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Optimization and Sensory Parameter of Pulse Milk Based Tofu Using Composite Design

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Abstract: ***Plant based milk is a potential dietary alternative for substitution of cow's milk in diet of people suffering from milk allergy and lactose intolerance. The present study was thus aim to evaluate the effects of different combinations of tofu developed by milk extracted from soy beans, chickpea, green gram, and horse gram. The composite milk was made from equal proportion of horse gram chickpea and green gram. The tofu was developed with different combination of soy milk and composite milk as T1 (70:30), T2 (60:40), T3 (50:50) and to only with soy milk. All the developed tofu's were examined for sensory properties. The combination T1 (70% of soy milk + 30% of composite milk) scored high in all sensory attribute. The proximate analysis revealed (68.00%) moisture, (1.24%) ash, (6.7%) pH, (108 Kcal) energy & (26.02g) protein. When compared to commercially available tofu, the nutritious profile of the tofu blend made with pulse milk was superior. The outcome revealed that the tofu developed from the milk extracted from green gram, horse gram, chickpea and soybean is a nutrient rich functional food product. Significant differences of P <0.05 were examined.***

Keywords: Pulse milk, dairy free alternative, composite milk, sensory properties

1. Introduction

Pulses are the edible seeds of plants in the legume family. Pulses grow in pods and come in a variety of shapes, sizes and colors. The term "pulses" is limited to crops harvested solely as dry grains, which differentiates them from other vegetable crops that are harvested while still green (1). Pulse consumption is being promoted by the Food and Agriculture Organization (FAO) due to favourable nutritional composition, economic accessibility, and benefits for soil health maintenance, and plays a prominent role as a protein source in the EAT-Lancet Commission on healthy diets from sustainable food systems (2).

Pulses are grown all over the world, especially Asia accounting for roughly half of total production, including India. (3) Pulses provide protein and fiber as well as they act as a good source of vitamins and minerals such as iron, magnesium, folic acid and zinc. Pulse proteins also have a comparable essential amino acid profile with grains and are inherently gluten-free, making them acceptable for gluten-intolerant or allergic people.

Eating a cup of beans or peas daily will improve nutritional quality by increasing your intake of nutrients like carbohydrates, proteins and fiber. (4) Additionally, the tannin, saponins, and phytochemicals found in pulses have antioxidant and anticarcinogenic properties, implying that pulses may have a considerable anticancer effect. (5) Soy milk is the most common and commercially accessible pulses milk. Soy is the best source of protein containing around 40% protein, the highest among all pulses and grains, and also rich in mineral nutrients and dietary fibre. (6) Other emerging pulse milk choices for dairy beverages, possibly healthier and tastier options apart from soybean, have been ranked based on sensory evaluation results as: pea, lupin, lentil, chickpea & faba bean.

Despite the growing demand, there is a gradual decline in the use of dairy-based products due to changing customer lifestyles and health concerns associated with the consumption of milk products, such as various allergic reactions in specific individuals, antibiotic residues in milk, and cholesterol. However, due to the rise in population, there is a massive demand for proteins, leaving industries looking for more sustainable and innovative alternative protein ingredients (Boland et al., 2013). (7) Using more affordable, accessible, and nutritious substitutes like legume proteins can effectively overcome the global protein challenge. Mung bean (Vigna radiata L.) belongs to the family of legumes and has a protein content of 20–27. (8)

Probiotics are live microorganisms that are commonly utilized in the making of baby food and are present in fermented foods and cultured milk. They are widely recognized as "health friendly bacteria," indicating possibilities for health advantages and favorably impacting the intestinal microbial balance (11). They boost up the micro flora of the gastrointestinal tract and helpful to enhance digestive system and immunity. Another benefit of the consumption of probiotics is their ability to reduce cholesterol absorption (12). Probiotic bacteria are useful to mitigate lactose intolerance, treatment of diarrhea, anti-carcinogenic properties, reduction in blood cholesterol and improvement in immunity (13). Consumption of high concentration of probiotic bacteria per gram of product is required to health benefits (14). Probiotics are used in plant-derived products; include high nutritional and sensory values in these raw materials. Probiotics enhance better assimilation of individual nutritional components; they synthesize some vitamins of B group and K. They increase absorption of minerals and vitamins. Tofu is thought to be a good medium for the growth of lactic acid bacteria due to a high protein content and pH close to neutral. During fermentation and growth of probiotic cultures a soy product becomes a product with functional properties (15). This process is accomplished with the aid of coagulants.

