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Effect of processing on proximate and phytochemical content of mango (*Mangifera indica*) kernel

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Abstract
Mango (*Mangifera indica* L.) is an important member of the family Anacardiaceae in order Sapindales. “Kesar” Mango is the queen of mangoes widely grown in the Gujarat state of India. It has a unique sweet taste. During processing of mango, kernel is generated as waste which is rich in various nutrients. Mango seed kernel can be used as a potential source for functional food ingredients, animal feeds, antimicrobial compounds and cosmetic due to its high quality of fat and protein as wells as high levels of natural antioxidants. Effect of processing on Mango kernel was studied with respect to the proximate composition, vitamin and mineral content and phytochemical content as total phenolic content, flavanoids, tannins, alkaloids and saponins which get reduced during processing into flour.

Keywords: mango, waste, kernel, phytochemical

Introduction

Mango (*Mangifera indica* L.) is an important member of the family Anacardiaceae in order Sapindales and is the most important fruit crop in India having a great cultural, socio-economic and religious significance since ancient times. It is said to be originated in the Indo-Burma (Myanmar) region, by virtue of its excellent flavor, delicious taste, attractive color, delicious fruit quality with richness in vitamins and minerals, accessibility to common man, liking by the masses, mango has been assigned the status of the ‘King of the fruits’ in the tropical world and it is the ‘National Fruit of India’.

“Kesar” Mango is the queen of mangoes widely grown in the Gujarat state of India. It has a unique sweet taste. Kesar is characterized by its golden color with green overtones. This variety is slightly smaller in size as compared to the Alphonso mango variety but offers a unique taste. Kesar variety of mangoes are considered to be one of the best mangoes, which are famous for their fruit quality, attractiveness fruit and pulp color, taste & good shelf life. This is a leading variety of Gujarat with a red blush on the shoulders. Fruit size is medium, shape oblong. The mango has high pulp content, and a saffron color (hence the Indian name-'Kesar'). It has a very rich pulp and is therefore ideal for pulping and juice concentrates.

During processing of mango, peel and kernel are generated as waste (40-50% of total fruit weight). They are rich in various nutrients and many value added products can be obtained from them. Kernels take up about 17-22% of the fruit. The major components of mango seed are starch, fat and protein. The oil of mango seed kernel consists of about 44-88% saturated fatty acids. Mango seed kernel can be used as a potential source for functional food ingredients, animal feeds, antimicrobial compounds and cosmetic due to its high quality of fat and protein as wells as high levels of natural antioxidants. Food industry waste and byproducts are substances that originated during processing and can be further utilized in different ways. If we could produce valuable products from the industry by products through new scientific and technological methods, environmentally pollution by product can be converted into products with a higher economic value.

Several studies have shown that mango seed kernels contain various phenolic compounds and can be a good source of natural antioxidants (Puravankara *et al*. 2000 [1]; Abdalla *et al*. 2007 [2]. Gallotannins and condensed tannin-related polyphenols were reported to be present in mango kernels (Arogba 1997) [3]. In addition, polyphenols from dry mango kernel meal were found to contain tannic acid, gallic acid, and epicatechin in the ratio 17:10: 1, respectively

(Arogba 2000) [4]. Mango kernel was also shown to be a good source of phytosterols including campesterol, β-sitosterol, stigmasterol and it also contains tocopherols (Soong 2004) [5]. The complete exploitation of these mango seed kernels not only eliminates the disposal problem but also results in valuable products production. But the information based on effect of processing are still lacking. The investigation was under taken to study the effect of processing on mango kernel during preparation of Mango kernel flour.

Materials and Methods

The present study was conducted to evaluate the morphological and physical attributes of Kesar mango fruit, stone and kernel. Study also deals with the effect of processing on Mango kernel. The study was conducted in the laboratories of the Department of food engineering, College of Food Technoogy, VNMKV, Parbhani. The Mango fruits (*Mangifera indica*) purchased from the local market of Parbhani.

Methods

Processing of Mango Kernel into 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 50 ºC for 4 hours and stored in air tight containers. During processing stored kernels were soaked (18-20 hr) in water, chopped into small pieces, blanched (1-2 min), dried (60 ºC for 5 hours) and ground into flour in electric blender, sieved and stored in air tight container (Yatnatti *et al*. 2014) [6].

