THE PROCESS STANDARDIZING OF MANGO (MAGNIFERA INDICA) SEED KERNEL FOR ITS VALUE ADDITION: A REVIEW

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ABSTRACT

Mango seed kernel (MSK) is the prime by-product obtained during the processing of mango. The kernel exhibits a significant amount of valuable nutrients and bioactive compounds. The legitimate utilization of this waste can generate innumerable valuable and better-quality products, including mango kernel oils, biodegradable films, mango seed kernel flour (MSKF), bakery products, mango kernel butter, and appreciably more. This paper illustrates the corporeal, alchemical, and functional characteristics of mango seed kernel flour (MSKF) accompanying its extraction process, which is entirely empirical, and research based. This inclusive standardized review vocalizes the prominence of mango seed kernel in the livestock feed manufacturing industry, consumer packaged goods (CPG) companies, nutraceuticals, and polymer industries. The main purpose of this paper is to provide an overview of the utilization of mango seed kernel for producing various value-added products.

KEYWORDS

mango seed kernel (MSK); mango seed kernel flour (MSKF); waste; antinutrients; value-added products; animals

1. INTRODUCTION

Mango (Magnifera indica) is a perennial crop regarded to be the world’s indispensable tropical fruit belonging to the Angifera family, consisting of several species of tropical fruit trees under the floral Anacardiaeae family (Kittiphoom, 2012; Okpala and Gibson-Umeh, 2013). This fruit is a vital source of carbs and proteins, rich in nutrients including vitamins, minerals, fibers, and has a particularly pleasant and distinctive flavor for the customer (Borrás-Enríquez et al., 2021; Yadav et al., 2016). The mango is known to have originated in Asia approximately 4,000 years ago, and the tropical and subtropical environment favors the trees (Ukwa et al., 2014). It is native to the Indian and Southeast Asia region, particularly in Central America, Andaman Islands, Burma, China, and, Eastern India and has grown in prominence worldwide (Fowomola, 2010; Yatnatti et al., 2014). There are several varieties of this fruit across the world. Ataulfo, Manila, Haden, Amrapali, Tommy Atkins, Alfamso, Kent, Keitt constitute around 30% of the world crop, while the others are varieties with similar physical and chemical qualities that are internationally recognized (Borrás-Enríquez et al., 2021).

Mango is produced worldwide in more than 100 nations, 65 of which generate over 1,000 metric tons annually. Mango fruit is the 2nd most abundant tropical fruit exported worldwide and the 5th substantially produced fruit worldwide selectively in America, Asia as well as in African states (Mwaurah et al., 2020; Yatnatti et al., 2014). As specified by FAO, the global aggregation of tropical main fruit output in 2018, after a 3.3 percent year-on-year increase over 2017, was estimated at 100 million tons. India contributes over 52 percent of worldwide mango production (http://www.fao.org/3/ca5692en/ca5692enp.pdf), which is the world’s largest mango producer (Kusuma & Basavraja, 2014). Additionally, as claimed by (Beyene and Araya, 2015). In 2010 mango output was stated to be 39 million tons together with guava and mango steen. The worldwide production of 80% accounts for China 11%, India 40%, Indonesia, Thailand, Nigeria, Mexico, Bangladesh, and the Philippines’s output. The majority of mangoes produced in India and Mexico are engrossed in their own country and approximately about 3% is exported. With the gradual elevation in the popularity of mangoes in North America and Europe during 1990-2009, the mango output doubled and exports grew 8 times over this period.

The cultivation, processing, and preparation of food all lead to enormous quantities of wastes generating health concerns as a result of the contamination of the environment. The waste material might be in the shape of leaf/pit, waste during harvest, food processing waste, waste after processing, un-useful material such as waste, food processing waste, etc. (Raj and Senapati, 2016). In mango, by-products like peel and kernel are generated as trash. A considerable amount of waste, about 40 and 60% of the total wt. of fruit, which largely consists of skins and seeds is thrown towards the conclusion of mango industrial processing (Ashoush and Gadallah, 2011; Diwekar et al., 2016; Yadav et al., 2016; Yatnatti et al., 2014). Due to a lack of management of these agroeconomic activities, there is a significant waste of food material. Waste material disposal has therefore been a problem for processors as numerous authorities pressure the waste material treatment to be environmentally acceptable (Raj and Senapati, 2016).

