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Effects of Malting on Nutritional Quality, Anti-nutrients and Functional Properties of Mothbean Flour

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Abstract:

The present study was carried out to assess the effects of malting on nutritional quality, anti-nutrients and functional properties of mothbean flour. In the malting process, the soaking (12hrs), germination(24hrs) and drying(12hrs) was carried out; during this process moisture, protein, and crude fibre content increased with a decrease in other parameters. Results obtained showed that the moisture, protein, fat, carbohydrate, ash and crude fibre content of raw and malted mothbean flour varied between 8.29±0.25 to 10.46±0.36%, 21.89±0.32 to 24.13±0.7%, 1.74±0.20 to 1.13±0.3%, 61.13±0.87 to 57.4±0.05%, 3.41±0.01 to 2.4±0.02%, 3.54±0.1 to 4.48±0.14% respectively. The trypsin inhibitor activity was reduced from 0.126±0.17mg/g to 0.025±0.08mg/g and the phytic acid content of raw mothbean flour 0.726±0.01g/100g was reduced to 0.349±0.01g/100g after malting. The functional properties were also increased after the malting process, the water absorption capacity increased from 2.23±0.08 to 2.62±0.06 g/g and the oil absorption capacity increased from 1.81±0.43 to 2.2±0.68 g/g. Therefore, the malting process can improve the nutritional value and can be a potential source for value addition in food commercialization.

Keywords: Mothbean, malting, nutritional quality, germination, anti-nutritional factor

1. Introduction:

Mothbean (Vigna aconitifolia L.) is a leguminous plant known for its drought resistance and belongs to the Fabaceae family. It is typically cultivated in arid and semi-arid regions of India and recognized by several names such as mat bean, Matki, Turkish gram, or dew bean. The state of Rajasthan, which is the driest in India, plays a pivotal role in mothbean cultivation, accounting for nearly 86% of the total cultivation area in the country (NAS, 1979). Moth bean considered a native crop of India and Pakistan, is typically cultivated during the kharif season. Given the challenging circumstances of water scarcity and increasing agricultural input costs, moth bean emerges as an advantageous crop due to its minimal resource requirements, particularly water. It thrives in arid and semi-arid regions including states like Rajasthan, Maharashtra, Madhya Pradesh, and certain areas in Uttar Pradesh and Punjab (Sathe and Venkatachalam, 2007).

India holds the distinction of being the world's leading producer and consumer of pulses, including moth bean, accounting for approximately 22-25% of global pulse production (FAO, 2012). In developing nations, legumes play a crucial role as a nutritional resource. Major pulse crops grown in India encompass chickpeas, pigeon peas, lentils, urad bean, mung bean, lablab bean, horse gram, pea, grass pea, cowpea, and faba bean. While legumes are generally recognized as valuable protein sources, they are noted for having relatively lower protein and starch digestibility (Ghavidel and Prakash, 2007). Moth bean, however, stands out in this category. Its seeds contain 24.1% protein, 0.8% crude fibers, 1.3% fat, 3% ash, and 9.6 mg of iron per 100 grams (Fatema et al., 2011).

Phytochemicals are natural bioactive compounds found in plants. Leguminous seeds are a significant source of proteins and natural antioxidants. Within legumes, various phenolic compounds like flavonoids, phenolic acids, and tannins can be found. There is substantial interest in exploring these natural phytochemicals and antioxidants from plants due to their potential role in preventing and treating various diseases. For instance, trypsin inhibitors have been linked to a reduced risk of certain cancers and possess strong anti-inflammatory properties (Gupta et al., 2016). Moreover, consuming moth beans four or more times a week, as opposed to less than once a week, has been associated with a 22% lower risk of coronary heart disease (Bazzano et al., 2001).

Germination improves the nutritional quality of pulses, not only by reducing antinutritive compounds but also by increasing protein content, dietary fiber, vitamins, and bioavailability of trace elements and minerals (Kaushik et al., 2010). Malting is a simple biotechnological technique that increases enzyme activity and causes carbohydrate and protein pre-digestion in legumes (Ghavidel and Davoodi, 2011).

