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Original Research Article

A Milk Substitute Preparation Study using Legumes and Improvisation of a Recipe of Common Consumption

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Abstract

The Protein deficiency continues to be a major nutritional concern in developing countries, particularly among populations with limited economic resources. Although milk is widely produced, its affordability and accessibility remain restricted for many low-income families. In such circumstances, plant-based protein sources, especially legumes and pulses, offer an economical and nutritionally rich alternative. Legumes are known for their high protein content along with essential vitamins, minerals, dietary fiber, and other beneficial phytochemicals, making them suitable for improving overall dietary quality. The present investigation was conducted to develop a nutritionally enhanced milk-based product by blending of multi-legume extract into bovine milk. Various blend proportions of legume extract and milk were formulated and subjected to sensory evaluation to determine consumer acceptability. Parameters including appearance, flavor, consistency, and overall acceptability were assessed. The blend receiving the highest sensory scores was selected for further nutritional evaluation. Proximate analysis of the selected formulation was carried out to determine its moisture, protein, fat, ash, and carbohydrate content. The results demonstrated that the addition of multi-legume extract improved the protein concentration and enhanced the overall nutrient density of the milk blend. Importantly, the incorporation did not negatively influence sensory characteristics, indicating that nutritional enrichment was achieved without compromising product quality. The developed formulation shows potential as a cost-effective, protein-enriched alternative that can contribute to address dietary protein gaps.

Keywords: Legume extract, Bovine milk, Protein quality, Sensory evaluation, Nutritive value

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Introduction

Proper nutrition is necessary for proper growth, maintenance, immunity and prevention of non-communicable diseases (NCDs). In the present situation, common nutritional deficiencies in developing nations are deficiency of energy, protein, iron, calcium, iodine, and vitamin A. Milk is a complete meal being rich source of all major nutrients except iron.[1] Despite rich nutritional value, the rising costs have rendered this precious wholesome meal unaffordable for economically weaker sections. These issues made it important to innovate affordable options with a rich nutritional profile.[2] Recently, development of legume-based extracts has taken a hype due to increased health awareness for high protein dietary options.[3,4]

A lot of researchers have documented that incorporating plant protein into dairy is a viable option to provide high protein in affordable limits.[2, 5]

Legumes are good sources of many vital nutrients, phytochemicals and dietary fiber. Therefore, these have protective role against many degenerative diseases. On the other hand, besides being a complete food, milk is sometimes adulterated with harmful substances like urea, formalin, caustic soda etc. to meet increased demand and for more profit margins, that may pose serious health complications.[1]

On the basis of literature reviewed, lobia (Vigna *unguiculata*) and Whole black gram (Vigna *mungo*) were selected for their high nutritive value. Additionally, extracts from lobia-whole black gram, when combined with bovine milk, can serve as a base for producing protein-rich savory foods and other dishes. These formulations offer various health benefits, including promoting muscle growth and aiding in weight management.

Aims & Objectives

- To prepare a multi-legume extract using two widely grown legumes viz. lobia (Vigna unguiculata) and Whole black gram (Vigna mungo), by improvising upon a household adaptable method of legume extract development.
- To blend the multi-legume extract and bovine milk in an appropriate acceptable proportion, conduct the nutritional analysis and prepare flavored milk, curd, buttermilk and paneer from it.
- To develop a rice and buttermilk-based recipe – Mahri using buttermilk formed from legume extract blend and doing and conduct acceptability evaluation studies.