The kernel portions of the fruits that have been dismissed are a valuable source of phytochemicals, carbohydrates, lipids, proteins, vitamins, and nutritional and protective fibers against oxidative stress-related illnesses that affect human health (Lasano et al., 2019). Despite these seeds...
containing potential nutrients and bioactive substances, consumers and fruit producers are widely disposed of as trash while preparing juices, jams, and snacks (Runyogote et al., 2020). This creates an enormous quantity of trash during industrial processing, which poses severe issues with disposal. The application of waste for the creation of added value goods is therefore extremely essential in food processing waste management (Beyene and Araya, 2015; Raj and Senapati, 2016).

Furthermore, the four conventional feed components (maize, soy meal, fish meal, and meat meal) can’t fulfill the following demand due to their huge incentives in the livestock production sector. The difference between local availability and demand of these conventional components will thereby increase over the next few decades, offering an imperative cause to investigate the utility of alternative feed products accessible locally in feed compositions. Substitution of maize with other untraditional sources of energy, such as mango kernel, is considered a promising approach (Adewale et al., 2016). An essential aspect to address feed shortages and competitiveness concerns might be the use of this large waste for animal feed (Beyene and Araya, 2015).

However, the difficulty with the elimination of antinutrients is substantially associated with their under-use in mango seed kernels. Though, through appropriate commercial processing the antinutrients including phytates, oxalates, and tannins can be reduced merely by boiling and soaking course of action (Runyogote et al., 2020). In the final phase, the generated trash, co-products, and residues might be converted into non-conventional feed supplies through appropriate processing and also be transformed into desired value-added goods (Wadhw and Bakshi, 2016). Thusly, this article can act as information material for the researchers, academicians, extension agents, and development workers who are attempting to propel their studies and expertise in the context of waste management, and food processing. Further, this paper demonstrates beneficiary significance to commercial industries.

2. COMPOSITION OF MANGO FRUITS

The fruit of the mango is characterized as an oval or kidney-like drupe with a light, leathery skin and light or dark green to pale yellow when mature (Okpala and Gibson-Umeh, 2013; Torres-León et al, 2016). Mango fruit is generally rich in organic compounds and carbs that are key sources of taste and energy and volatile chemicals are the flavor components (Liu et al., 2013). The fruit comprises an exocarp with a thick peel, a resiny and fleshy edible mesocarp and an endocarp with stone which is the primary by-products (Beyene and Araya, 2015; Monteiro et al., 2021). Mango seed is a single flat oblong seed, which, according to its variation, is enclosed by a fleshy mesocarp coated with a fibrous covering. Accordingly, the seed is hence a woody outer shell, i.e., a thick, tough endocarp which correctly encloses the kernel.

A fine fringe with a single embryo, 4.5 to 7 cm length and 3.2 to 4.5 cm broad built in 1.5-2.5 mm thick seed coat is present (Divekar et al., 2016; Torres-León et al, 2016). The mango seed can be mono-embryonic or poly-embryonic; the majority of the mango seed types are mono-embryonic, but in India, Philippine, and Malaysia, the mono-embryonic variants are plentiful (Tharanathan et al., 2006; Torres-León et al, 2016). In the preliminary tests, it was found that the seed is 10-25%, and the kernel is 45-85% or approximately 20% of the overall fruit depending upon the type. The result is from 40% to 85% of the seed. Additionally, the fruit comprises 66.1-70.4% pulp, 9.80%-14.30% peel, and 7.50-9.30% tests (Das et al, 2019; Fajriyati Mas’ud1, Akhmad Rifai, 2020; Mwaurah et al, 2020; Poul & Babar, 2019; Torres-León et al, 2016).