Many traditional methods of food preparation, such as malting, enhance the nutritional value by reducing certain antinutrients. These processing techniques are widely employed in societies where cereals and legumes constitute a significant portion of the diet (Hotz and Gibson, 2007). Malting involves controlled germination followed by controlled drying of the kernels. The primary aim of malting is to facilitate the development of hydrolytic enzymes, which are not present in ungerminated grains (Dewar, 2003; Latha and Muralikrishna, 2009). Malting enhances nutrient content by breaking down complex compounds into simpler ones, facilitating easier digestion. Malting also helps in increasing the bioavailability of micronutrients like iron and calcium. Iron is essential for boosting blood levels and preventing anaemia, while calcium contributes to stronger bones and the formation of healthy teeth (Singh, 2018).

Malting involves three key stages: steeping, germination, and drying. Steeping serves to soften the grains and enhance water absorption. During germination, enzymes are generated which facilitate the breakdown of starch and protein, releasing sugars and amino acids for easy accessibility. Drying is the final stage malting process and is essential for halting further kernel growth, lowering moisture levels and reducing water activity. This results in a stable product with active enzymes. (Baranwal, 2003).

2. Materials and Methodology:

A. Selection of ingredients:

The initial step involved acquiring unprocessed mothbeans from the local market in Parbhani. These raw grains underwent a manual cleaning process to eliminate any dust, stones, twigs or other extraneous materials. The research was conducted at the Department of Food Chemistry and Nutrition located within the College of Food Technology at Vasantrao Naik Marathwada Krishi Vidyapeeth (VNMKV) in Parbhani.

B. Sample preparation:

Mothbean malted flour was produced by using the method described by (Mankotia and Modgil, 2003). Mothbean grains were steeped in potable tap water for 12 hrs. Grain to water ratio was 1:3. The soaked grains were tied in a muslin cloth and allowed to germinate at an ambient temperature of 25 ± 2^0C. Grains were sprinkled with water. It took 24 hrs for grains to germinate. When the sprouts were 1-2 cm long germinated grains were dried in cabinet drier at 50 ± 3^0C for 12 hrs. After drying the rootlets were removed and samples were milled to pass through a 40-mesh sieve. After grinding samples were kept in air-tight plastic containers till further analysis was done.

C. Proximate Analysis:

Different chemical properties of samples were analyzed for moisture content, ash, fat, protein and total carbohydrate. The results were expressed as the average value, and each determination was made three times.

Moisture content:

Moisture content was determined as per the method given by AOAC (2005). It was calculated using the following formula.

$$\%\ \text{Moisture content} = \frac{\text{Initial weight (g) - Final weight (g)}}{\text{Weight of the sample}} \times 100$$

Ash:

Drying the sample at 100^0C and churned over an electric heater. It was then ashes in a muffle furnace at 550^0C for 5 hrs. It was calculated using the following formula:

$$\%\ \text{Ash content} = \frac{\text{Weight of the ash}}{\text{Weight of the sample}} \times 100$$

Fat:

The AOAC (2005) method using soxhlet apparatus was used to determine the crude fat content of the sample. The percent of crude fat was expressed as follows:

$$\%\ \text{Fat content} = \frac{\text{Weight of ether extract}}{\text{Weight of sample taken}} \times 100$$

Protein:

Protein content was determined using AOAC (2005) method. The percentage of nitrogen and protein is calculated by the following equation:

$$\%\ \text{Nitrogen content} = \frac{T_s - T_B \times \text{Normality of acid} \times 0.014}{\text{Weight of sample taken}} \times 100$$

Where,

Ts = Titre volume of the sample (ml),
T_B = Titre volume of Blank (ml), 0.014= M eq. of N
% Protein = Nitrogen × 6.25

Crude fibre:

The crude fibers were determined according to the methodology described by Ranganna (2011).

Total carbohydrate:

The total carbohydrate content of the samples was determined as total carbohydrate by difference, calculated by subtracting the measured protein, fat, ash and moisture from 100.

Water and oil absorption capacity:

Following the procedures described by (Sosulki et al., 1976), 1 gram of the flours was added with either 10 ml of distilled water or purified sunflower oil. properly mixed and kept at ambient temperature for 30 min. The resulting mixture was centrifuged at 2000rpm for 10 min in a weighed centrifuge tube and the supernatant was decanted. OAC and WAC were calculated as the difference between the initial weight of the sample and the weight of the sample after the water/oil added had been decanted. The results were expressed in terms of the water/oil content bound per gram of flour sample, reported on a dry basis.

Trypsin inhibitor activities:

Trypsin inhibitor activity of legume samples were measured according to the procedure of (Roy and Rao, 1971).