Preparation of pulse- based tofu with different pulses other than soy bean has been investigated by a number of

researchers in different parts of world. But, in India very few research works has yet been done on the manufacture of cost- effective tofus. Hence in the present study, an attempt was made to develop a cost- effective pulse based tofu with chick pea, green gram and horse gram with variations.

2. Methodology

Ingredients like chickpea, soybean, green gram & horse gram were selected for the preparation of plant based milk. The selected ingredients were purchased from the departmental stores. As per the studies these particular pulses are choosen due to its high nutritive value, dietary fiber, low cost of investment and its easy availability.

Preparation of Tofu:
The pulses such as chickpea, green gram and horse gram were soaked separately in the ratio (40:30:30) to prepare a composite milk. 40gms of chickpea, 30gms of green gram and 30gms horse gram were soaked in water overnight for 8-10 hours for 20-30 ℃. Due to the absorption of water, the weight of pulses increased thrice. The soaked pulses were ground to form a paste, from which milk was extracted for formulating tofu.

The same process was continued to extract milk from soybeans. 100 gm of soy beans were used to extract soy milk. The obtained composite milk (chickpea, green gram and horse gram) and soybean milk were mixed with different proportions as per experimental plan. The mixture was

heated upto 700C, citric acid (2 gm/liter of milk) was used as coagulant then stirring continuously, till the soluble solids and whey was separated visually. The obtained solid was filtered through the muslin cloth and pressed in paneer press for 15-20 minutes at constant pressure for each sample. The pressed solids was then removed from the press box and immediately transferred in chilled water and stored in refrigerator. The chickpea, green gram, horse gram and soybean is mixed with proportion given below.Total 4 samples were prepared in the lab. After heating the prepared samples to 70℃, they were coagulated with a 2% citric acid solution while being constantly stirred until the clear whey separated. The mixture was then allowed to cool to room temperature. The resulting solid was then traced in a created paneer press under continuous pressure for fifteen minutes after the resultant whey was extracted by filtering through double-layered muslin cloth. After being obtained, the paneer block was submerged in cooled water and kept in a refrigerator.

Variation of the Composite Pulse milk

S. No.	Variation/ Ingredients	Soybean Milk	Composite milk (chickpea, green gram and horse gram)
1.	Control	200	0
2.	V1	150	50
3.	V2	120	80
4.	V3	100	100

Proximate composition of Soybean and Composite milk tofu
Proximate composition of **Soybean and Composite milk tofu** samples of different proportions, like moisture content (Air oven method), fat (Soxhlet method), ash, protein (N x 6.25) and carbohydrates were determined. The yield of **Soybean and Composite milk tofu** samples were measured using standard procedures.

Textural properties of Soybean and Composite milk tofu
Using the Textural Analyzer (TAX-II-TI), the textural characteristics of soy-groundnut paneer made with varying ratios of soymilk and groundnut milk were assessed in accordance with Bourne's (1968) recommended methodology [3]. A 25 mm dia perplex cylindrical probe was used to successfully compress paneer samples with a thickness of 10 mm. Up to 30% of the sample's original length was compressed. The probe's speed was set at 0.5 mm/s during the samples' pre-test, compression, and relaxation. Samples were physically held up against the base plate during testing.

Sensory evaluation of Soybean and Composite milk tofu
Samples of chickpeas, green grams, horse grams, and soybean tofu were cut into uniformly sized pieces of 10 x 10 mm for sensory evaluation. 25 students from the Department of Food Processing at Hindusthan College of Arts & Science in Coimbatore, who are semi-trained, make up the panel. The usual procedure was used to conduct the sensory evaluation [17]. Color, flavor, texture, appearance, and overall acceptance are the several qualitative features of soy-groundnut paneer that were evaluated using a 9-point hedonic scale. The information was tallied and statistically assessed.

3. Results & Discussion

Proximate analysis of Soybean and Composite milk tofu
The moisture content of pulse milk tofu prepared from different proportions of chickpea, green gram, horse gram and soybean ranged between 69 to 73.8 per cent (Table 1). The maximum moisture content (73.85%) was observed in the proportion of 50:50, whereas the minimum moisture content (69%) was observed in the proportion of 150:50. The chickpea, green gram, horse gram and soybean tofu prepared from 150:50 proportions was having desired hardness as compared to other samples prepared from different proportions of chickpea, green gram, horse gram and soybean tofu

Table 1: Yield and Proximate analysis of Soybean and Composite milk with different proportion of Soybean and Composite milk (200 ml milk)

