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Harshita Bordia
M.Sc. Research Scholar, Department of Food Science and Nutrition, College of Community and Applied Sciences, MPUAT, Udaipur, Rajasthan, India

Dr. Renu Mogra
Professor, Department of Food Science and Nutrition, College of Community and Applied Sciences, MPUAT, Udaipur, Rajasthan, India

Corresponding Author:
Harshita Bordia
M.Sc. Research Scholar, Department of Food Science and Nutrition, College of Community and Applied Sciences, MPUAT, Udaipur, Rajasthan, India

Physical properties and nutritional composition of mango seed powder for development of value-added products

Harshita Bordia and Dr. Renu Mogra

Abstract
Mango seed powder has an effective nutritional impact as it is rich in dietary fiber, protein, and micronutrients. Antioxidants included in mango seed powder are effective in the treatment of diabetes, diarrhoea, irregular bowel movements, allergies, cancer, urinary tract infections, and haemorrhoids. Mango seed powder's physical characteristics and nutritional makeup were studied in this study. The bulk density, swelling capacity, swelling index, hydration capacity, and hydration index of mango seed powder are each 0.54 ± 0.01 g/ml, 2.30 ± 0.26 ml/g, 0.07 ± 0.02, 0.86 ± 0.03%, and 0.43 ± 0.02 respectively. The quantity of crude energy, protein, calcium, iron, and phosphorus content in mango seed powder was found to be higher. Our research suggests that since mango seed powder has a higher concentration of nutrients that are good for health, it can be used in various other food products.

Keywords: Antioxidants, health benefits, mango seed powder, nutrients

1. Introduction
Mangoes (*Mangifera indica*) are among the most commercially significant fruits that may be utilized both raw and ripe. It is referred to as the "King of Fruits". Both the eating qualities and nutritional content of mango are excellent. There are 45.23 million metric tons of mangoes produced worldwide (FAOSTAT, 2013). India, China, and Thailand are the largest producers of mangoes in the world. India is home to about 1500 varieties of mango. The mango production in India accounts for about 40% of the global production. Some important commercial varieties of mango produced in India are *Neelum, Totapuri*, Bombay Green, *Chausa, Dashehari*, Alphonso, etc.
Mango processing generates peels and seeds as bio-wastes, though they also have nutraceutical significance. The mango seed has higher antioxidant and polyphenolic contents than the pulp and peel and is used for oil extraction; it's possible usage in combination with corn and wheat flour in preparing nutraceuticals is being increasingly emphasized.
The large amount of waste produced by the food industries causes serious environmental problems and also results in economic losses if not utilized effectively. Different research reports have revealed that food industry by-products can be good sources of potentially valuable bioactive compounds. The mango juice industry uses only the edible portions of the mangoes, and a considerable amount of peels and seeds are discarded as industrial waste. This could be a menace to the environment and also bring economic loss to fruit processing industries. Mango by-products, especially seeds and peels, are considered to be cheap sources of valuable food and nutraceuticals ingredients. Proper management of mango processing waste using the concept of bio refinery could help mitigate the environmental issues of waste disposal and help gain economic benefits.
Mango seed powder contains an abundance of nutrients. As a result, adding mango seed powder to food products is thought to be an excellent substitution for nutritional enhancement. The main components of mango seed powder are protein, fat, and starch Mango seed powder provides starch, which is utilized in the food and pharmaceutical industries. Even though mango seed powder has low protein content, the protein is of good quality since it contains the majority of the essential amino acids, with the highest concentrations of leucine, valine, and lysine. It can therefore be used as a nutrient-rich dietary source.
High concentrations of iron, potassium, calcium, magnesium, sodium, and phosphorus are found in mango seed powder. In the metabolism of carbohydrates and as a binding agent for cell walls, magnesium and calcium play significant roles.

Calcium is necessary for the growth of teeth. Magnesium aids in the function of enzymes and controls the body's acid-base balance. The growth of bones, kidney function, and cells all depend on phosphorus. Red blood cell formation and the conversion of blood sugar to energy both require iron for proper function. Urinary tract infections are the second most common type of infection worldwide. Natural plant substances called phytochemicals share chemical characteristics with manufactured antibiotics. Through a cold methanolic extraction process, bioactive chemicals are removed from mango seed powder. These extracts have antimicrobial properties. Additionally, it has a number of other health benefits, including antimicrobial, antidiabetic and antiallergic.