The by-products including peel and kernel are generated during mango processing. Protein, starch and fats are the main constituent of mango seed (Abd-Elaziz, 2018). In broad sense, the nutrient or chemical composition of the kernel of mango contains 32.34%-76.81% carbs, 6% -15.2% fat, 6.36% -10.02% protein, 0.26% -4.69% raw fiber, 6.05% moisture and 1.46% -3.70% ash on a dry wt. basis (Diarra, 2014; Mwaurah et al, 2020; Yadav et al, 2016). Similarly, as claimed by, around 6.35% crude protein (CP), 2% crude fiber (CF), 42.5% moisture, 3.2% ash, 13% oils, and 32.2% total dry wt. carbohydrates were present in the mango kernel whereas 50.98% was moisture, 6.9% fat, 1.6% fiber, and 2.46% wet ash (Das et al, 2019; Elegebre et al, 1995). Likewise, per 100g of mango kernel, 210 mg of magnesium, 170 mg of calcium, 368 mg of potassium, 610 mg of zinc, 2.65 mg of sodium, 9.30mg of iron, and 4.20 mg of copper was present on dry wt. basis respectively (Abd-Elaziz, 2018; Abdalla et al, 2007; Mwaurah et al, 2020). Mango-core contains significant amounts of vitamin K (0.58 mg/100 g), vitamin A (15.26 IU), vitamin E (1.32 mg/100 g), and vitamin C (0.55 mg/100 g) on a dry weight basis. Vitamins of 0.08, 0.03, 0.19, and 0.12 mg/100 g are also included with vitamins B1, B2, B6, or B12, respectively on a dry wt. basis (Mwaurah et al, 2020). Studies reveal that, depending on the mango cultivars, the dry wt. of proteins in the mango kernel is between 6% to 13% (Diarra, 2014; Mwaurah et al, 2020).

Despite a moderate amount of protein, the majority of crucial amino acids in the mango kernel exist including valine (5.79), lysine (4.30), leucine (6.90), and isoleucine (5.41) mg/100 g protein on dry wt. basis. Phenylalanine (3.40), tyrosine (2.72), methionine (1.20), and threonine (3.42) mg/100 g on a dry wt. basis are also available as amino acids (Mwaurah et al, 2020). As per, the kernel of the mango contains 4.45 mg/100g phenylalanine, 3.2 mg/100 g isoleucine, 3.8 mg/100 g valine, and 3.2 mg/100 g tyrosine, and 2.0 mg/100 g dry-matter methionine, respectively (Fowomola, 2010; Mwaurah et al, 2020). Conclusively, the index of essential amino acids and grade of protein is premium, which indicates good protein quality (Mwaurah et al, 2020). Addition, the mango seed kernel includes around 44-46 percent saturated and 52-56 percent unsaturated fatty acids that are known to promote health, including stearic (24%-57%), oleic (34%-56%), xanthones, flavonoids, and phenolic acid (Abd-Elaziz, 2018; Ballesteros-Vivas et al, 2019; Shehabeldin et al, 2021). The kernels of mango seed hence contain thereafter balanced nutritional amounts, substances, and high metabolizable energy, equivalent to maize, depending on which variety can function as a feed ingredient and feed byproduct of humans (Beyene and Araya, 2015; Diarra and Usman, 2008; Shehabeldin et al, 2021).

The residues of mango (peel, endo-carp, kernel) are widely recognized to have a substantial quantity of therapeutic bioactive components that enhance our health and lower the risk of disease (Borrás-Enriquez et al, 2021). Polyphenols, phytosterols, and tocopherols are the principal bioactive components in the mango kernel. The phenolic components include anthocyanins, quercetin, homogamperine, mangiferin, and isomangiferin are the predominant components in the mango kernel and other phenolic acids includes gallic, ellagic, caffeine, coumaric, Protocatechuic, and ferulic (Mwaurah et al, 2020). Unoonost, 4.89 percent and 6.84 percent of total skin and kernel, phenols are found in mango. However, the astringent activity of polyphenol synthetics (e.g., tannins) that collaborate with starches, minerals, and proteins lessens the nourishing substance of the meal and relying on the proportion of seed pieces and mango peel given to ruminants, diminishes the admission and edibility (Shehabeldin et al, 2021). Moreover, tannins and gallotannins identified as metabolites of secondary plants may have adverse health consequences especially if they are linked to proteins (Mwaurah et al, 2020). In correspondence to the portions of polyphenols per 100g of dry mango kernel conclude 4.24 mg of mangiferin, 20.25 mg vanillin, 10.40 mg ferulic acid, 11.3 mg cinnamic acid, 12.5 mg coumarin, 20.70 mg tannin, 6 mg gallic acid, and 7.75 mg caffeic acid (Martin and He, 2009; Mwaurah et al, 2020).

3. EXTRACTION OF MANGO SEED KERNEL FLOUR

![Figure 1: Extraction of Mango Seed Kernel Flour (MSKF)](image-url)

The extraction of mango seed kernel can be simply portrayed through several listed stages:

1. Cleansing stage: Each replication is produced and divided into various sections by a representative homogenous sample (peel, pulp, and seed).

