analysis of samples was conducted using five-point hedonic scale, where 5 stands for like very much and 1 for dislike too much. The evaluation was held either at 10 am for morning session or at 3 pm for afternoon session. The samples were evaluated for overall acceptability, color, texture, taste and flavor. For these evaluations, a special testing area was used so that distractions can be minimized and conditions can be controlled. The testing room was quiet, comfortable with uniform level of lighting and good ventilation. Each panelist was provided with water for rinsing. All these conditions were equalized for all tests. The samples were also given codes before being tested. Each panelist was provided with enough privacy to avoid a biased assessment.

Chemical Analysis

Chemical tests (Moisture, Brix, pH, Titrable Acidity, Total Ash, Free Fatty Acids, Acid Insoluble Ash and Salt) were carried out at Maiyas Beverages and Food Pvt. Ltd. Laboratory. Moisture content [20] [21], brix degree [26], pH [27], titrable acidity percentage [21] [22], total ash percentage [21] [23], total solids content [28], titrable acidity percentage [21] [29], salt content [21] [25], acid insoluble ash content [21] [24] and free fatty acids percentage [21] [30] [31] were determined by the methods prescribed. These were carried out in duplicates according to the standard methods.

Microbial Analysis

Total Viable Count (TVC), Total Yeast and Mould Count, *E. coli*, *E. coli* and coliforms, *S. aureas*,

Mesophilic count and Thermophilic count were determined by the methods prescribed by [34][35][36][37][38] [39][40] respectively, where serial dilutions of the samples were poured into respective plates and incubated at 37°C for 48 hours while yeast and mould plates were incubated at 25°C for 3-5 days and 55°C for Thermophilic count for 48 hrs. The counts were expressed as cfu/ml or cfu/g of sample. The analysis was carried out in duplicates as per the standard methods.

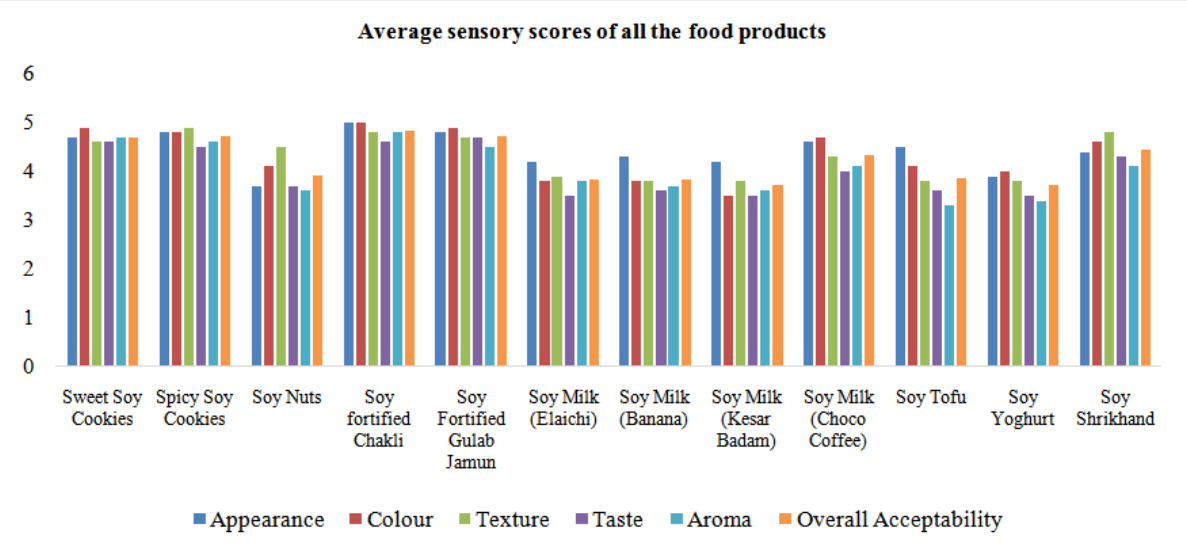
III. Results and Discussion

The present project work was based on development of different soy products. Samples were produced and stored before sensory, chemical and microbial analysis. The developed products were subjected to sensory evaluation by a panel of 10 trained panelists and were evaluated for appearance, color, texture, taste, aroma and overall acceptability and are presented in Table 1 and Graph 1, where 5 stands for like very much and 1 for dislike too much.

Table 1: Average sensory score of all the food products

Product Name	Appearance	Color	Texture	Taste	Aroma	Overall Acceptability
Sweet Soy Cookies	4.7	4.9	4.6	4.6	4.7	4.7
Spicy Soy Cookies	4.8	4.8	4.9	4.5	4.6	4.72
Soy Nuts	3.7	4.1	4.5	3.7	3.6	3.92
Soy fortified Chakli	5	5	4.8	4.6	4.8	4.84
Soy Fortified Gulab Jamun	4.8	4.9	4.7	4.7	4.5	4.72
Soy Milk (Elaichi)	4.2	3.8	3.9	3.5	3.8	3.84
Soy Milk (Banana)	4.3	3.8	3.8	3.6	3.7	3.84
Soy Milk (Kesar Badam)	4.2	3.5	3.8	3.5	3.6	3.72
Soy Milk (Choco Coffee)	4.6	4.7	4.3	4	4.1	4.34
Soy Tofu	4.5	4.1	3.8	3.6	3.3	3.86
Soy Yoghurt	3.9	4	3.8	3.5	3.4	3.72
Soy Shrikhand	4.4	4.6	4.8	4.3	4.1	4.44

Graph 1: Average score of all the food products



The chemical parameters such as moisture, titrable acidity, total solids, pH, total ash, acid insoluble ash, salt, brix and free fatty acids were tested according to the standard methods as mentioned above. The chemical characteristics of each product are listed in Table 2 and all the parameters satisfy the quality of the products.