Mango seed powder is a potential source of natural antioxidants due to the presence of phenolic chemicals. Antioxidant properties from mango seed powder are extracted using a variety of extraction techniques. The mango seed powder supplement also contains ellagic acid, gallic acid, coumarin, ferulic acid, vanillin, and cinnamic acid as additional antioxidant components.

A variety of value-added products can be created by combining mango seed powder flour with other flours. Mango seed powder can be used to create goods having therapeutic value. It helps increase the oxidative stability of food, which makes it useful as a food preservative. Due to the presence of secondary metabolites such as tannins, alkaloids, glycosides, flavonoids, and saponin, Mango seed powder has ant diarrheal action and reduces intestinal motility. Despite the existence of research studies, little is known about the nutritional profiles of mango seed powder, including its chemical composition, mineral content, and physiochemical characteristics.

2. Materials and Methods

2.1 Procurement and preparation of mango seed powder

Mangoes were procured in a single lot from the local market of Udaipur city. Mango seeds were extracted from the fruit, and were cleaned properly to remove any dirt, dust or insect. After processing the clean mango seeds were ground into powder in an electric grinder and sieved through sieve. Before use, the flour samples were stored in an airtight container.

2.2 Physical properties of mango seed powder

The bulk density of mango seed powder was measured using the method suggested by Okaka and Potter (1977) [18]. Fifty grams of mango seed powder was filled into a 100 ml graduated cylinder by gently tapping it on a bench top 20-30 times. The bulk density was determined as weight of seeds (g)/final volume of seeds (ml). Also swelling capacity, swelling index, hydration capacity and hydration index was determined by using the method given by Bishnoi and Khetarpal (1993) [5].

2.3 Nutritional composition of mango seed powder

Proximate analysis was conducted on the mango seed powder according to Association of Official Analytical Chemists (AOAC 2000) [2] standard methods. Mango seed powder was analysed for moisture content using (NIN 2003) [16]. In a dried and weighed petri dish, a ten gram sample was weighed. The sample and petri dish were weighed at regular intervals until a constant weight was obtained.

Crude fat analysis was conducted based on a Soxhlet Extraction Method (AOAC 2000) [2]. Ash content analysis was carried out based on dry ashing method by burn up samples in a muffle furnace at 550 °C to white ash (AOAC 2000) [2]. Crude protein analysis was determined based on Micro-Kjeldahl Method (AOAC 2000) [2].

Carbohydrate content was calculated from moisture, crude fat, ash, and crude protein contents as follows: % Carbohydrate = 100% - (Moisture + crude fat + Ash + Crude protein) %. The energy content was calculated using physiological fuel values of 4 Kcal per gram for protein, 9 Kcal per gram for fat and 4 Kcal per gram for carbohydrate content as follow: Energy (Kcal/100 g) = (% protein x 4) + (% carbohydrate x 4) + (% fat x 9) for mineral estimation, the samples were wet acid digested, using nitric acid and perchloric acid mixture (HNO_3:$HClO_4$, 5:1 w/v). The total amounts of iron, calcium and phosphorus in the digested samples were determined by Atomic Absorption Spectrophotometry (Lindsey and Nowell, 1969).

2.4 Estimation of Antioxidant activity

According to the technique described by Ara and Nur (2009) [3], based on that of Molyneux (2004), the free radical scavenging capacity of the methanolic extracts was assessed using DPPH.

3. Results and Discussion

3.1 Physical properties of mango seed powder

The data on physio-chemical properties of mango seed powder are presented in Table 1. The bulk density of mango seed powder was determined to be 0.54 ± 0.01 g/ml. Excess moisture content and insect attack generally affect grain bulk density (FAO,2012) [6], which is important in determining quality standards, material handling and various food sector (Karuna *et al*. 1996).

Swelling capacity is referred to as the amount of water a molecule holds in response to its volume of growth, which it retains until a colloidal suspension is obtained and uptake is prevented by intermolecular interactions in the swollen particle (Houssou and Ayernor, 2002) [7]. The swelling capacity and swelling index were found to be 2.30 ± 0.26 ml/g and 0.07 ± 0.02 respectively.