2. Dissociation stage: The seeds were manually broken to remove the shells and kernels (Legesse and Emire, 2012; Okpala and Gibson-Umeh, 2013). The core is then rinsed away for 2 minutes to eliminate any sticking debris (Menon et al., 2014).

3. Dissevering stage: In improving preprocessing treatments it is crucial to have the kernels chopped into little dimensions (about 0.5 cm broad) so that the surface area is larger. The kernels should thus be cut into smaller dimensions (Adewale et al., 2015; Mwaurah et al., 2020). The kernel preprocessing is therefore essential to remove it (Mwaurah et al., 2020). It is significantly reported that fermentation, drying, boiling, leaching, and soaking are the simplest techniques for detoxifying those feed materials to minimize the number of anti-nutrients and harmful components (Beyene and Araya, 2015).

Processing methods to reduce anti-nutrients from the mango seed kernels:

I. Dehulling: It is physical therapy for the removal of the skin (coats) containing undesirable chemicals from the skin such as tannins. The skin is thus removed to lessen the additive taste (Legesse and Emire, 2012).

II. Soaking: This procedure involves the pulping of the mango, the seed shell manually cracked; the kernel smeared and the freed kernel washed into sulfate water at 300C, 400C, and 500C for 48 hours (770 mg of sodium metabisulphite liter-1) with occasionally decantation and water replacement until the water remained uncolored (Legesse and Emire, 2012). As reported by, 61% of the tannins and 84% of the hydroxyacids may be removed by this efficient treatment (Beyene and Araya, 2015).

III. Autoclaving/boiling: The mango pieces can be autoclaved at 121°C for 10, 20, and 30 minutes at a water proportion of 1:2 (w/v) to eliminate tannins from the mango kernel or dried at 50°C for 48 hours (Legesse and Emire, 2012; Safdar et al., 2017). Also, boiling with alkalis also reduced the phythic acid concentration most efficiently (Shehabdin el et al., 2021). The slices should be chilled quickly after treatment to protect volatile parts of the kernel (Mwaurah et al., 2020). The nutritional worth of mango kernels is improved by bubbling, which reestablished development discouraged with untreated portions. Boiling or autoclaving removes anti-nutrients such as trypsin and tannins. Inclusively, soaking without boiling could also decrease anti-nutritional elements, but not sufficiently to return growth to the control diet level (Beyene and Araya, 2015).

Whence, boiling is beneficial in decreasing the mango kernel tannin concentration. It can also decrease the kernel tannin concentration from 9.89 to 1.26 percent, which is around 87.26 percent (Beyene and Araya, 2015; Diarra and Usman, 2008). No detrimental effects of boiling on ether extract, crude protein (CP), nitrogen-free extract, and crude fiber (CF) from the kernel were documented by (Diarra, 2014).

IV. Combined process: The combined effect of soaking and autoclaving is the greatest tannin reduction and improvement of MKS proteins (Legesse and Emire, 2012). In addition, boiling followed by soaking lowers the concentration of mango kernel antinutritional factors (Mwaurah et al., 2020; Shehabdien et al., 2021).

As aforesaid, the detoxifying techniques include boiling, washing, dehulling, drying and soaking. The main factors of the nutritional composition of the resultant flour are, however, the time to soak and boil and the drying temperatures. Remarkably, the temperature of drying particularly has a substantial influence on the near constituents, with the lowest impact on ash and fiber content. Soaking substantially influences protein, fat, and ash levels. Each component should thus be consistently performed (Mwaurah et al., 2020; Uzomah et al., 2019).

In the opinion, the kernels were dried for 30 minutes, boiled for about 15 minutes, and dried at 60 to 65°C in a dryer cabinet for 15 to 16 hours (Amin et al., 2018; Das et al., 2019). In addition to boiling and soaking kernels in the water concentrates, alkali therapy has also shown a considerable reduction of antinutrients. After alkali treatment, they observed an 80 percent decrease in chemicals that are anti-nutritional substances (cyanogenic glycosides, trypsin inhibitors, tannins, and oxalates). While some researchers evaluated by treating the kernel pieces with 0.1 percent sodium metabisulphite (Na2S2O5) at 285°C and observed a decrement in antinutritional components after 72 hrs. of drying (Uzomah et al., 2019). In his research, tannin reductions (125 to 135%), 61% of tannins, and 84.2% of 100 g db were recorded. He stated that the soak duration should not exceed 24 hours to preserve nearby components, while the temperature of drying should not surpass 65°C. To retain the nutrients and decrease the antinutrients, there should be an ideal balance between temperature and time.