Research Methodology

The methodological aspects of the study are presented in the elaborate study design. It has been divided into 6 phases:

1. Multi-legume extract preparation
2. Multi-legume extract-Bovine milk blends preparation and selection of best blend through 9-point hedonic evaluation
3. Proximate and selected mineral analysis of best blend
4. Development of Mahri using multi-legume blend and bovine milk buttermilk
5. Sensory evaluation of the products using 5-point composite evaluation
6. Analysis and interpretation of data

1. Multi legume extract preparation: Legume extracts are obtained through a series of processing techniques including combining lobia – whole black gram in 1:1 ratio. The legumes were soaked in water with a pinch of sodium bicarbonate for 24 hours. Then it was blanched and boiled for 12-15 minutes, after which they were dehulled to improve extract quality. The dehulled legumes were ground and blended with 350-400 ml of water to form a homogenous mixture. The blended suspension was then filtered. The filtered extract was concentrated by boiling for 15-20 minutes, then cooled.
2. Multi legume extract bovine milk blend preparation and selection of best blend: Multi-legume extract was blended with bovine milk in various ratios. Sensory evaluation was conducted using 9-point hedonic scale and composite scoring test to determine the most

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acceptable combination. The most acceptable variant was selected for analysis of nutritive value.

3. Proximate and mineral analysis: Estimation of Moisture, ash, protein, fat, carbohydrate, calcium and iron content were done using standard methods as shown in below table 1:

S.No.	Nutrient Estimation	Reference Method
1	Moisture	AOAC, 2019[6]
2	Ash	AOAC, 2019
3	Protein	AOAC, 2019 (Kjedahl method)
4	Fat	AOAC, 2019 (Soxhlet method)
5	Fibre	AOAC, 2019
6	Carbohydrate	AOAC, 2019 (Difference method)
7	Calcium	NIN 2003[7]
8	Iron	NIN 2003 (Wong's method)

Table 1. Reference methods of proximate composition and minerals

Multi-legume extract- bovine blend	Overall Acceptability
Standard (bovine milk)	8.5
Sample 1 (lobia – whole black gram bovine milk blend) (40:60 ratio)	8.2
Sample 2 (lobia – whole black gram bovine milk blend) (50:50 ratio)	6.1
Sample 3 (lobia – whole black gram bovine milk blend) (60:40 ratio)	5.2

Table 2. Sensory evaluation scores for various milk legume extract bovine blends

Figure 1. Sensory evaluation of multi-legume extract – bovine milk blends

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4. Development of mahri using multi-legume blend and bovine milk: In this study, the traditional savoury product, Mahri, was formulated using the best blend ratio of 40:60 (multi-legume blend: bovine milk). The selected blend ratio was finalized based on its superior sensory acceptability among the tested combinations. Two variations of Mahri were developed for comparative analysis: a control sample prepared using standard bovine milk buttermilk, and an experimental sample prepared using buttermilk derived from the multi-legume blend. For the preparation of both variations, 60 g of rice was soaked in water for one hour prior to cooking. A pressure cooker was heated, and 1 teaspoon of ghee was added, followed by cumin seeds (Cuminum cyminum) for tempering. Subsequently, the respective buttermilk (standard and multi-legume blend) was added and brought to boiling. Approximately 50 ml of water was incorporated into each preparation, and salt was added according to standardized levels. The pre-soaked rice was then added to the mixture, and the contents were cooked under pressure until one whistle was achieved. The prepared samples were cooled to serving temperature and subjected to further evaluation.
5. Sensory evaluation: Sensory evaluation of multi-legume extracts bovine milk, prepared using lobia- whole black gram with cow milk, was conducted by a trained panel. It was performed using a 9 - point hedonic scale test and 5 - point composite scoring test.[8]
6. Statistical analysis: Values obtained were analysed by applying suitable statistical analysis such as mean, merit of mean and standard deviation.[9]

Results

The study has been undertaken in three phases and the results were discussed under the following heads:

1. Preparation of different legume extract combinations and its blending with milk.
2. Nutrient analysis
3. Product Development

1. **Preparation of different legume extract combinations and its blending with milk**: To prepare the multi-legume extracts, various household processing techniques were employed, including soaking, dehulling, blanching, grinding, filtering and cooking. One combination was formulated lobia – whole black gram and extracts were prepared accordingly. These legume extracts were then blended with cow's bovine milk. The resulting blends were evaluated for sensory acceptability using the 9-point hedonic scale. Based on the sensory evaluation results, the most acceptable blend lobia – whole black gram with bovine milk, was selected for further analysis of nutritive value and for development of a sweetmeat product.

