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Processing and Nutritive Value of Mango Seed Kernel Flour

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ABSTRACT

Processing of ripe mango fruit, generates its peel and seed as waste, which is approximately 40-50 % of the total fruit weight. Present study was undertaken to process mango seed kernel and to study its nutritional value. Mango seeds of Totapuri variety were procured from local food processing industry. Kernels were separated from seeds and processed into flour through various processing steps. Particle size distribution of the flour was studied. The Mango Kernel Flour (MKF) was subjected for chemical analysis. The nutrients analyzed for mango kernel flour were moisture, protein, fat, crude fibre, ash, calcium, magnesium, potassium, sodium, manganese, copper, zinc and iron by standard methods. Carbohydrate and energy contents were computed. Mango kernel oil was extracted by solvent extraction method. Results revealed that recovery per cent of mango kernel flour was 80.6 and maximum flour particles passed through 60 mesh. MKF is good source of protein (7.53 g/100g), fat (11.45 g/100 g) and energy (421 k.cal /100g). It also contains appreciable levels of calcium (170 mg/100g), magnesium (210 mg/100g) and potassium (368 mg/100g) which are important macro minerals required for vital functions of the body. Oil yield from mango kernel flour was found to be 11.5 per cent which was studied for selected physical and chemical properties.

Key words: Mango seed kernel, Processing, Nutrient composition.

INTRODUCTION

The processing of fruits results in high amounts of waste materials such as peels, seeds, stones, and oilseed meals. A disposal of these materials usually represents a problem that is further aggravated by legal restrictions. Thus, new aspects concerning the use of these wastes as by-products for further exploitation on the production of food additives or supplements with high nutritional value have gained increasing interest. It is well known that by-products represent an important source of sugars, minerals, organic acid, dietary fibre and phenolics which have a wide range of action which includes anti-tumoral, antiviral, antibacterial, cardio-protective and anti-mutagenic activities (Jasna, 2009).

Mango (*Mangiferaindica*) is the main fruit of Asia and has developed its own importance all over the world. India is the largest producer of mangoes with 44.14 per cent of the total world production (Kusuma and Basavaraja, 2014).As mango is seasonal fruit, about 20 per cent of fruits are processed for products such as puree, nectar, leather, canned slice and chutney, juices, ice cream, fruit bars and pies.During the processing of ripe mango, its peel and seed are generated as waste, which is approximately 40-50 % of the total fruit weight. (Ashoush and Gadallah, 2011).Mango seed is a single flat oblong that can be fibrous or hairy on the surface, depending on the cultivar. The kernel inside the seed represents 45 to 75 per cent of the seed and about 20 per cent of the whole fruit.

The kernel obtained after decortication of mango stone can be utilized as a supplement to wheat flour or for extraction of edible oil. Besides its use in animal feed, mango kernel flour can be utilized for edible purposes. In this regard processing of mango seed kernel is important to utilize it in food product development. Assessment of nutritive value of processed mango kernel flour will be supportive in understanding its nutritional significance and in selection of food products for its incorporation. Hence study was conducted with the objective to process mango seed kernel and to analyse its nutritive value.

MATERIALS AND METHODS

Procurement of mango seed sample

Seed waste of Totapuri variety fruit was procured from a local mango processing, Safal industry, Bengaluru, Karnataka, India.

Processing of mango seed into kernel flour

Mango seeds were washed and dried in hot air at 60° C for 6 hours. Kernels were separated from stone manually using stainless steel knife and dried in hot air oven at 50º C for 4 hours and stored in air tight containers. During processing stored kernels were soaked (6-7 hors) in water, chopped into small pieces, blanched (1-2 min), dried (60º C for 5 hours) and ground into flour in electric blender, sieved and stored in air tight container.

Table. 1: Per Cent Distribution Of Mango Fruit Parts (Per Kg)

Mango fruit parts	Weight (g)	Per cent (%)
Pulp	680.9	68.1
Peel	169.8	17.0
Seed coat	59.5	05.9
Kernel	89.8	09.0

*Table showing weight of mango fruit parts viz. pulp, peel, seed coat and kernel per Kg of fruit (also expressed same in percentage)

Particle size distribution of mango kernel flour was determined using a set of standard sieves (44, 60 and 72); 25 g of sample was placed on the largest sieve, and the weight of samples retained on each sieve after 10 min of manual shaking was recorded. The particle size was expressed as the percentage of particles retained on each sieve (Chen, *et al*., 1998).

Nutrient composition of mango kernel flour (MKF) and oil properties

The mango kernel flour was subjected for chemical analysis. The nutrients analyzed were moisture, protein, fat, crude fibre, ash, calcium, magnesium, potassium, sodium, manganese, copper, zinc and iron according to the standard AOAC, 1990 methods. Carbohydrate and energy contents were computed. The samples were worked in triplicates and average values were recorded.