5. Drying: Then the treated kernels are dried in a 60°C heat oven for 5 hours or in 60-65°C mechanically for 2 days (Menon et al., 2014; Yatnati et al., 2014). Kernels fell to 90.6% of their initial wt. after they have been dried. The milling of these dry kernels fell to 84.2% due to a 6.4% friction loss (Yatnati et al., 2014).

6. Pulverizing stage: In a universal mill or a hammer mill, the dried mango kernel is then crushed to a powdery form individually. To achieve a fine meal from every mango waste, the milled output is next passed through 60 μm, 100 μm, or 120 μm strainers. Standard sieving according to the necessity (Adewale et al., 2015; Borrás-Enríquez et al., 2021; De L’si et al., 2016; Legesse and Emire, 2012; Menon et al., 2014; Okpala and Gibson-Umeh, 2013). Following the sieving of milled flour, 80 percent of the wt. of processed mango kernel flour (MKF) represents a percent rehabilitation of 100 g of kernel mango kernel flour (Yatnati et al., 2014).

7. Storage stage: Mango seed kernel flour is then kept at room temperature (25°C) in air-tightened containers such as polyethylene bags, aluminum foil bags, a bottle of dark glass, or a desiccator until further use (Borrás-Enríquez et al., 2021; Legesse and Emire, 2012; Menon et al., 2014; Okpala and Gibson-Umeh, 2013). The mango kernel flour were increased correspondingly in storage during several experiments carried out by (Simi et al., 2016). This signifies the microbiological storage count of the meal might get impacted by many intrinsic and external variables such as humidity, relative humidity, storage temperature, sample type, containers, etc. (Simi et al., 2016).

Similarly, in proportion to Mango stones were cleaned by washing with water twice and were placed in the air to dry (Abd-Elaziz, 2018; Legesse and Emire, 2012). After that each stone was hammered, the kernels were taken out from the outside cover manually. Further, kernels were soaked in the water at 55°C for 48 hrs. then autoclaved at 121°C for 30 min, and dried in the tray at 24°C. The dry material was crushed into a powdery shape in a hammer mill and stored in a closed container of dark glass at 4°C for subsequent examination. Equivalently, in correspondence to Mango seed was cleaned and for reducing moisture, they were dried in a hot air oven at 62°C for 6 hrs (Yatnati et al., 2014). Further, the kernels were hand-held using a knife made of steel and were dried once again at 55°C for 4 hrs. straight. The kernels were then soaked in water for 6-7 hrs. throughout processing, sliced into fine pieces, blanched in warm water for 1-2 minutes, dried (5 hrs. at 60°C), and converted into flour using electric blenders, screened, and stored in air-close containers. Likewise, according to the mango kernels were first disinfected and washed to eliminate external contaminants from the exterior (Das et al., 2019; Menon et al., 2014). The pieces were then kept in water for soaking purposes for approximately 30 minutes to diminish anti-nutrients. Then the kernels boiled for 15 minutes and were dried with a cabinet dryer at 60-65°C for 15-16 hours. The dried kernels had been melted and the flour processed through a typical mesh sieve in 30 sizes, to produce the fine MKF. The flour was then maintained for subsequent usage in high-density polyethylene.

4. Physical, Chemical or Nutritional and Functional Characteristics of Mango Seed Kernel Flour (MSKF)

1. Physical characteristics: The mango seed kernel flour’s physical features indicate its specific gravity, color, and texture. The specific wt. was determined to be 0.89 at 24°C, and the melting point 30.0°C (Abd-Elaziz, 2018). The MKSF is somewhat red, while the wheat flour is slightly yellowish in comparison. This shows that MKSF’s h axis was yellowish but in WF it was somewhat green. It can thus be inferred that wheat flour is
more appealing to color than mango flour. The texture of the flour also resembles that of the flour of wheat, which is thick, elastic, and chewy (Abd-Elaziz, 2018; Das et al., 2019).

2. Chemical or Nutritional characteristics:

I. Moisture: The moisture content of MSKF is lower (7.58%) than that of the wheat meal (11.91%) (Das et al., 2019; Yatmatti et al., 2014).