2. **Nutrient analysis**: Out of the three blends, 40:60 lobia -whole black gram: bovine milk blend was the most acceptable blend. The proximate analysis i.e., moisture, ash, protein, fat, fiber and carbohydrate and minerals such as calcium and iron content was estimated.
Results obtained for nutrient analysis has been depicted in table 3.

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Proximate analysis (g/100g)	Bovine milk (standard)	Lobia whole black gram – bovine milk blend (40:60)
Moisture	87.50	89.67
Ash	0.80	0.93
Protein	3.23	2.98
Fat	4.48	4.17
Crude Fiber	-	0.53
Carbohydrate	4.40	1.72
Calcium (mg/100 g)	119.8	100.19
Iron (mg/100 g)	0.74	2.08

Table 3. Nutrient composition (g/100g)[10]

The moisture content of the multi-legume extract bovine milk blend was found to be 89.67g/100g.While the moisture content of cow's milk was found to be 87.50g/100g. The ash content was found to be 0.93g/100g in the multi legume extract-bovine milk blend, the blend consists of legumes which has slightly higher mineral content, while the ash content of cow's milk was found to be 0.80g/100g.

The protein content was found to be 2.98g/100g in the multi-legume extract-bovine milk blend, while the protein content of cow's milk was found to be 3.23g/100g. The fat content found to be 4.17g/100g in the multi-legume extract-bovine milk blend, while the fat content of cow's milk was found to be 4.48g/100g.

Cow's milk did not contain crude fiber, but the multi-legume extract has fibrin. The multi-legume extract-bovine milk blend showed 0.53g/100g of fiber in it which is a good amount. Although there was a loss of fiber during dehulling and processing, it was still found to be in sufficient amount. The carbohydrate content was found to be 1.72g/100g in multi-legume extract-bovine milk blend while the carbohydrate content of cow's milk was found to be 4.40g/100g. The calcium content is found to be 100.19mg/100g in the multi-legume extract-bovine milk blend, while in cow's bovine milk was found to be 119.8mg/100g. The iron content is found to be 2.08mg/100g in the multi-legume extract-bovine milk blend, while in cow's milk it was found to be 0.74mg/100g.

3. **Product development:** After performing sensory evaluation and nutritive value analysis, the best acceptable ratio of the blend of legume extract and bovine milk, was further used to develop a traditional savoury product, Mahri.

Figure 2. Final product Mahri

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Sensory evaluation of developed savoury product – Mahri: Results for the sensory evaluation of the developed mahri has been shown in the figure 3.