According to the hydration capacity and hydration index results, mango seed powder has a hydration capacity of 0.86 ± 0.03 percent and a hydration index of 0.43 ± 0.02.

Table 1: Physical properties of Mango seed powder

S. No.	Physical property	Mean ± SD
1.	Bulk Density (g/ml)	0.54 ± 0.01
2.	Swelling capacity (ml/g)	2.30 ± 0.26
3.	Swelling index	0.07 ± 0.02
4.	Hydration capacity (%)	0.86 ± 0.03
5.	Hydration index	0.43 ± 0.02

All values are (Mean ± SD) of three observations

3.2 Nutritional composition of mango seed powder

Proximate composition: The Table 2. comprises with the results of proximate composition of mango seed powder. The mean moisture content of mango seed powder was noted to be 3.30±0.10 per 100 g. According to another investigation (Ogunsina *et al.* 2012) [17] the mean moisture content for mango seed powder was 2.5 g, which is significantly lower than the current study. The current study found a mean value of crude protein 5.94±0.06 per 100 g per 100 g whereas (Ogunsina *et al.* 2012) [17] reported the protein content to be

8.9 g. The difference in stated moisture content may be caused by the various mango quality, various environmental elements, various phases of fruit development, and various climatic growth conditions.

Mango seed powder has a mean ash content of 2.10 ± 0.10 per 100 g while according to Baneerjee *et al.* 2016 [4], the average amount of ash in mango seed powder is 2.1 g. The total amount of mineral present in a sample is indicated by the quantity of ash of the food material.

The mean fat content and crude fiber content of mango seed powder in the current study was 9.20 ± 0.10 per 100 g and per 2.48 ± 0.17 g 100 g respectively. Whereas Ifesan 2017 [8], stated that the fat and fiber content of mango seed powder was 10.01 g and 2.63 g respectively.

The carbohydrate and energy content of mango seed powder was found to be 77.34 ± 0.21 g per 100 g and 415.51 ± 0.45 Kcal per 100 g respectively.

Table 2: Proximate composition of Mango seed powder

S. No.	Nutrients	Mean ± SD
1.	Moisture (g)	3.30 ± 0.10
2.	Crude protein (g)	5.94 ± 0.06
3.	Fat (g)	9.20 ± 0.10
4.	Ash (g)	2.10 ± 0.10
5.	Crude fiber (g)	2.48 ± 0.17
6.	Carbohydrates (g)	77.34 ± 0.21
7.	Energy (kcal)	415.51 ± 0.45

All values are (Mean ± SD) of three observations

The calcium, iron and phosphorus content of mango seed powder is shown in Table 3. and it is abundantly evident that the calcium level of mango seed powder had been recorded as 168.93 ± 0.13 mg per 100 mg. According to Yatnatti *et al.* 2014 the calcium content was 170 mg per 100 g. Mango seed powder's iron content was calculated to be 12.46 ± 0.11 mg per 100 g. And the phosphorus content of mango seed powder was 94.74 ± 0.13 mg per 100 g.

Table 3: Mineral content of Mango seed powder (mg per 100 g)

S. No.	Nutrients	Mean ± SD
1.	Calcium	168.93 ± 0.13
2.	Phosphorus	94.74 ± 0.13
3.	Iron	12.46 ± 0.11

All values are (Mean ± SD) of three observations

3.3 Antioxidant activity of mango seed powder

The anti-nutritional components of Mango seed powder, including antioxidants, saponins, and phytic acid, are known to Lower the digestion as well as elevate tannin content and both of these are characteristics of Indian mango kernel powder. The antioxidant activity of mango seed powder in the current study was observed to be 73.26 ± 0.24 mg TE/ 100g.

4. Conclusion

According to this study mango seed powder is an excellent source of protein, calcium, iron, phosphorus and vitamin B12. Mango seed powder have higher antioxidant and polyphenolic contents. Mango seed powder's high nutritional value strongly suggests that it can improve health when added to food products. Mango seed powder's variety and nutrient content can contribute to a nutritious diet and enhance the quality of products being prepared.

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