Chemical Composition

Proximate Analysis

Moisture content, Fat, Protein, Ash, Crude fibre and Carbohydrate content were determined according to AOAC method (2005) [7].

Analysis of Minerals

Mineral content of food was estimated by method given by (Ranganna, 1986) [8].

Analysis of Vitamin Content

The vitamin A and C content were determined spectrophotometrically using a standard method of AOAC, 2000 [9]. Vitamin E was determined spectrophotometrically using a modified standard method of AOAC, 2005 [7].

Phytochemical analysis of Mango Kernel Flour

Determination of total phenolic content

Preparation of sample extracts

The extracts of samples were obtained as described by Bloor (2001) [10]. Half gram from samples was extracted with 20 ml of methanol: water (60:40 v/v). The mixture was centrifuged and the supernatant was adjusted to 25 ml. An aliquot of these extracts were used for the quantification of total phenolics content.

Determination of total phenolic content

Total phenolics content of the extracts were used for the quantification of total phenolics. The total phenolics content was determined colorimetrically, using the Folin-Ciocalteu method as described by Singleton *et al*. (1999) [11]. Aliquots of 1 ml of the extract were added to 1 ml of Folin-Ciocalteu reagent followed by addition of 1 ml of an aqueous 7.5% solution of sodium carbonate. The mixture was stirred and allowed to stand for 30 min. The absorbance at 765 nm was measured using a model UV/VIS-Spectrophotometer. A blank sample consisting of water and reagents was used as a reference. The results were expressed as milligrams of gallic acid equivalents per gram flour (mg GAE/g).

$$C = c\ V/m$$

Where:

C-Total content of phenolic compounds in gallic acid equivalent (GAE)

C-Concentration of gallic acid extrapolated from the calibration curve, mg/ml

V-Volume of methanolic sample extracts (ml)

M-Weight of the sample taken.

Determination of total tannin content

The vanillin method was used to determine total tannin content as described by Sundang *et al*. (2012) [12]. Concentrations of 0, 5, 10, 20, 30, 40, 50 and 100 µg/ml of reference catechin were prepared to obtain a calibration curve, and 100 µg/ ml of each sample was prepared to determine total tannin content in catechin equivalent. Samples or reference (1.0 ml) was mixed with 3.0 ml of 4% (w/v) vanillin followed by addition of 1.5 ml 1 M HCl, then incubated in the dark for 5 min and the absorbance measured at 500 nm using a UV-Vis spectrophotometer.

Determination of total flavonoid content

The determination of the total flavonoid content of the plant extract was based on the aluminium chloride colorimetric method of Zhilen *et al*. (1999) [13] and modified by Miliauskas *et al*. (2004) [14]. Distilled water (0.4 ml) was added to 0.1 ml of sample extract or reference. This was followed by 0.1 ml of 5% sodium nitrite. After 5 min of incubation, 0.1 ml of 10% aluminium chloride and 0.2 ml of sodium hydroxide were added and the volume was made up to 2.5 ml with distilled water. The absorbance at 510 nm was measured against the blank. A stock solution of quercetin (1 mg/ml) was prepared. Aliquots of 0.2, 0.4, 0.6, 0.8, and 1 ml were taken. Each volume was made up to 2 ml with distilled water and treated as described above, in order to prepare a calibration curve. The total flavonoid content of the sample was then calculated as shown in the equation below and expressed as mg quercetin equivalents per gram sample. The analysis was conducted in triplicate.

$$X = q\ V/w$$

Where X-total content of flavonoid compounds in quercetin equivalent

Q-Concentration of quercetin extrapolated from the reference curve

V-Volume of extract (ml)

W-Weight of the sample

Determination of alkaloid content

Five gram of the sample was weighed into a 250ml beaker and 200ml of 10% acetic acid in ethanol was added and allowed to stand for 4minutes, this was filtered and extract was concentrated on a water bath to one quarter of the original volume. Concentrated ammonium hydroxide added drop wise to the extract until the precipitation was completed. The whole solution was allowed to settle and the precipitate was collected and washed with dilute ammonium hydroxide and then filtered. The residue was alkaloid which was dried and weighed (Harbone, 1973) [15].

$$\% \text{ Alkaloid} = \frac{W_3\text{-}W_2}{W_1} \times 100$$

Where:
W_1 = initial weight of sample,
W_2 =weight of the extract,
W_3 = final weight of the residue

