Original Research Article

Exploring the Fatty Acid Profile and Nutritional Attributes of Golden Kernel Blend: A Novel Flour Blend of Mango Seed Kernel and Chickpea

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***Received:** 12th February, 2025; **Accepted:** 12th April 2025; **Published:** 30th April, 2025*

Vantage: Journal of Thematic Analysis

A Peer Reviewed Multidisciplinary Publication of Centre for Research, Maitreyi College, University of Delhi. Volume 6, Issue 1, April 2025. *https://vantagejournal.com* , ISSN(E): 2582-7391

How to cite:

Rani K., Rehman M., Seth M., and Bhatnagar T. (2025). Exploring the Fatty Acid Profile and Nutritional Attributes of Golden Kernel Blend: A Novel Flour Blend of Mango Seed Kernel and Chickpea. *Vantage: Journal of Thematic Analysis*, 6(1), 18- 23. https://doi.org/10.52253/vjta.2025.v06i01.18

ABSTRACT

The mango (*Mangifera indica*) is a significant fruit that is widely produced, marketed, distributed and consumed. Mango consumption has many health benefits. Mango wastes, namely the peel and mango seed kernel (MSK), have significant nutritional and functional value. For the purpose of study, Alphanso mango's seed kernel and chickpea flour mix oil was extracted using petroleum ether to remove all of the polar and non-polar components. For the food and pharmaceutical industries interested in using mango seed kernel and chickpea flour as a raw resource, this study provides information on the physicochemical characteristics and nutritional and fatty acid composition of the Golden kernel blend. Oil (66 ± 0.08 %), starch (43± 1.90 %), and crude protein (18.06 ± 0.02 %) were all abundant in the flour. According to liquid chromatography–mass spectrometry (LC-MS/MS) lipid acid profiling, kernels may be a substantial source of Monounsaturated Fatty Acid (MUFA). The primary fatty acids were oleic and steric acid. According to the current study's findings, golden kernel blend offer substantial nutritional advantages.

Keywords: Fatty acid, Mango seed kernel, Bio-waste, Nutrition

1. INTRODUCTION

Human life depends on food since it supplies the necessary nutrients for sustaining healthy bodily growth and development. There is a food scarcity in some parts of the world as a result of the growing global population (Myers, 2020). Furthermore, the primary causes of food insecurity are poverty and unequal food distribution. To ensure stability in food availability, the circumstances necessitate careful planning and the establishment of new goals and objectives at the governmental level. The fruit of the mango (*Mangifera indica*) is processed to make a variety of goods, including canned or sliced mango, juice, nectar, jam, sauce, chutney, and syrup (Yadav et al., 2017). The seed/stone, which makes about 15–25% of the total fruit weight, is produced as a by-product when mangos are processed for pulp (Yatnatti et al., 2014).

Mango seed kernels are rich in macronutrients and micronutrients, including calcium, potassium, magnesium, and vitamins A, E, K, and C (Jahnavi et al., 2020). Tocopherols, phytosterols, carotenoids, polyphenols (gallotannins, flavonols, mangiferin, homomangiferin, isomangiferin, and quercetin) and phenolic acids (4-Caffeoylquinic acids, Gallic, and Ferulic acid) are among the phytochemicals that have been reported to have substantial therapeutic potential (Mwaurah et al., 2020). According to Sogi et al. (2013), the levels of trypsin inhibitors, hydrogen cyanide, and phytotic acid—all of which have anti-nutritional properties—are typically low and within the safe concentration range (below >20 mg/100g) and do not appear to be life-threatening. A recent study by Chaudhary and Chhabra (2024) shows that mango seed kernel flour is completely safe for the consumption. The kernels must undergo detoxification before consumption (Banerjee, 2016). Several techniques/methods have recently been reported for debittering the seeds, including fermentation, soaking, ultrasound, vacuum, and microwave methods (Mustafa et al., 2023).

Mango seed kernels (MSK) are a significant source of both oil and minerals (Das et al., 2022). The focus has mostly concentrated on the kernel's lipid component and its potential use as a natural nutritious supplement in food products like chocolate and biscuits as well as in the confectionery sector as a source of cocoa-butter alternative (Nadeem et al., 2016). Mango seed kernel oil's (MSKO) high quality and nutritional value may find use in human diets since the fatty acid (FA) profile is a key factor in determining the oil's quality and is significant as a metabolite and nutritional substance in living things. According to the nutritional and toxicological characteristics of the mango seed kernel, its fat shows promise as a safe and nutrient-dense edible oil that can be used in place of any solid fat without causing negative side effects. The mango seed kernel flour when mixed with chickpea flour, produces novel flour with enhanced characteristics. The protein content increases for better digestion and it leads to more availability (Sahu et al., 2024).

