INTERNATIONAL JOURNAL OF LATEST TECHNOLOGY IN ENGINEERING, MANAGEMENT & APPLIED SCIENCE (IJLTEMAS)

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue V, May 2026

Effect of Drying Methods on Chemical Properties of Mango Paste

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DOI: https://doi.org/10.51583/IJLTEMAS.2026.150500126

Received: 25 May 2026; Accepted: 29 May 2026; Published: 08 June 2026

ABSTRACT

The influence of drying methods (hot-air, microwave, and sun drying) on the bioactive compounds and mineral composition of mango paste was investigated. Mango paste samples were processed under the different drying conditions and analyzed for vitamin C, beta-carotene, lycopene, total phenolic, flavonoids content, and selected minerals, including potassium (K), iron (Fe), magnesium (Mg), calcium (Ca), and phosphorus (P). Significant differences ($p < 0.05$) were observed among the drying methods for all parameters evaluated.

All the drying methods resulted in a reduction in vitamin C and phenolic compounds, while beta-carotene, lycopene, and most mineral elements increased significantly due to concentration effects associated with moisture removal. Fresh mango recorded the highest vitamin C content (64.08 mg/100 g), whereas hot-air drying caused the greatest reduction (25.80 mg/100 g). Sun-dried mango paste retained relatively higher vitamin C (61.62 mg/100 g) among the dried samples. Beta-carotene content increased from 5.82 mg/100 g in fresh mango to 10.92 mg/100 g in sun-dried mango paste, while lycopene content was highest in microwave-dried mango paste (2.37 mg/100 g). Total phenolic content decreased substantially after drying, with hot-air-dried mango paste recording the lowest value (0.65 mg/100 g). Conversely, microwave drying enhanced flavonoid retention, producing the highest flavonoid content (79.00 mg/100 g).

Mineral analysis revealed significant increases in potassium, iron, magnesium, and calcium contents following drying. Sun-dried mango paste exhibited the highest potassium concentration (501.45 mg/100 g), whereas microwave drying produced the highest calcium content (41.55 mg/100 g). In contrast, phosphorus content decreased in all dried samples compared with fresh mango.

Overall, microwave drying demonstrated superior retention of bioactive compounds and minerals, indicating its suitability for preserving the nutritional and functional quality of mango paste.

Keywords: Mango, Drying, Bioactive Compounds and Mineral Content.

INTRODUCTION

Mango (Mangifera indica L.) is a tropical fruit that is widely commercialized and consumed in the world. It is a fruit that belongs to the family of Anacardiaceae, which is grown on a large scale worldwide. Mango fruit is cultivated on approximately 3.7 million hectares and occupies the second position among tropical fruit crops (Tewodros et al., 2019). Mango is a very popular fruit due to its superior taste, colour, and flavour, apart from its organoleptic properties; Mango contains high nutritional value, including high levels of vitamin C, carotenoids, vitamin E, and moderate levels of phenolic compounds (Herath et al., 2020).

Consumption of mango has been reported to have medicinal and functional benefits in preventing several diseases (DOA, 2018). Various parts of mango fruits contain several bioactive phytochemical compounds, namely polyphenols, carotenoids, flavonoids, tannins, and vitamins. These compounds have potent antioxidants,

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue V, May 2026

anti-cancer, anti-diabetic, skin-protecting, anti-ageing, anti-microbial, and anti-inflammatory properties (Lebaka et al., 2021).

However, mangoes are climacteric fruits, meaning they can ripen off the tree. The ripening period is identified by a series of endogenous biochemical changes, which include enhanced production of ethylene and increased respiration rate (Muhammad et al., 2017), fast ripening, and rapid deterioration, leading to an increase in postharvest losses. Edward et al. (2017) reported postharvest losses in mango to be within the range of 25–40% from harvesting until they get to consumers. In Nigeria, mango faces postharvest losses of up to 50% due to high relative humidity, temperature, and poor postharvest handling techniques and lack of adequate storage facilities (Alamu et al., 2018).