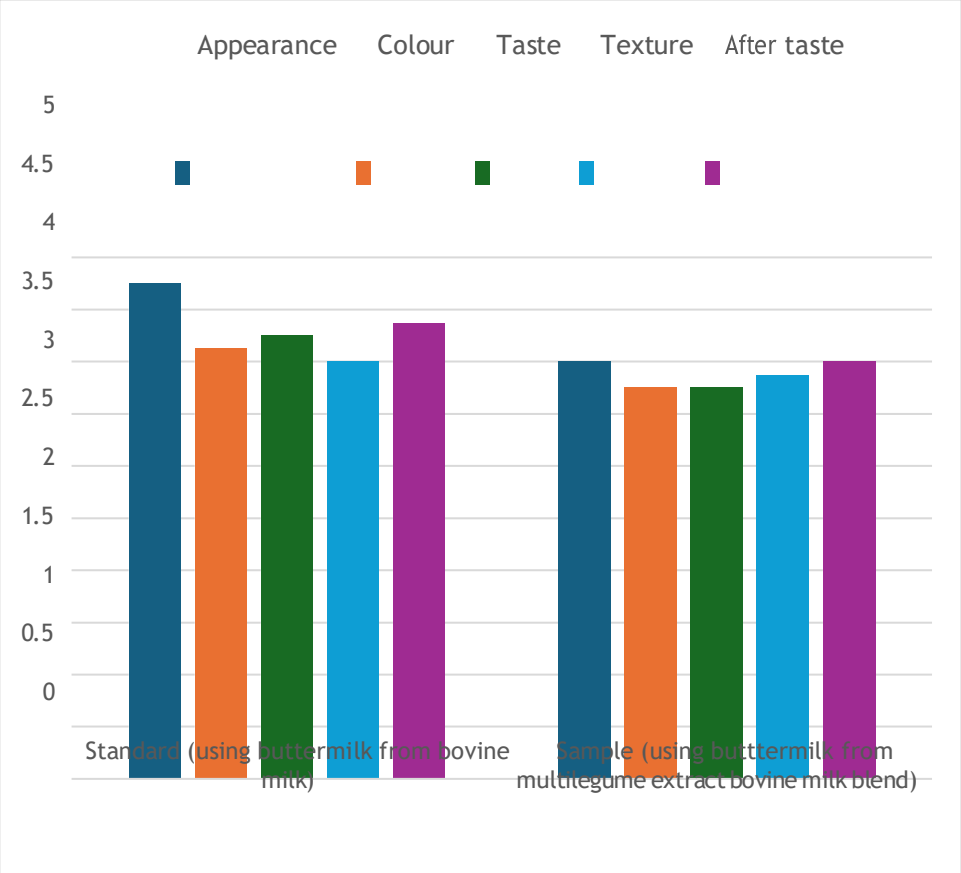

Figure 3. Sensory evaluation of Mahri

Discussion

The nutritional analysis revealed notable changes in composition after blending legume extracts with milk. The multi-legume extract blend showed increased levels of moisture, ash, crude fiber, and carbohydrates compared to standard milk. A reduction in fat content was also observed, which may offer dietary benefits for individuals aiming to reduce overall fat intake.

An improvement in protein content was another significant outcome. The addition of lobia and whole black gram contributed additional plant-based proteins, thereby increasing total protein availability in the blend. Plant proteins complement dairy proteins and may contribute to a more balanced amino acid profile. Moreover, increasing the proportion of plant-derived nutrients in the diet is often associated with improved long-term health outcomes when consumed as part of a balanced diet.

The mineral profile of the blend also demonstrated improvement. While milk is naturally rich in calcium, it contains limited iron. The inclusion of legume extracts led to an increase in iron content, thereby enhancing the micronutrient value of the preparation. The presence of both calcium and iron in improved amounts supports better overall nutritional adequacy.

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From a sensory perspective, Mahri prepared using buttermilk derived from the multi-legume extract blend was compared with Mahri prepared from standard bovine milk buttermilk. Organoleptic evaluation indicated that the modified version was highly acceptable and comparable to the traditional preparation in terms of taste, texture, aroma, colour, and overall acceptability. Since Mahri is a savoury dish, maintaining its characteristic flavour and consistency was essential. The results suggest that the incorporation of the multi-legume blend did not negatively affect sensory quality, demonstrating its suitability for traditional culinary applications.

An important strength of this study was the use of traditional household preparation methods for both the blend and the Mahri dish. This approach ensured that the developed formulation remains practical, culturally acceptable, and easily adaptable within the community. By selecting a commonly consumed savoury preparation rather than a novel product, the study increases the real-world applicability of its findings.

Conclusion

The successful preparation of Mahri using buttermilk derived from the blend demonstrates that nutritional improvement can be achieved without compromising cultural food practices or sensory appeal. The integration of lobia and whole black gram extracts with bovine milk presents a promising strategy for enhancing the nutritional value of traditional savoury dishes. Such plant-dairy combinations have the potential to improve protein intake, mineral availability, and overall diet quality in a sustainable and culturally relevant manner.

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