Determination of saponin content

Two gram of the finely grinded sample was weighed into a 250 ml beaker and 100 ml of Isobutyl alcohol was added. Shaker was used to shake the mixture for 5hours to ensure uniform mixing. The mixture was filtered using No. 1 Whatman filter paper into 100 ml beaker containing 20 ml of 40% saturated solution of magnesium carbonate. The mixture obtained again was filtered using Whatman filter paper No. 1 to obtain a clean colorless solution. One (1 ml) was added into 50 ml volumetric flask using pipette, 2 ml of 5% iron (iii) chloride ($FeCl_3$) solution was added and made up to the mark with distilled water. It was allowed to stand for 30 min for the color to develop. The absorbance was read against the blank at 380 nm (Bruneton, 1999) [16].

$$\text{Saponin} = \frac{[\text{Absorbance of sample x concentration of standard}]}{\text{Absorbance of standard}} \text{-1}$$

Result and Discussion

Effect of Processing on Proximate composition of Mango kernel

The chemical composition is a simple and convenient way of illustrating the amount of nutrients was highly desirable and which could be noticed in present study. Proximate composition of mango kernel flour moisture, protein, fat, ash, crude fiber and carbohydrate and is as shown in table 1.

Table 1: Chemical composition of Mango kernel and Mango kernel flour

Parameters (%)	Mango kernel	Mango kernel Flour
Moisture	8.08	7.79
Protein	10.02	9.36
Fat	9.87	9.59
Ash	2.03	1.31
Crude Fiber	2.23	1.76
Carbohydrate	67.80	70.69

* Each value is an average of three determinations

The data presented in table 1 shows that the moisture content of mango kernel and mango kernel flour was 8.08 and 7.79 per cent. The analysis included the content of protein, fat, ash, carbohydrate and crude fiber. The protein content in mango kernel was 10.02 per cent, the fat 9.87 per cent, and ash 2.03 per cent. The carbohydrate and crude fiber were 67.80 and 2.23 per cent whereas Mango kernel flour showed decrease in moisture, protein, fat, ash and crude fiber content as 7.79, 9.36, 9.59, 1.31 and 1.76 percent. Simultaneously the carbohydrate content of mango kernel flour was found to be increased as 70.69 percent. Ash content is an indication of the level of minerals present in food material this suggests that mango kernel can help in boosting the mineral content of prepared product. The carbohydrate level in mango kernel flour meaning they can be exploited as energy source foods. Similar findings with respect to the effect of processing were observed by Dakare *et al.* (2012) [17].

Findings of present investigation related to the values of mango kernel were in close conformity with values described in literature with slight differences by Fowomola (2010) [18]. He reported that Mango kernel flour contains crude protein (10.06%), crude oil (14.80), ash (2.62), crude fibre (2.40), carbohydrate (70.12%) and energy (453 kcal).

The observed differences may be due to varietal variations, environmental factors like climate and location and method of preparation etc.

Effect of processing on mineral content of mango kernel

The data presented in table 2 revealed that mango kernel flour is rich in mineral content. Among all minerals mango kernel contained potassium in high amount and observed as 580 mg/100g which significantly increased in mango kernel flour to 645mg/100g. Potassium records an important nutritious role in any organism.

Second abundant mineral in mango kernel was calcium and recorded as 180 mg/100g. In mango kernel flour it was increased to 325 mg/100g. One of the main benefits from calcium is related to interactions between cells walls. Therefore, it ensures the cells structure by hard cementing them. Calcium is a cellular component and regulator of the nervous excitability (Marschner, 1986) [19]. It's also a factor of ethylene synthesis during the fruits ripening (Morard, 1996) [20].

Table 2: Mineral composition of mango kernel and mango kernel flour

Parameters (mg/1oo g)	Mango kernel	Mango kernel Flour
Potassium	580	645
Calcium	180	325
Magnesium	160	178
Sodium	20	22

* Each value is an average of three determinations

The magnesium content of mango kernel and mango kernel flour was 160 and 178 mg/100g. Magnesium has major nutritional and therapeutic actions. Indeed, magnesium is an essential mineral for the cells functions. A daily sufficient intake is necessary for the energy production of the organism, the keeping of good cardiac rate and the fight against stress. Magnesium intervenes in several metabolic reactions like activator or enzymatic regulator. Thus, it improves the good functioning of the digestive tract, the maintenance of the structures of bones, teeth and the proteins synthesis. It takes part in the regulation of some minerals such as calcium, potassium, copper or zinc. Numerous nutritional investigations revealed that the magnesium intakes are generally below the securities. Thus, the European health authorities recommend daily contributions of 150 to 500 mg of magnesium for the adults (Ilja, 2005) [21].