Mango kernel oil was extracted by solvent extraction method. Physical parameters studied were oil yield, specific gravity and refractive index. Yield of oil for known weight of flour sample was recorded and expressed as per cent. Refractive index was measured by hand/pocket refractometer. Specific gravity and chemical analysis of oil (iodine, acid, saponification and peroxide value) were studied according to method described by Raguramulu *et al.,* 2003.

Table. 2: Recovery Of Mango Kernel Flour (MKF)

Processing steps	Weight (g)	% increase / decrease in weight (%)
Weight of kernels	500	-
Weight of kernels after soaking	832	166.4
Weight of kernel after drying	453	90.6
Weight of kernel after milling	421	84.2
Milling loss	32	6.4
Recovered flour after sieving (40 mesh)	403	80.6

*This table reveals, per cent increase/ decrease in weight of kernels (500 g) during each step of processing (soaking, drying, milling, sieving) into flour. 5X

RESULTS AND DISCUSSION

Parts of mango fruit

Per cent distribution of mango fruit was studied and depicted in Table I. Mango seed coat and kernel together represent 14.9 per cent of the whole mango fruit weight, out of which mango kernel alone represents 9 per cent of whole fruit weight. Results obtained were in agreement with the findings of Dhingra and Kapoor (2007), reported that seed and kernel comprised 18 and 10 per cent of total fruit, respectively. Elegbede *et al.* (1995) reported that kernel constitutes 10 per cent of the fruit weight. Variations in seed and kernel per cent of the mango fruits is attributed to the varietal difference. According to Kittiphoom *et al.* (2013) seed content of different varieties of mangoes ranges from 9 to 23 per cent of fruit weight. In the present study the variety of mango was Totapuri**.**

Processing

During processing hard kernels were soaked in water for 18-20 hours to soften them. Soaking increased the weight of kernels to 166.4 per cent of initial weight (500 g). Soaked kernels were chopped and dried in hot air oven at 60°C for 5 hours. After drying kernel sample decreased to 90.6 per cent of initial weight. Milling of these dried kernels decreased the weight to 84.2 per cent due to milling loss of 6.4 per cent. After sieving the milled flour through 40 mesh, processed mango kernel flour (MKF) weight was observed to be 80. 6 per cent, which indicate the per cent recovery of the mango kernel flour for 100 g of kernels (Table II).Prathima (2008) studied the recovery of flour from jackfruit seeds by different methods and reported 50, 46 and 43 per cent from boiling, lye peeling and mechanical peeling methods respectively, which was found to be low due to presence of husk (11.6 %).

Particle size distribution

Particle size of mango kernel flour was studied and depicted in Table III. Maximum per cent of flour particles (64 %) were passed through 60 mesh sieve, followed by 16 per cent of flour particles passed through 72 mesh sieve. Only 6 per cent of flour particles had particle size more than 44 mesh sieves which remained in the sieve and about 14 per cent had particle size of 44 mesh, which passed through the same mesh number and remained on 60 mesh sieve. Particle size reduction of the starting raw

Table. 3: Particle Size Of Mango Kernel Flour (MKF)

Mesh size	Sample weight(g)	Per cent(%)
44<	01.5	6
44	03.5	14
60	16.0	64
72	04.0	16

*Table shows when 25 g of mango kernel flour was passed through series of sieves, amount of flour remained on each sieve indicating particle size and same expressed in percent.

* It reveals distribution mango kernel flour particles

Table. 4: Nutrient composition and oil quality characteristics of mango kernel flour (MKF)

Nutrient	Content
Moisture (%)	7.05
Protein (g)	7.53
Fat (g)	11.45
Crude fibre (%)	2.20
Carbohydrate (g)	69.77
Energy (k.cal)	421
Ash (g)	1.00
Calcium (mg)	170.00
Magnesium (mg)	210.00
Sodium (mg)	2.90
Potassium (mg)	368.00
Iron (mg)	12.40
Copper (mg)	8.60
Zinc (mg)	5.60
Quality Characteristics of mango kernel oil	
Oil (%)	11.5
Specific gravity at 24° C	0.89
Refractive Index at 30ºC	1.58
Iodine value (g/100g oil)	46.0
Saponification value (mg KOH/g)	192
Free fatty acids (%)	3.97
Peroxide value (meq/kg of oil)	1.73

*This table reveals nutrient analysis of mango kernel flour which involves both selected macro and micro nutrients.

*It also reveals selected physicochemical properties of oil extracted from mango kernel flour material is an important factor which influences the efficiency of value added processing (Russin*et al.,* 2007). Smaller the sieve number on which maximum flour particles retain bigger will be the particle size. MKF had slightly coarser flour particles. A range of particle sizes is evident in flour samples because the grinding process creates a broad particle size distribution which includes both smaller and larger particles. Bran particle containing fibre will have bigger particle size compared to flour particles containing adequate quantity of starch and protein (Chen *et al.*, 1998).