Phytic acid content:

Phytic acid was determined by standard procedure of (Wheeler and Ferrel, 1971).

3. Result and Discussion:

A. Nutritional composition of raw and malted mothbean flour:

The data pertaining to the nutritional composition of raw and malted mothbean flour were determined and results were obtained and illustrated in table.1

Table 1: Nutritional composition of raw and malted mothbean flour

Chemical Properties (%)	Raw Mothbean Flour	Malted Mothbean Flour
Moisture	8.29±0.25	10.46±0.36
Protein	21.89±0.32	24.13±0.7
Fat	1.74±0.20	1.13±0.3
Carbohydrate	61.13±0.87	57.4±0.05
Ash	3.41±0.01	2.4±0.02
Crude Fibre	3.54±0.1	4.48±0.14

Results are given in the above table. 1 indicated that the mean value for moisture, protein, fat, carbohydrate, ash and crude fiber content of raw and malted mothbean flour varied between 8.29±0.25 to 10.46±0.36%, 21.89±0.32 to 24.13±0.7%, 1.74±0.20 to 1.13±0.3%, 61.13±0.87 to

57.4±0.05%, 3.41±0.01 to 2.4±0.02%, 3.54±0.1 to 4.48±0.14%, respectively. The results reported are in close agreement with the findings of (Baghmare et al., 2019). Malting increases moisture, protein and crude fibre content with a decrease in other parameters.

The process of sprouting can lead to an apparent rise in protein content due to the reduction in dry weight (carbohydrates). It was also possible that the increase in protein was due to the uptake of water during germination. Higher true protein may be due to the synthesis of new protein (Ghavidel and Prakash, 2007). The decrease in fat in mothbean may be due to the increased activity of lipase (Pawar and Ingle., 1988).

The decrease in starch content was maximum in sprouted grain and this decrease might have been due to hydrolysis of starch during germination. Soaking medium likely to increase the porosity of seed throughout the germination period, thereby imparting leaching out of solid matter during pre-germination soaking process could be the reason for the reduction of mineral matter in sprouted moth beans and so in the moth bean malt (Ghavidel and Prakash, 2007). The increased fibre content during germination processes, causes the synthesis of cellulose and hemicellulose present in grown mass which act as structural carbohydrates and are important component of cell wall. These results in increase in fiber content during malting (Chung et al., 1998).

B. Effect of malting on anti-nutritional factors of mothbean:

Trypsin inhibitory activity reduced from 0.126±0.17 to 0.025±0.08 mg/g respectively in raw flour and malted mothbean flour. While phytic acid content was also reduced from raw moth bean 0.726±0.01g/100g to malted moth bean 0.349±0.01 g/100g.

Table 2: Effect of malting on anti-nutritional factors of mothbean

Anti-Nutritional Factors	Raw Mothbean Flour	Malted Mothbean flour
Trypsin inhibitor activity(mg/g)	0.126±0.17	0.025±0.08
Phytic acid (g/100g)	0.726±0.01	0.349±0.01

C. Functional properties of raw mothbean and malted mothbean flour

The WAC of malted mothbean flour (2.62±0.06 g/g) is found to be higher than that of mothbean flour (2.23±0.08 g/g); which may be due to starch gelatinization and protein denaturation. The similar determinations of higher WAC in malted flour are due to a rise in protein content and high hydrogen bonding of flour, as reported by (Bhokre et al., 2015).

Table 3: Functional properties of raw mothbean and malted mothbean flour

Properties (g/g)	Raw Mothbean flour	Malted Mothbean flour
Water absorption capacity	2.23±0.08	2.62±0.06
Oil absorption capacity	1.81±0.43	2.2±0.68

Similarly, the OAC of malted mothbean flour (2.2±0.68 g/g) is significantly higher than that of raw mothbean flour (1.81±0.43 g/g), which is due to the existence of the hydrophobic nature of proteins. The results reported are in close agreement with the findings of (Baghmare et al., 2019).

4. Conclusion

In conclusion, malting process would be an alternative to enhance the nutritional properties of mothbean bringing many advantages. The present investigation reveals that malting of mothbean enhances the nutritional quality just before the development of food products. These processes also significantly reduce the anti-nutritional components and enhance the functional properties in the same. Therefore, malted mothbean flour can be used in combination with food products and considered to be one of the best preventable measures for disorders of protein malnutrition. Therefore, malting can enhance the nutritional content and shelf-life and also could be used in the formulation of new nutritive products.

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