Drying has been reported to be one of the ways to tackle postharvest losses (Abe-Inge et al., 2018; Farhana et al., 2018; Surendar et al., 2018). The cost of transportation, handling, and storage is considerably lower than that of other methods of preservation (Mohamed et al., 2017; Wang et al., 2019). Many researchers have reported various drying methods commonly used for fruits. However, drying methods can alter the physicochemical properties and nutritive qualities of the dried products despite the extended shelf-life (Adepoju and Osunde, 2017; Albernaz et al., 2017; Izli et al., 2017; Mohamed et al., 2017; Mwamba et al., 2017; Sehrawat et al., 2018; Link et al., 2018). Therefore, it is important to understand the effects of various drying methods on the chemical properties (vitamin C, beta-carotene, lycopene, flavonoids, phenols) and mineral content of mango paste, which are essential for producing high-quality mango paste. Thus, this study aimed to determine the effect of drying methods on the chemical properties of mango paste, thereby providing valuable insight for food processors and researchers in tropical fruit preservation.

MATERIALS AND METHODS

Materials

Fresh mango (Mangifera indica L.), Ogbomoso mango variety was harvested from a farm in Owode village, Ogo-Oluwa Local Government Area, Ogbomoso. Lime and granulated white sugar were purchased from Sabo Market, Ogbomoso. Botanical authentication of the mango variety was carried out at the Herbarium unit of the Department of Pure and Applied Biology, Ladoke Akintola University of Technology, Ogbomoso. Analytical grade reagents and chemicals were obtained from Nutrichem Procurement Ltd., Lagos.

Methods

Sample Preparation

Mango fruits were sorted at ripening stage 3 based on firmness, colour, and size using the USDA (2007) mango colour chart, then washed with potable water. The fruits were manually peeled and sliced into 5 mm thickness using a fruit slicer (Box Grater Model 5.0) following the procedure described by Adepoju and Osunde (2017).

Osmotic Pre-treatment

Osmotic pretreatment was performed according to Bolarinwa and Ajetunmobi (2020). Sucrose solutions of 55 ºBrix were prepared by dissolving 550 g of sugar in 450 ml of warm distilled water, followed by thorough mixing and equilibration. Mango slices (1000 g) were immersed in the sucrose solutions at a ratio of 1:2 (w/w) and held at 45 °C for 30 minutes in a water bath according to the method described by Gonzalez-Perez et al. (2023) with a few modifications.

Lime Concentration Preparation for Pre-treatment

Lime fruits were sorted and washed with potable water to remove the dirt. The fruits were manually cut into equal halves using a knife and sequenced into a clean glass beaker to obtain lime concentration. The lime juice was passed through the muslin cloth to obtain a clear juice. Lime concentrations of 8% w/v, with reference to the weight of mango slices (1000 g), were set aside by weighing 80 ml of the lime juice.

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Mango Paste Production

Osmotically pretreated mango slices were processed into puree following the procedure described by Phaokuntha et al. (2014), with slight modifications. Briefly, granulated sugar (4% w/w of mango slices, equivalent to 40 g) and lime juice (8% w/v) were incorporated into the osmotically treated slices. The mixture was homogenized at high speed for 3 min using a Pyramid blender (Model PM-Y44B3) until a uniform puree was obtained. The process flow for mango paste production is presented in Figure 2.1. The resulting mango puree was subjected to three different drying methods: hot-air, microwave, and sun drying.

For hot-air drying, the puree was evenly spread on grease-proof paper-lined trays and dried in a convective oven (Uniscope SM9053, Surgifriend Medicals, England) at temperatures of 85 °C for 3 h. Microwave drying was conducted using a domestic microwave oven (Severin 700 W and Grill, Model 7900) operated at power levels of 600 W for 20 min. For sun drying, the puree was spread on grease-proof paper-lined stainless trays, covered with fine mesh to prevent contamination, and exposed to direct sunlight. Drying was terminated when the moisture content values remained constant over three consecutive measurements.