Garbanzo beans, also known as chickpeas (*Cicer arietinum L.*), are regarded as a rich source of high-quality protein and have a strong nutritional value for human nutrition. Traditionally, dietary protein—which offers energy and a balanced supply of vital amino acids—has been necessary for the development and upkeep of bodily processes. Fatty acids, carbs, minerals, vitamins, folate, protein, and b-carotene are all readily available and reasonably priced. Chickpeas have the potential to improve health by slowing the onset and progression of several chronic illnesses, such as type 2 diabetes and cardiovascular disease (Begum et al., 2023). Chickpeas contain a higher percentage of non-digestible carbohydrates, dietary fibre, minerals (potassium, phosphorus, magnesium, and calcium), bioactive compounds (phenolic acids, isoflavones, and saponins), lipids (unsaturated fatty acids, mainly linoleic and oleic acids), and vitamins (folic acid, tocopherol, and niacin) (Vinod et al., 2023).

As a viable substitute for gluten free products such as breads, cookies etc., Chickpea flour (CF) offers enhanced functional, nutritional, technical, and sensory qualities. With its high protein, vitamin, and dietary fibre content, CF may help avoid cardiovascular and cancerous conditions. By adding CF to gluten free products, the glycemic response is decreased and dough stability, uniformity, and loaf volume are improved. For people with gluten intolerances, it creates the potential for more palatable, nutritious, and nutritious choices, making it a very promising element for meeting contemporary dietary needs (Vinod et al., 2023).

A by-product after consuming the fruit's flesh, mango seeds are typically thrown away carelessly, which contributes to environmental contamination (Athiappan et al., 2020). Additionally, as previously indicated, the mango fruit contributes to agro-waste and pollution because of its highly perishable nature. Among other investigations, researchers have looked into the potential for oil extraction, fatty acid profile and characterisation of the oil derived from the mango seed kernel. Therefore, the nutritional advantages of mango seed kernel and chickpea flour mix oil, including its fatty acid content, were examined in this study after reducing the anti-nutritional matter.

2. MATERIALS AND METHODOLOGY

2.1 Preparation of mango seed kernels and chickpea

Seed waste of Alphanso Mangoes fruit variety was procured because Alphonso dominate 90% of the processing industry (As, 2024). Chickpea was collected from local ration shop. Mango waste was collected from local mango processing stalls/shops at Gurugram, Pataudi, Dwarka, Haryana, India, as they produce a generous amount of waste that is dumped in open landfills. After removing the seeds from the fruits, the outer shell of the seeds was manually broken to extract the kernels, and the seeds were then sun-dried for around three weeks after being cleaned with tap water to remove any remaining fruit pulp.

Chickpea were thoroughly washed and were sun dried for 2-3 days.

2.2 Detoxification of mango seed kernels

The seeds were placed in an incubator and steeped in sulfite water for 72 hours during the preparation phase until the water becomes colourless, then it was replaced after every 24 hours. After the process of soaking, the seeds were broken into small pieces, blanched for 10 to 15 minutes at 90 degrees Celsius in a water bath, dried overnight at 60 degrees, and then milled into flour using an electric blender. The flour was then placed in an airtight container after being sieved (Yatnatti et al., 2014).

The chickpeas were also milled into flour using an electric blender.

2.3 Preparation of golden kernel blend

Mango seed kernel flour and chickpea flour were combined in a 40:60 ratio to create the golden kernel blend, which was then submitted for additional examination.

2.4 Extraction of oil

To extract oil from flour, AOAC (Association of Official Analytical Chemists) method no. 920.85 was used. To evaporate, 10 grams of the material were combined with 75 millilitres of petroleum ether and baked at 180 degrees for 30 seconds. It was repeated six or seven times. After filtering the mixture, the supernatant was stored in a hot air cabinet overnight and weighed to determine the final results (Yadav et al., 2017).

2.5 Nutritional composition of golden kernel blend

The golden kernel blend was subjected to chemical analysis as well. The nutrients analysed were ash content (A.O.A.C method no. 923.05), moisture (A.O.A.C method no. 930.04), fat content (A.O.A.C method no. 920.86) (De Paula et al., 2021), carbohydrate, and protein (Aguirre, 2023**)**

2.6 Fatty acid profiling of golden kernel blend

Verification of the fatty acid profile was done using gas chromatography–mass spectrometry (GC-MS) (Stroher et al., 2012). The lipids were tranesterified for analysis and quantification. A gas chromatography system with a fused silica capillary column (100 m length, 0.25 mm, and 0.39 µm) and a flame ionization detector was utilised to examine the fatty acid methyl esters. For 50 minutes of chromatographic analysis, the column temperature was set to begin at 165°C for 12 minutes, and then heat at a rate of 40°C /min up to 180°C, which was maintained for 15 minutes, and then heat at a rate of 15°C /min up to 240°C, which was maintained for 18.6 minutes. The temperature of the injector and detector was 230°C. The carrier gas (H2) had ultrapure gas flows (White Martins) of 1.4 mL /min, the make-up gas (N2) had 20 mL /min, and the flame gas, H2, and synthetic air had 30 and 300 mL /min, respectively. 1:80 was the sample split ratio that was employed.

