



Fababean Meat an Enriched Quality Plant Protein Meat Substitute

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Abstract

A plant-based meat substitute, similar to minced meat and rich in protein, was developed using faba beans. The product, referred to as faba bean meat, contains 58% crude protein, 26% crude fat, and 6% ash content. Citric acid was found to be the most effective agent for isolating crude protein from faba beans during testing with different acids. To enhance its resemblance to real meat, food-grade color and other additives were used. The product's nutritional profile was validated through experiments with rats over 40 days, showing comparable results to animal-based meat in terms of protein efficiency ratio and net protein utilization.

Keywords: faba bean, protein, meat substitute, high altitude

Introduction

Faba bean belongs to a leguminous crop in Gilgit Baltistan it is known as barduk in shina and nustung in balti. It is a good source of plant protein, cultivated above 7000 feet from sea level in Chitral and Gilgit-Baltistan Pakistan. Faba bean is also a good source of micro nutrients that attracts nutritionist for development of baby foods due to its nutritional profile.¹ In Gilgit Baltistan Pakistan total faba bean production was 2.55 metric tons in 2010 that shows a very little amount in relation to the total production of soybean.²

Proteins are a vital part of the human diet. While legumes, including faba beans, are known for their high protein content, they often fall short of being considered alternatives to animal derived foods. Animal-based proteins, although nutritionally superior, remain inaccessible to many due to their high cost. For individuals with limited financial means, the rising prices of meat and dairy necessitate a shift toward more affordable protein sources.³ Additionally, rapid population growth in certain regions has created a widening gap between demand and supply for animal protein. Since producing animal protein involves a time consuming and costly process of converting crops into livestock, this issue is projected to worsen over time.

Efforts to address this challenge have led to innovations in producing plant-based proteins that mimic the texture and appearance of meat. One such technique involves the creation of spun protein fibers. This process includes dispersing proteins into a medium, extruding the mixture through spinnerets, and precipitating it into filaments using an acid-salt bath. These filaments, combined with edible binders and coated in melted fat, are then formed into meat like chunks. While the result is visually and texturally similar to natural meat, the production process is complicated and expensive.⁵

OBJECTIVE

The aim of this study was to develop a cost-effective and straightforward method for producing a meat substitute that can be manufactured continuously. The resulting product is convenient to handle, store, ship, and prepare. It is low in fat and, due to its polyunsaturated content, offers a healthier alternative for individuals with high blood cholesterol levels.

MATERIALS AND METHODS

The faba beans used in this study were cultivated in the Astore region of Gilgit-Baltistan and belonged to the fabaceae family. The beans were cleaned by removing stalks, stones, and damaged grains. They were then soaked in tap water overnight at room temperature. After soaking, the beans were ground into a slurry using a pin grinder and filtered through muslin cloth.

The resulting filtrate was heated to boiling and treated with various acids—lactic acid, acetic acid, hydrochloric acid, and a saturated citric acid solution—until a clear whey separated. The precipitate was washed to eliminate excess acid. To mimic the appearance of meat, caramel (0.05%), red (0.025%), and yellow (0.015%) food-grade colors were added, along with monosodium glutamate (0.5%), yeast extract (0.35%), salt (1%), and butylated hydroxyl anisole (0.02%).

The product was then dehydrated in a cabinet-type dehydrator (Model No. 6298 M. fchells) at 60°C for 10-12 hours until it reached a moisture content of 6.5%. For comparison, beef was also minced and dehydrated to the same moisture level.

Analytical Procedures

The meat substitute was analyzed for total protein, oil, moisture, ash content, urease activity, and peroxide value. Protein content was determined using the Kjeldahl method, while moisture and ash content were analyzed using AOAC methods. Urease activity and peroxide value were assessed using AACC 2000 methods.⁶

Microbiological Analysis: The product's microbiological safety was assessed by testing for total microbial count, yeast, mold, total coliforms, E. coli, Salmonella, and

Shigella. The total plate count was determined using nutrient agar, while malt extract agar was used to measure yeast and mold counts. Coliforms and E. coli were analyzed in lactose broth, Salmonella on bismuth sulphite agar, and Shigella on MacConkey and desoxycholate citrate agar AOAC 2011.⁷⁻⁸

Rehydration and Cooking Procedure

To prepare the product, 100 grams of the dehydrated meat substitute was soaked in 400 ml of water for 30 minutes. Separately, 50 grams of sliced onions were sauteed in 100 grams of vegetable oil until light brown. Ground garlic (35 grams), red chili powder (1/2 teaspoon), salt (1 teaspoon), and chopped tomatoes (125 grams) were added and cooked for 1-2 minutes. The rehydrated meat substitute, along with the soaking water, was then added to the mixture and cooked for 10 minutes. Green peppers, coriander, large cardamom, and cumin seeds were added for flavor and cooked for another minute.