While sodium content of mango kernel and mango kernel flour was 20 and 22 mg/100g. Intake of higher potassium and less sodium content could prevent the hypertension, source of the cerebral vascular damages and the heart diseases (Cook, 2009) [22]. It is the main intracellular mineral and takes part in the muscular activity and to the heart muscular. A diet with high potassium content is favourable to the healthy bone due to its alkaline effect (Anonyme, 2010) [23]. Similar findings with respect to the effect of processing were observed by Dakare *et al.* (2014) [24].

The high mineral content of the mango kernel flour justifies its role for utilizing it as an ingredient in the preparation of various foods. The results obtained during present investigations are more or less similar with obtained by Nzikou *et al*. (2010) [25] and Fowomola (2010) [18].

Effect of processing on vitamin content of mango kernel

Vitamins are organic nutrients needed in small quantities to perform specific functions. They do not provide energy but are necessary in the use of energy. Vitamins aid an animal by helping regulate body functions, keeping the body healthy and promoting resistance to diseases. The results pertaining to vitamin content of mango kernel and mango kernel flour are summarized in Table 3.

Table 3: Vitamin composition of Mango kernel flour

Parameters (mg/1oo g)	Mango kernel	Mango kernel Flour
Vitamin A	45.53 IU	44.21
Vitamin E	1.10	1.03
Vitamin C	0.68	0.45.

* Each value is an average of three determinations

It is observed from Table 3 that mango kernel is unique source of vitamins. Vitamin A content of mango kernel and mango kernel flour was 45.53 and 44.21 IU /100g. Vitamin A is necessary for normal vision its deficiency is the leading cause of blindness (Penninston, 2006) [26]. Vitamin A deficiency is the leading cause of preventable childhood blindness and reduced immunity towards infections. Deficiency of vitamin A adds more to burden of malnutrition in India. The province of biochemical vitamin A deficiency is 62 per cent in children under in India. Vitamin A supplementation results in 24 per cent reduction in childhood mortality (Bhutai *et al*. 2013) [27].

Vitamin E content of mango kernel and mango kernel flour was 1.10 and 1.03 mg/100g. The novel roles of vitamin E include regulation of signal transduction via membrane-bound or recruited enzymes, regulation of gene expression, activity as a redox sensor, participation in cellular trafficking and control of inflammation. In the domain of cardiovascular health, α-tocopherol has been shown to inhibit smooth-muscle cell proliferation endothelial dysfunction and platelet aggregation (Brigelius-Flohe, 2009) [28].

Vitamin C content of mango kernel and mango kernel flour was 0.68 and 0.45 mg/100g. The vitamin C is water soluble essential nutrient which act as an antioxidant, involved in iron metabolism, biosynthesis of carnitine, a neurotransmitter, collagen and in the cross linking of these fibers in bone and a cofactor in various enzymatic and hormonal processes and also involved in immune system by stimulating white blood cell function (Meister, 1994 [29] and Palacios, 2006) [30]. The results obtained are significantly superior to the results revealed by Fowomola (2010) [18]. The difference in the readings may be due to the varietal difference.

Effect of processing on phytochemical content of mango kernel

Phytochemicals may display their health protective effects in diverse ways. Phytochemical content of mango kernel and mango kernel flour was estimated and results pertaining to same are presented in Table 4.

Table 4: Phytochemical composition of mango kernel flour

Parameters (g/1oo g)	Mango kernel	Mango kernel Flour
Total Phenolic a Content	61.27	53.85
Flavonoid Content	0.95	0.87
Tannin Content	0.36	0.21
Alkaloid Content	7.62	4.1
Saponin content	0.15	0.12

A-mg of Gallic Acid Equivalent/g dw basis

It is seen from table 4 that mango kernel and mango kernel flour are excellent source of phytonutrients. Mango kernel was extracted with methanol and total phenolic content in extracts was determined. In whole mango kernels total phenolic content was found to be 61.27 mg GAE per g. Higher values were reported by Soong (2004) [5] i.e. 117 mg GAE per g this variation may be attributed to varietal difference. In MKF it was observed to be low compared to whole mango kernel (53.85 mg GAE per g), which may be due to loss of certain water extractable phenolic compounds during processing of MKF (observed through the colour change of water during soaking and blanching) which indicate processing methods have impact on total phenolic content of mango kernel flour. This result is in close agreement with Yatnatti (2017) [31].