Three separate injections of 2 µL of the sample were made. By comparing the retention periods with those of fatty acid methyl ester standards (Sigma) that were co-eluted (spiked) with the samples and by equivalent chain length (ECL), the fatty acids were identified. The Star program was used to identify the peak spots.

2.7 Statistical analysis

Each data set was collected in triplicates, and StatistiXL, version 1.10, was utilised for the analysis. Descriptive and inferential statistics were used to get the mean and standard deviation. The hypothesis was tested using one-way analysis of variance, and t-statistical significance was set at $p<0.05$. Tukey's honestly significant difference test was used to assess significant differences and separate means, with a statistical significance threshold of $p<0.05$ (Melo et al., 2020).

3. RESULTS AND DISCUSSION

3.1 Nutritional composition of the golden kernel blend

The golden kernel blend has a mean ash content of 66 ± 0.07 % per 100 g. The mean moisture content of the blend was determined to be 56 ± 0.01 % per 100 g. The chickpea flour mixing lead to relative low moisture content of the mix contributing to longer shelf life. The current study found a mean value of crude protein 18.06 ± 0.02% per 100 g. The chickpea flour enhances the protein and fiber content (Felisiak et al., 2024). The difference in stated moisture content may be caused by the mango qualities, environmental elements, various phases of fruit development, and climatic growth conditions. The mean fat content of the golden kernel blend in the current study was 66 ± 0.08 %. The carbohydrate content of the blend was found to be 43 ± 1.90% per 100 g. The data on nutritional properties of the

Table 1: Nutritional properties of the Golden kernel blend

Sr.No.	Nutritional property	Observation (Mean ± SD)
1	Ash content	66 ± 0.07 %
2	Moisture content	56 ± 0.01 %
3	Fiber content	0.17 ± 0.01 %
4	Fat content	66 ± 0.08 %
5	Protein content	18.06 ± 0.02 %
6	Carbohydrate	43 ± 1.90 %

All values are (Mean ± SD) of three observations (% = percentage)

Table 2: Fatty acid profiling of the Golden kernel blend

Sr.No.	Fatty acid profiling	Observation (Mean ± SD)
1	Caprylic acid	1.2 ± 0.01 %
2	Lauric acid	0.70 ± 0.02 %
3	Palmitic acid	7.88 ± 0.01 %
4	Palmitoleic acid	0.31 ± 0.01 %
5	Stearic acid	4.04 ± 0.26 %
6	Oleic acid	38.86 ± 0.02 %
7	Linoleic acid	32.43 ± 0.02 %
8	Docosahexaenoic acid	0.47 ± 0.01 %
9	Eicosepentaenoic acid	7.04 ± 0.01 %

All values are (Mean ± SD) of three observations % = percentage

Golden kernel blend are presented in Table 1.

3.2 Fatty acid profiling of the golden kernel blend

Overall, the findings showed that the Golden kernel blend oil's total saturated and unsaturated fatty acid contents were in a ratio of 4:5. Compared to saturated fatty acids, unsaturated fatty acids were greater. Palmitic acid was the primary saturated fatty acid with a value of 7.88 ± 0.01 % followed by stearic acid 4.04 ± 0.26 %, whereas oleic acid was the primary unsaturated fatty acid 38.86 ± 0.02 %, followed by linoleic acid 32.43 ± 0.02 %.

The abundance of oleic and linoleic fatty acids in the Golden kernel blend oil is evident. While a high linoleic fatty acids concentration suggests that the oil is durable and resistant to rancidity, a high oleic level suggests that the oil is healthy. MSKF fat possesses the usual qualities of a vegetable butter due to its high linoleic fatty acid concentration. In addition, it contains a lot of stearic fatty acids, which are also excellent for health. Because of this, the Golden kernel blend oil is a useful resource for creating high-value edible oils (Mas'ud et al., 2020). The data on fatty acid analysis of the Golden kernel blend are presented in Table 2.

4. CONCLUSION

The study investigates the nutritional and fatty acid content of mango seed kernels, particularly from the Alphonso variety and chickpea flour mix named as the Golden kernel blend. It reveals that blend is rich in carbohydrates (43), proteins (18.06), and bioactive compounds, making it a valuable functional food ingredient. The processing of mango seeds into flour involves drying, de-shelling, and grinding, achieving a 90.1% recovery rate. MSKF exhibits significant nutritional properties, with potential applications in bakery products and gluten-free formulations. The research emphasises sustainable practices by utilising agricultural waste, highlighting the economic and environmental benefits of incorporating MSKF into food products while calling for further studies on its bioavailability and clinical efficacy.

Authorship contribution: The authors are accountable for the accuracy, originality, and integrity of the work.

Funding: No funding by any agency.

Conflict of interest: Authors has no conflict of interest with anyone.

Declaration: It is an original data and has not been sent or published anywhere.

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