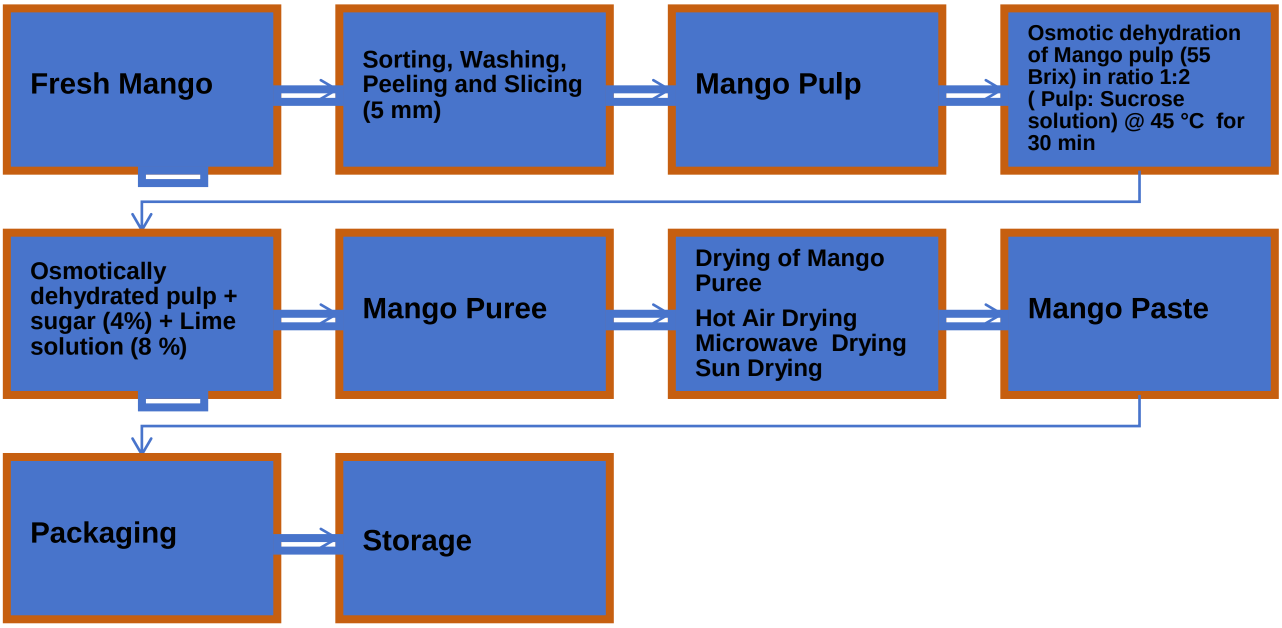

Figure 2.1: Process Flow for Mango Paste Production

Chemical Analyses

Chemical analyses include determination of vitamin C, beta-carotene, total phenol, lycopene, flavonoid, and mineral contents.

Determination of Vitamin C

Vitamin C contents of the samples were determined using the method of Ordonez-Santos et al. (2017). The sample (5 g) was diluted with distilled water (100 ml) and filtered to obtain clear solutions. The solution (2 ml) was pipette into small flasks and 25 ml of glacial acetic acid was added. The mixture was titrated with indophenols solution [2, 6 dichlorophenol indophenols (0.05/100 ml)] to a faint pink colour, which persists for 15 seconds. Vitamin C content was calculated as follows:

$$\text{Vitamin C}\left(\frac{\text{mg}}{100\text{g}}\right) = \text{Titrevalue}\times\text{dyefactor}\times\frac{\text{volume (100 ml)}}{\text{Aliquot of extract}}\times\text{volume of the sample}$$

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Determination of Beta-carotene

The beta-carotene content of mango paste samples was determined following the method described by Bolarinwa et al. (2020)**,** with slight modifications. Approximately 5 g of the sample was homogenized in 10 mL of acetone, followed by the addition of a few crystals of anhydrous sodium sulfate to remove residual moisture. The mixture was allowed to settle, and the supernatant was decanted into a clean beaker and transferred into a separating funnel. Subsequently, 10 mL of petroleum ether was added, mixed thoroughly, and allowed to separate into two layers. The lower aqueous layer was discarded, while the upper organic layer containing beta-carotene was collected into a 100 mL volumetric flask and made up to volume with petroleum ether. The absorbance value of the resulting solution was measured at 452 nm using a UV–Vis spectrophotometer (with petroleum ether as the blank).

The β-carotene concentration (mg/100 g) was calculated using the following equation.

$$\text{Beta-carotene}\left(\frac{\text{mg}}{100\text{g}}\right) = A \times V \times 1000 / A1\%,1cm \times P \qquad 2.2$$

Where A = Absorption value of the solution at 452 nm

V = The final volume of the sample extract

P = Initial weight of the sample

A1%,1cm = Absorption coefficient (2592 for Petroleum Ether)

1000 = The mathematical constant required to scale the units perfectly to mg/100g of the sample (AOAC, 2016).