Nutrient composition

Nutrient composition of mango kernel flour (MKF) per 100 g is depicted in Table IV. Results indicate that processed mango kernel flour has 7.05 per cent moisture. Macro nutrient composition is as follows, protein: 7.53g, fat: 11.45 g, crude fiber: 2.20 g, carbohydrate : 69.77 g and provides energy of 421 K cal. It contains 1 g of ash, which includes important minerals like calcium (170 mg), magnesium (210mg), sodium (2.90 mg), potassium (368 mg), Iron (12.4 mg), copper (8.60 mg) and Zinc (5.60 mg).

Results showed that MKF is good source of protein, fat and energy and are in line with the findings of Dakare *et al.* (2012) who reported the proximate composition of mango kernel flour samples processed with 9 different techniques. Protein content of these flour samples ranged between 6.03 to 7.40 g, fat 8.50 to 12 g and energy 316 to 340 kcal. Higher values were reported by Fowomola (2010) for crude protein (10.06%), crude oil (14.80), ash (2.62), crude fibre (2.40), carbohydrate (70.12%) and energy (453 kcal).

Results of the present study revealed that MKF has appreciably high levels of calcium, magnesium and potassium which are important macro minerals required for vital functions of the body. Several studies reported that copper was not detected in mango kernel, but in present research work it was found to be 8.6 mg / 100 g. Zinc content was found to be higher than the studies reported (5.60 mg/100g) presented in Table IV. Lower values were reported by Elegbede *et al.* (1995) in which calcium content ranged from 47 to 49, magnesium 80 to 100, zinc 1.2 to 2.1, iron 9.5 to 11, potassium 345 to 365, sodium 2.8 to 3 mg per 100 g for three varieties of mango kernels. Fowomola (2010) reported the sodium, potassium, calcium, magnesium, iron and zinc content of mango seeds was, 21, 22.3, 111.3, 94.8, 11.9, 1.10 mg per 100 g respectively. These variations of mineral contents of kernels may be due to the variety of the mango fruit, type of soil and environmental conditions.

Oil properties

Oil was extracted and tested for its physical and chemical properties through various parameters. Results of physicochemical parameters of mango seed kernel oil are presented in Table IV.

Oil yield from mango kernel flour was found to be 11.5 per cent. Findings are on par with the results reported by Mahale and Goswamigiri (2011). According to Fahimdanesha and Bahrami (2013) content and yield of oil is affected by variety of mango fruit, cultivation climate, ripening stage and extraction method used and reported 12.5 per cent which was observed to be slightly higher.In the present study specific gravity of the selected

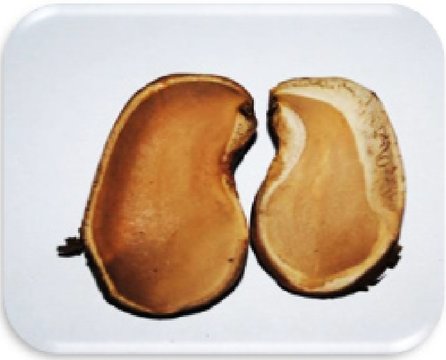

Fig. 1: Mango seed kernel (Totapuri)

Fig. 2: Processed Mango Kernel Flour (MKF)

variety of mango kernel oil (Totapuri) was 0.89 g/ml. This was on par with the results of Mahale and Goswamigiri (2011), reported that specific gravity of the mango seed kernel oil was 0.910 g/ml at 28ºC. Refractive index of mango kernel oil was found to be 1.58 at 30º C. Lower value 1.45 was reported by Olajumoke (2013). Fahimdanesha and Bahrami (2013) reported refractive index of mango kernel oil 1.443 at 40 ºC. Mahale and Goswamigiri (2011) reported higher refractive index values (2.5).

Results obtained for iodine value oil from mango kernel flour in the present study (46.0 g per 100 g of oil) is on par with the results reported by Mahale and Goswamigiri (2011). Iodine value of both, mango kernel crude oil and refined oil was 45.5 gram of Iodine per 100g of oil. In the present study saponification value of mango kernel oil was found to be 192 mg of KOH per gram and on par with the results reported by Fahimdanesha and Bahrami (2013).The free fatty acid content is known as acid number or acid value and it was found to be 3.97 (Table 4) per cent, on par with the results reported by Nzikou *et al.* (2009), indicated extraction method has the impact on free fatty acid values. Higher values (8.17 mg/100g) were reported by Olajumoke (2013). Peroxide value serves as an indicator of the extent of formation of primary oxidation products (Anwar *et al.,* 2005). In the present study, peroxide value of the mango kernel oil found to be 1.73 meq/kg oil. Lower values, 1.26 meq/kg of oil was reported by Fahimdanesha and Bahrami (2013)and Olajumoke (2013) 1.20 meq/kg oil.

It may be concluded that, mango seed kernel which represent about 9 per cent of total fruit weight and treated as processing waste, can be processed into flour with maximum recovery, which can be used to incorporate into food product as supplement. Nutritive analysis of MKF reveals that it is a good source of nutrients like protein, fat, energy, calcium, magnesium and potassium. Oil property study of mango kernel flour helpful to understand its chemical nature and to select food products for its incorporation.

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