II. Starch: Starch from MKS is represented with a velvety feel as a light brown powder. The humidity content of starch is 9.86%. The size and structure of natural starch granules are different in between plant species and are mature because they are organized in crystalline zones alternating by semi-crystalline areas (Silva et al., 2013; Souza et al., 2021).

III. Ash: The MSKF includes a greater ash percentage (2.16%-2.5%) on a dry wt. basis than a wheat meal (0.54%) (Das et al., 2019; Fajriyati Mas’u’di, Akhmad Rifai, 2020). The high level of ash in MSKF suggests that MKF might be an excellent source of food (Das et al., 2019).

IV. PhenoTs concentration: The MSKF contains 62.4-72.9 mg of total polyphenols/g, though thoroughly detoxification of MKS is done during the preprocessing stage. There are several phenolic chemicals in MSKF, for example, tannins, vanillin, coumarins, cinnamon, mangelin, gallic, and caffeic acids. The consolidation of phenolic substances is 4.6 times greater in the seed kernels than in the pulp, making this potential waste a viable source of polyphenol. The MSKF consisted largely of galactose, gallic acid, coumarins, ellagic acid, vanillin, and ferulic acid, and with primary phenolic compounds (Ballesteros-Vivas et al., 2019; Fajriyati Mas’u’di, Akhmad Rifai, 2020).

V. Macronutrients: Carbs, crude proteins, total lipid content, and crude fibers of MSKF have been reported to amount to 36.2–39.3%, 5.2–6.6%, 6.0–7.5%, and 22.2–25%, respectively, for a dry wt. basis. Compared with wheat flour, the MSKF has significantly greater (about 12 times) fat. In addition, the MSKF energy value estimated is 411.84 Kcal for 100 g flour, respectively (Das et al., 2019; Fajriyati Mas’u’di, Akhmad Rifai, 2020; Yatmatti et al., 2014).

VI. Micronutrients: Depending on the cultivars, MSKF includes large quantities of potassium, phosphorus, and magnesium. The contents ranged from 82.8–124.0 mg of magnesium, 5.6 mg of zinc, 21.6-37.7 mg of sodium, 12.40 mg of iron, 25.3-36.9 mg of calcium, 7.28-95.2 mg of phosphorus, 9.42-14.28 mg of potassium, and 8.6 mg of copper per 100 grams (Fajriyati Mas’u’di, Akhmad Rifai, 2020; Yatmatti et al., 2014).

On the reported of processed MSKF includes 2.0% crude fiber (CF), 2.6% ash, 76.8% carbs, 6.80% crude protein (CP), 10.50% crude fat (CF), and 430.0 kcal of calories (Kaur and Brar, 2017). For comparison, the study showed that wheat meal included, 73.90% carbohydrate, 0.42% fiber, 0.9% fat, 1.30% ash, 10.22% protein, and 344.0 kcal/100% energy. The MSKF had 11.8 g of iron, 59.7 g/100 g of calcium, and 94.0 g of magnesium, differentiated to 2.40 g of iron, 15.0 g of calcium, 0.8 g of zinc, and 29.65 g/100 g of magnesium found in refined wheat flours, in terms of the mineral content. Furthermore, the study discovered that MSKF and wheat flour contained 75 and 22.4 percent antioxidants, respectively (Mwaurah et al., 2020).

3. Functional characteristics: The functional properties counting bulk density, water absorption capacity, swelling index, and oil holding capacity of mango seed kernel flour (MSKF) is listed below:

I. Bulk density: The bulk density of mango seed kernel flour (0.64 g/ml) showed that MSKF had a greater unit volume of wt, than wheat flour, thus, was more than that of wheat flour (0.579 g/ml). This high density of bulk can aid to enhance the amount of MSKF augmented meals. Differing bulk density might be caused because of the fluid and milling process change in particle size (Das et al., 2019).

II. Water absorption capacity: The water absorption capacity of the mango seed kernel flour (121.8%) varied considerably in distinctive to the wheat meal in its water absorption capability (66.6 percent). It shows that MSKF absorbs more water for a typical paste than wheat flour (Das et al., 2019). The research have shown that the composite flour dough consumes more water than the wheat flour. Highly water-absorbing flours are helpful in bread items for practical purposes, as they could reduce stalling by minimizing humidity loss (Obatolu et al., 2006; Okpala and Gibson-Umeh, 2013). The impact of drying temperature on flour indicates a decline in the water solubility index when temperature increases (Poul and Babar, 2019).