Determination of Total Phenol

Total phenol content of the samples was determined using Folin-Ciocalteu reagent (Ndou et al., 2019). The samples (0.1 ml) were homogenized in 2 ml of 80% methanol containing 1% HCl, at room temperature using a BV 1000 vortex mixer. The mixture was centrifuged at 10,000x g for 15 min. The supernatant (2 ml) was used to determine the total phenolic content. Briefly, 9 µl of extract (supernatant) was mixed with 109 µl of Folin – Ciocalteu reagent, followed by 180 µl of 7.5% sodium carbonate (Na_2CO_3). The solution was mixed, incubated for 5 min at 50 °C, and cooled to 25 °C. The absorbance of the sample solution was measured at 760 nm. Total phenolic content was calculated using a standard curve of gallic acid equivalent in mg/100g of the sample.

Determination of Lycopene

Lycopene was determined according to the methods outlined by Owusu et al. (2015). 0.1g of the sample was weighed into a test tube. 10ml of a mixture of hexane: acetone [6:4 (v/v)] was used for the extraction. The mixture was mixed and allowed to extract for 10 min, after which it was centrifuged for 3 min at 2000 rpm. Thereafter, the absorbance was measured spectrophotometrically at 505, 453, and 663 nm, respectively. The solvent of extraction was used as the blank. The Lycopene content in the sample was calculated as follows:

$$\text{Lycopene(mg/100g)} = 0.0458 \times A663 + 0.372 \times A505 - 0.0806 \times A453 .$$

The values obtained were expressed as mg/100 g DW (dry weight) sample

A is the Absorbance.

Determination of Flavonoids

Total flavanoid content of the sample was determined using a colorimetric method (Plabon et al., 2019). The sample (1 g) was mixed with 4ml of distilled water and 0.3 mL of 5% sodium nitrite ($NaNO_2$) solution. The mixture was added to 0.6 ml of 10% aluminium chloride hexahydrate ($AlCl_3.6H_2O$) and was allowed to stand for 6 min before 2 ml of 1M sodium hydroxide (NaOH) was added to the mixture, and the solution was vortexed.

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Absorbance was measured immediately at 510 nm using a V-730 UV-Vis spectrophotometer (Jasco, USA). Catechin standard concentrations (20 to 100 µg/ml) were run with the test samples, from which a standard curve was plotted. The total flavonoid content of the samples was expressed as mg of Quercetin equivalent per 100g of fresh mass.

Mineral Analysis

Determinations of mineral content in the samples were carried out following the procedure described by Achikanu et al. (2013). Acid digestion of the samples was required to determine mineral content. For this purpose, the samples (5 g) were digested with 10 mL of 5N concentrated hydrochloric acid. The mixtures were placed on a water bath and evaporated almost to dryness. The solutions were cooled and filtered into a 100 mL standard flask, then diluted to volume with distilled water. A colorimetric/UV-spectrophotometric method was used to analyze the minerals separately after acid digestion of the samples.

Determination of Potassium (K)

The sample (5 ml) was pipette into a test tube in duplicate. Then, cobalt nitrite (2 ml) was added and shaken vigorously, allowed to stand for 45 min, and centrifuged for 15 min. The supernatant was drained off, and ethanol (2 ml) was added to the residue. The solution was boiled for 10 min with frequent shaking to dissolve the precipitate. Choline hydrochloride (1 ml of 2%) and sodium ferric cyanide (1 ml of 2%) were added. Distilled water (2 ml) was added, and the solution was homogenized, and absorbance was taken at 620 nm against a blank.

Determination of Iron (Fe)

The sample (2.5 ml) was pipette into a test tube in duplicate, and 5N sodium hydroxide (0.4 ml) was added to bring the pH between 4.0 and 4.5. Acetate buffer of pH 4.5 (0.75 ml), hydroquinone (0.5 ml of 25%), α^1 α^1 dipridyl (0.5 ml of 0.1), and distilled water (0.35 ml) were added to make it up to 5 ml. The absorbance was taken at 520 nm against the blank.

Determination of Magnesium (Mg)

The sample (5 ml) was pipette into a test tube in duplicate. 0.67 N sulphuric acid (1 ml), titan yellow (1 ml of 0.05%), gum acacia (1 ml of 0.01%), and sodium hydroxide (2 ml of 10%) were added. The solution was mixed,

Determination of Calcium (Ca)

The sample (1 ml) was pipette into a test tube in duplicate. Then 3 ml of calcium working reagent was added, and absorbance at 515 nm was read against the blank.