Proportion (Soy Milk: Composite Milk)	Yield (%)	Moisture content (%)	Energy (Kcal)	Carbohydrates (g)	Fat (g)	Ash (%)	Protein (g)	Dietary Fibre (g)
200:0	17.1	71.40	152	14.8	3.52	1.33	31.58	3.8
150:50	15.6	68.00	108	17.2	5.61	1.24	26.02	2.0
120:80	14.7	69.75	101	11.76	2.40	1.25	21.01	3.1
100:100	8.8	73.80	90	10.69	1.81	1.32	17.4	4.3
SE±	-	0.588	0.045	0.023	0.07	0.013	0.123	0.021
CD	-	**1.81	**0.24	**0.07	**0.20	**0.042	**0.37	**0.010

*** Significant at 5% level of significance*

The fat content of soybean and composite paneer prepared from different proportion of soybean and composite paneer was ranged between 3.52 to 1.81 per cent. The maximum fat content (5.61%) was observed in the proportion of 150:50. A lowest value of fat content 1.81 per cent was observed in the proportion of 100:100.

The protein content of soybean and composite paneer ranged between 31.58 to 17.4 per cent. The lowest protein content was observed in the proportion of 50:50, whereas the proportion of 200:0 and 150:50 were significantly superior as regards to the protein content in other proportion.

The carbohydrate content in soybean and composite paneer was in the range of 14.8 to 10.69 per cent. The maximum carbohydrates were observed in the proportion of 150:50, whereas the lowest carbohydrates (7.62%) were observed in the proportion of 100:100. The protein content and carbohydrates percent was decreased in the soy-groundnut paneer with decreasing soymilk percentage.

Textural analysis of soybean and composite milk tofu

Table 2 indicates that all textural properties hardness, chewiness, cohesiveness, gumminess, and springiness of soybean and composite milk tofu prepared from different proportions of soymilk and composite milk significantly varies. [18] also studied different textural properties of soybean and composite milk tofu like hardness, springiness, chewiness, cohesiveness and reported similar trend.

Table 2: Textural properties of soybean and composite milk tofu with different proportion of soymilk and composite milk.

Proportion (Soy Milk: Composite Milk)	T.P.A. characteristics				
	Hardness (g)	Chewiness (g)	Cohesive-ness	Springiness	Gummi-ness (g)
200:0	666.7	305.2	0.60	1.14	380.24
150:50	659.1	309.64	0.54	0.87	355.91
120:80	512.6	223.79	0.49 251.17	0.89	0.89
100:100	93.2	108.44	0.34	0.87	148.14
SE±	0.75	0.47	0.0068	0.05	13.65
CD	**2.32	**1.44 **41.9	**0.02	**0.015	**0.015

*** Significant at 5% level of significance*

The hardness of the sample prepared from 150:50and 120:80proportion of soymilk and composite milk was similar to hardness of paneer sample prepared from 100% soymilk. As the g composite milk percentage increases in the soy paneer sample hardness value decreased. This may be due to increase in fat and protein content.

Sensory Evaluation of soybean and composite milk tofu

Soybean and composite milk tofu prepared from the proportions 120:80 and 100:100 were found a fragile and brittle texture and obtained less score for all the sensory attributes. It was observed during experimentation that as composite milk percentage increased off- flavour increased. This may be due to more functional groups of off-flavor compounds present in the pulses.

From Table 3, it is observed that score of all sensory properties of soybean and composite milk tofu were decreased with increasing composite milk percentage. Statistically all sensory properties were highly significant at 5 per cent level of significance. It was observed that the body and texture and overall acceptability of the proportions 150:50 were equivalent to 100 per cent soymilk tofu.

Table 3: Sensory score of soy-groundnut paneer with different proportions of soymilk and groundnut milk

Proportion (Soy Milk: Composite Milk)	Sensory attributes					
	Colour	Flavour	Appearance	Taste	Body and texture	Overall acceptability
200:0	7	**6.3**	7	7.5	7.4	7.5
150:50	7.4	**7.8**	**8.6**	**7.5**	**8**	8
120:80	7.33	**6.2**	**7.33**	**7**	**7.33**	6.3
100:100	2	**1**	**1**	**1**	**1**	1
SE±	0.21	**0.20**	**0.20**	**0.19**	**0.21**	0.17
CD	**0.60	**0.56	**0.57	**0.45	**0.58	**0.47

*** Significant at 5% level of significance*

4. Conclusion

The soybean and composite milk tofu contains 26.02 per cent protein, 5.61 per cent fats and about 68 per cent moisture content. Soy tofu fortified with 10% composite milk improved taste soybean and composite milk tofu and reduced typical beany flavour of pulses. The soybean and composite milk tofu prepared from 150:50 proportion of soybean and composite milk produced maximum yield and best quality attributes in terms of proximate composition, textural characteristics and organoleptic properties as compared to other proportions of soybean and composite milk.

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