III. Oil absorption capacity: The oil absorption capacity of MSKF is 0.94 g oil/g of the sample. This research, therefore, suggests that all MSKF supplement bakery items can assist in reduced oil absorption (Das et al., 2019; Poul and Babar, 2019). The meal’s capacity to absorb oil is crucial since it works as a retarding agent and enhances the mouthfeel. In food compositions, it is an important element (Okpala and Gibson-Umeh, 2013).

IV. Swelling index: The MSKF’s swelling index is 1.45, whereas the wheat meal is 3.56, which indicated that the wheat meal has a very high swelling capacity compared with MSKF (Das et al., 2019). Though, the swelling index value of the wheatmeal was observed to be 4.00 as per, who were further able to conclude that the index decreases with an increase in the sprouted meal of the kernel mangoes (Menon et al., 2014). They showed that a greater concentration of fat and protein may cause the value to decrease.

5. Value-Added Products of Mango Seed Kernel

The by-products and trash available after mango processing may be utilized to generate high-value goods for economic growth (Babu, 2016; Borrás-Enríquez et al., 2021). In creating esteem added merchandise, for example, biofilms, mango kernel butter, kernel oil, mango kernel meal, and other differentiated items, the kernel’s food profile shows its utility as a food component. (Mwaurah et al., 2020). The shell-kernel stone has been already manufactured in the manufacture of animal food, activated carbon, and vegetable butter due to their fat content (about 15%) (Henrique et al., 2013; Jahurul et al., 2015).
production (Kumar et al., 2017). Starch films from customary sources like potato, sweet potato and maize are as of now accessible (Ghanbarzadeh et al., 2010). The enormous demand for these films requires a diversified, sustainable starch supply, which is why researchers investigate the mango kernel as a viable source of starch among other non-conventional materials (Mwaurah et al., 2020). Additionally, to make the biodegradable plastic (polyhydroxyalkanoates) by utilizing soil insulating Bacillus megaterium, it is possible to use a mango seed kernel as an alternative to glucose (Nasir-Naema et al., 2016).

IV. Bakery products: Mango seed meal (MSKF) can be used in different cuisine recipes as an amalgamated flour or as a halfway replacement for the wheat meal (Fairyati Mas’ud, Ahkimad Rifai, 2020). Other researchers suggested improving the fat content, protein, and phenolic content by incorporating mango seed flour into wheat flour for the preparation of biscuits (Ashoush and Gadallah, 2011). Without altering sensorial characteristics, up to 50.0% of wheat flour may be replaced by mango seed powder and can thus be utilized as a functional component in bread goods due to their high phytochemical content (Das et al., 2019; Torres-León et al., 2016). Alternatively, mango seed flour may be utilized for other functional food components as a possible source. It may also be turned into essential foods, including nutraceuticals and medicinal meals (Legesse and Emire, 2012).

V. Mango kernel oil: The kernels of mango seeds can be utilized as an alternative edible oil source. Withal, the oil also contains therapeutic properties so that it may be used allopathically (Kittiphoam, 2012).

6. Conclusion

Based on the above reviews, it tends to be presumed that the mango seed piece has an appropriate measure of supplements and other functional characteristics that make it prominent for utilization. Nevertheless, immense quantities of wastes produced by mango processing units are being atrophied and engendering serious effects on the environment. However, through genuine exertion of these wastes, they can be transfigured into an asset by manufacturing aforesaid value-added products. The implication of mango seed kernel in the feed industry can metamorphose the existing competitiveness between humans and boilers for cereals. Further, the MKO significantly has practically all fundamental attributes of cocoa butter, thus showing great potential to supplant it, which straightforwardly diminishes the production cost of confectionery industries. In like manner, the most brought up issue of the 21st century, “When will we replace plastic?”, the appropriate response lies here. The mango seed kernel contains simply a good amount of starch, which is inexpensive and easily accessible that can be used to fabricate films to replace plastic usage. Furthermore, it is a viable source of starch among other non-conventional materials and its easy accessibility makes it more usable since it can handle the enormous demand to replace plastic films. However, the antinutrients present in the seed kernel can create hindrance in overall processes, but through the above-mentioned detoxifying techniques, they can be eliminated and by-products available after mango processing may be utilized to generate high-value goods for economic growth. Subsequently, reducing enormous quantities of generated wastes and minimizing health concerns of every being on the earth’s surface. Thereupon, the mango seed kernels can be actively utilized instead of merely dumping them as trash.

References