Sensory Evaluation

The faba bean meat products prepared using lactic acid, acetic acid, hydrochloric acid, and citric acid were evaluated for sensory qualities. Beef was used as a reference. A panel of 12 judges assessed the products over three days, and the mean scores for each product were recorded.⁹⁻¹⁰

Acceptability Calculation

The overall acceptability of the product was assessed based on five parameters: color, flavor, texture, taste, and chewability. The acceptability percentage was calculated using the formula:

$$\text{Acceptability (\%)} = (\text{Average of 5 parameters} \times 100) / 50$$

Statistical Analysis

The data collected was analyzed using statistical methods, specifically Analysis of Variance (ANOVA). The differences in mean values were tested using Duncan's Multiple Range Test.¹¹

Biological Evaluation

Protein Efficiency Ratio (PER): To evaluate the protein efficiency ratio (PER) of the meat substitute, 12 albino rats (weighing approximately 160 grams each) were divided into three groups. The control group received a standard non-nitrogenous diet, while the other two groups were fed either the meat substitute or minced meat alongside the standard diet. The feeding trial lasted 30 days, during which food intake and weight gain were recorded. PER was calculated using the formula:

$PER = \text{Weight gain} \div \text{Protein consumed}$

Net Protein Utilization (NPU): For NPU determination, another set of 12 albino rats (weighing 240 grams each) was divided into three groups. The control group received a standard diet, while the other two groups were fed minced beef or the faba bean meat substitute.¹² Over four days, feces and urine were collected every 24 hours, thoroughly mixed, and nitrogen content was determined using the Kjeldahl method. NPU was calculated as follows:

$NPU = \text{Digestibility} \times \text{Biological Value (BV)}$

$NPU = \frac{1 - (F - M) - (U - UK)}{100}$

Results and Discussion

The products were analyzed for moisture, total protein, oil, ash content, urease activity, and peroxide value (Table 1). Among all samples, Sample 4 exhibited the highest protein content, oil content, and yield percentage. Urease activity and peroxide values for all samples fell within acceptable limits.

Organoleptic Evaluation

The five samples were evaluated for sensory characteristics—appearance, flavor, taste, texture, and chewiness—by a panel of 12 judges over three separate days. Mean scores for each parameter were recorded and used to determine overall acceptability.¹³



Figure 1. Faba bean seed.



Figure 2. High quality plant protein enriched faba meat.

Statistical analysis of the organoleptic data showed that Sample 4 (Figure 1) was significantly more acceptable than the other samples at a 5% significance level. Results from ANOVA were further validated using Duncan's Multiple Range Test, confirming the superiority of Sample 4.

Table 1. Faba meat analysis

Sr. No.	Moisture %	Protein %	Oil %	Ash %	Urease pH change	Proximate value Meg/kg	Yield %
1.	6.7	52.8	21.0	5.06	0.02	17.0	20
2.	6.5	55.3	20.3	5.0	0.04	15.0	35
3.	6.8	51.2	20.9	5.1	0.03	16.0	40
4.	6.5	60.0	21.5	4.9	0.05	15.9	60
5.	Beef 7.0	60.0	-	3.2	0.00	14.0	-

Table 2. Organoleptic evaluation

Sr. No.	Appearance (10)	Flavor (10)	Texture (10)	Taste (10)	Chewiness (10)	Total	%
1.	6.0	5.0	5.0	5.0	5.0	26.0	52.0
2.	6.5	5.5	6.0	5.0	5.0	28.0	56.0
3.	7.0	5.0	5.0	4.0	4.0	25.0	50.0
4.	8.0	7.9	9.0	8.5	8.0	41.4	82.0
5.	Beef 9.0	9.0	9.0	9.0	9.0	45.0	90.0

Table 3. Microbial status number of organisms per gram of sample

Sr. No.	Total count bacteria/ml	Yeast & mould	Total Col: MPN	Salmonella	E.coli	Shigella
1.	100	nill	5	0	nill	nill
2.	70	-	6	0	-	-
3.	80	-	4	0	-	-
4.	65	-	2	0	-	-
5.	200	-	2	0	-	-

Table 4. Determination of protein efficiency ratio of faba meat sample no. 04

Source of protein	Total protein intake	Wt. gain	PER
Soy meat	12gm	42.0 gm	3.5
Beef	12gm	43.2 gm	3.6

Table 5. Determination of NPU of faba meat sample no. 04

Source of protein	Total protein intake	Protein in feces	Protein in urine	NPU %
Soy meat	12gm	4.0 gm	0.008 gm	65.5
Beef	12gm	3.59 gm	0.006 gm	70.0

Conclusion

This product mimics dried minced meat and, once rehydrated and cooked, offers a texture similar to meat. Made entirely from vegetable protein, it is particularly suitable for diets emphasizing plant-based ingredients and controlled fat levels. It can be incorporated into flavorful and nutritious meals with vegetables and rice. Additionally, it serves as a valuable addition to casseroles, patties, meatballs, sandwich fillings, burgers, and various convenience foods, making it an excellent alternative for meat-free days.

Authors' contributions statement

Faizullah Khan, Dr. Shahid Masood, Dr. Muhammad Ashraf, conducted trials, developed products and conducted test; Alim-un-Nisa, Tariq Umar Khan, Ammarah Kanwal, prepared the draft; Dr. Asma Saeed, Dr. Ijaz Ahmad reviewed and finalized the draft.

Conflict of interest

The authors declare no conflict of interest.

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Availability of data and material

We declare that the submitted manuscript is our work, which has not been published before and is not currently being considered for publication elsewhere.

Code availability

Not applicable.

Consent to participate

All authors participated in this research study.

Consent for publication

All authors' submitted consent to publish this research article in this journal.

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