In human phenolic compounds have been reported to exhibit a wide range of biological effects including anti-bacterial, anti-inflammatory and antioxidant property (Han *et al*. 2007) [32]. The bioactive compounds such as phenolic compounds are responsible for valuable antioxidant potential of extracts from different plant materials such as fruits, seed, peels, leaves and stem and these are regarded as health beneficial constituents (Ghafoor, 2011) [33]. The use of phenolic is also reported for lowering and preventing obesity, effecting secretion of a dipokine and prevention of oxidative stress (Dalar *et al*. 2014) [34].

The flavonoid content of mango kernel and mango kernel flour was found to be 0.95 and 0.87 g/100g respectively. It is clear from the obtained result that mango kernel and flour are excellent source of flavonoid. The biological function of flavonoids includes protection against allergies, inflammation, free radicals platelet aggregation, microbes, ulcers, hepatoxins, viruses and tumors (Okwu, 2004) [35]. As a result of availability of flavonoids in mango kernel flour, they prevent platelet stickiness and hence platelet aggregation. As antioxidant flavonoids help in digestion and assimilation of food to the body system.

The alkaloid content of mango kernel and mango kernel flour was found to be 7.62 and 4.1g/100g respectively. Apart from flavonoids, other secondary metabolite constituent of mango kernel flour includes the alkaloids. Pure isolated plant alkaloids and their synthetic derivatives are used as basic medicinal agent for analgesic, anti pasmiodic and bacterial effects (Okwu, 2004) [35] they exhibit physiological activity when administrated to animals. Most of the plant parts used in the cure of diseases have been reported to contain traces of alkaloids, for instance *Azadirachta indica* used in the cure of malaria contain alkaloids (Harbone, 1988) [36]. The presence of alkaloids in the mango kernel investigated showed that it has medicinal benefits.

While the tannin content of mango kernel and mango kernel flour was found to be 0.36 and 0.21 g/100g respectively. The presence of tannin could be responsible for the bitter principle and sour taste. Tannin has astringent properties, hastens the healing of wounds, and inflamed mucous membranes (Okwu, 2004) [35].

Saponin content of mango kernel and mango kernel flour was found to be 0.15 and 0.12 g/100g respectively. Some of the general characteristics of saponin include formation of foams in aqueous solution, hemolytic activity and cholesterol binding properties and bitterness (Sodipo *et al*. 2000) [37]. Saponin have natural tendency to ward of microbes which makes them good for treating fungal and yeast infections. These compounds serve as natural antibiotics, helping the body to fight infection and microbial invasion (Okwu, 2004)

[35]. Saponin therefore binds cholesterol and thus interferes with cell growth and division. Agroba (2014) [38] presented more or less similar findings for the flavonoids, tannins content in mango kernel. Variations may be due to varietal difference, climate and type of sowing. Similar findings with respect to the effect of processing were observed by Dakare *et al*. (2012) [17].

Our results are in agreement with these assertions as a range of phytochemicals *viz*. alkaloids, tannins, flavonoids, saponins were detected in the mango kernel flour. Nevertheless, the presence of these phytochemicals may therefore make this hitherto ignored mango stone an untapped source of pharmacologically important materials. This suggests that by-product recovery from mango wastes offers dual benefit. The industrial economics of the processing unit is enhanced as useful by-products are produced from the waste materials while considerably reducing environmental pollution.

Conclusion

The present investigation was aimed to study effect of processing on proximate and phytochemical content of Mango Kernel. The variety selected in this study is locally available Kesar Mango and Mango stone was separated and processed to prepare Mango kernel flour. In the light of scientific results of the present investigation, it can be concluded that Mango kernel which is discarded as waste from processing industries, is having excellent phytochemical profile and is a mine of nutraceutical components. Various phytonutrients viz total phenolic contents, alkaloids, flavonoids, Saponin and tannin and minerals are present in abundant quantity.

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