A good packaging plays an important role for protecting every product. A suitable packaging material is essential to maintain the quality of food. The safe use of food products can be determined on the basis of their microbial content (TVC, Yeast and Mould, E. coli, E. coli and Coliforms, Mesophiles and Thermophiles) which were selected as target organisms to test the quality of the food products. Table 3 shows the microbial content of soy products. Microbial counts of the products are expressed as cfu/g or cfu/ml. All the products were safe for human consumption looking into the standard limits prescribes by [32] for certain time period depending on the food product.

Table 2: Chemical Parameters of all the food products

Products	Chemical Parameters								
	Moisture (%)	Total Solids (%)	Titrable Acidity (%)	pH	FFA (%)	Acid Insoluble Ash (%)	Total Ash (%)	Salt (%)	Brix (°)
Soy Yoghurt	86.1	13.9	0.30	4.89	NA	NA	NA	NA	NA
Soy Tofu	52.3	47.7	0.09	4.92	NA	NA	1.25	NA	NA
Soy Shrikhand	71.4	28.6	0.71	4.2	NA	NA	0.09	NA	2
Soy Milk (Elaichi)	78.8	21.2	0.16	6.26	NA	NA	NA	NA	20
Soy Milk (Banana)	78.68	21.32	0157	6.24	NA	NA	NA	NA	21
Soy Milk (Kesar Badam)	79.58	20.42	0.163	6.20	NA	NA	NA	NA	21
Soy Milk (Choco Coffee)	79.68	20.32	0.156	6.25	NA	NA	NA	NA	22
Soy Nuts	2.56	NA	0.11	6.63	0.27	0.21	NA	2.94	NA
Soy Sweet Cookies	2.79	NA	0.06	8	0.18	0.38	1.17	NA	NA
Spicy Soy Cookies	2.89	NA	0.029	7.55	0.26	0.36	0.17	NA	NA
Soy Fortified Gulab Jamun	32.28	NA	0.044	7.56	0.35	NA	1.86	NA	52
Soy Fortified Chakli	1.97	NA	0.087	6.24	0.091	0.28	1.23	3.42	NA

NA – Not Applicable

Table 3: Microbial Parameters of all the food products

Products	Microbial Parameters						
	Units	Mesophiles/ TVC	Thermophiles	*E. coli*	*E. coli* and Coliforms	Yeast and Mould	*S. aureus*
Soy Yoghurt	(CFU/g)	NA	NA	Absent	Absent	Absent	Absent
Soy Tofu	(CFU/g)	4320	NA	Absent	4	Absent	Absent
Soy Shrikhand	(CFU/g)	8	NA	Absent	Absent	7	Absent
Soy Milk (Elaichi)	(CFU/ml)	Absent	Absent	NA	NA	NA	Absent
Soy Milk (Banana)	(CFU/ml)	Absent	Absent	NA	NA	NA	Absent
Soy Milk (Kesar Badam)	(CFU/ml)	Absent	Absent	NA	NA	NA	Absent
Soy Milk (Choco Coffee)	(CFU/ml)	Absent	Absent	NA	NA	NA	Absent
Soy Nuts	(CFU/g)	3	NA	Absent	Absent	9	Absent
Soy Sweet Cookies	(CFU/g)	Absent	NA	Absent	Absent	Absent	Absent
Spicy Soy Cookies	(CFU/g)	Absent	NA	Absent	Absent	Absent	Absent
Soy Fortified Gulab Jamun	(CFU/g)	Absent	Absent	NA	NA	NA	Absent
Soy Fortified Chakli	(CFU/g)	Absent	NA	Absent	Absent	Absent	Absent

NA – Not Applicable

IV. Conclusion

The Soybean (Glycine max), which is considered to be a miracle bean by many people, was first grown as a crop in China. Its seeds contain more than 36% protein, 30% carbohydrates and appreciable amounts of dietary fiber, vitamins and minerals. Soybean has 3% lecithin, which is helpful for brain development. The demand for alternatives to dairy products is growing due to problems with intolerance and allergy. Hence the interest in soya-based foods has been developed. In this view the study was conducted to utilize Soy bean in different forms of food for production of Soy nuts, Soy milk, Soy paneer, Soy Yoghurt and Soy Shrikhand and okara was utilized in production of Gulab Jamun, Chakli and Cookies. The chemical, microbial & sensory parameters of the soy products are also tested. All the physicochemical and microbial parameters fall under the acceptable limits and all the products are safe for human consumption. Shelf life/stability study for the Soy

Products is also tested. It can be concluded that soy products which was developed can be marketed for commercial purpose.

Future Scope

Further research is needed of the incorporation of *Soy beans* in various food products for a better nutrition.

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