Determination of Phosphorus (P)

Phosphorus content was determined using the method described by AOAC (2020). The samples (5 ml) solution was pipette into a 50 ml graduated flask, and the molybdate mixture (10 ml) was added and diluted with water to mark. The solution was allowed to stand for 15 min for colour development. The absorbance was read at 400 nm against a blank.

Statistical Analysis

Data obtained in this study were subjected to One-Way Analysis of Variance (ANOVA). All experimental procedures were repeated in duplicate, and the mean values were estimated using SPSS version 20 (Statistical Package for Social Sciences, USA). Duncan's multiple range test was used to compare the difference between means at a probability level ($p<0.05$).

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RESULTS AND DISCUSSION

Effect of Drying Methods on Chemical Properties of the Mango Paste

Drying methods significantly ($p<0.05$) influenced bioactive compounds and mineral composition of mango paste samples. Variations among hot-air, microwave, and sun drying may be attributed to differences in temperature, drying time, and moisture removal efficiency.

Vitamin C

According to Sehrawat et al. (2018), mango is a rich source of bioactive compounds, including vitamin C (ascorbic acid), beta-carotene, and various polyphenolic compounds. Table 3.1 shows the effect of drying methods on bioactive compounds in mango paste. Vitamin C is a major nutrient in the human diet, with 50% supplied by fruits and vegetables (Owolade et al., 2017). It is necessary for healthy teeth and gums and is essential for the proper functioning of the adrenal and thyroid glands (Hussein, 2020). Vitamin C content varied significantly among the drying methods used for processed mango paste, as presented in Table 3.1. The values ranged from 25.80 to 61.62 mg/100g. Sun-dried samples had the highest vitamin C content, followed by microwave-dried samples, while hot-air-dried samples had the lowest.

Table 3.1 Effect of Drying Methods on Bioactive Compounds of Mango Paste

Drying Methods	Vitamin C (mg/100g	Beta-carotene (mg/100g)	Lycopene (mg/100g)	Phenol (mg/100g)	Flavonoid (mg/100g)
Fresh mango	64.08 ± 0.12^{d}	5.82 ± 0.005^{a}	0.94 ± 0.000^{a}	5.36 ± 0.019^{d}	75.05 ± 0.00^{c}
Hot-air	25.80 ± 0.12^{a}	6.92 ± 0.625^{b}	1.49 ± 0.000^{c}	0.65 ± 0.019^{a}	10.50 ± 0.00^{a}
Microwave	58.43 ± 0.12^{b}	9.89 ± 0.170^{c}	2.37 ± 4.412^{d}	1.54 ± 0.170^{c}	79.00 ± 0.47^{d}
Sun	61.62 ± 0.12^{c}	10.92 ± 0.029^{d}	1.15 ± 4.412^{b}	1.24 ± 0.381^{b}	30.83 ± 0.235^{b}

Mean values in the same columns bearing the same superscript are not significantly different ($p<0.05$).

Mwambai et al. (2017) reported similar findings when comparing the effects of drying methods on mango slices; they observed that sun-dried samples had higher vitamin C content than hot-air-dried samples. This might be due to the high temperature of the hot-air oven, which favoured oxidation and thermal decomposition of vitamin C, leading to its degradation. The results suggested a significant effect of drying methods on the vitamin C content of mango paste. Compared with the vitamin C content of the fresh mango sample, a decrease in vitamin C content was observed. According to Thuy et al. (2020), vitamin C is heat-labile, which could lead to its degradation. Also, losses in vitamin C content may depend on drying methods, the type of raw material, and additional factors such as pretreatments (Wijewardana et al., 2016).

Beta-Carotene

One of the main factors determining the nutritional quality and orange colour of ripe mango fruit is beta-carotene. It is known as provitamin A and is generally the predominant carotenoid in ripe mango (Hor et al., 2019). The beta-carotene contents of the samples are presented in Table 3.1. The values ranged from 6.92 to 10.92 mg/100g. A significant ($p\leq0.05$) increase was observed in all dried samples compared with the fresh sample. This result was in agreement with Ojo-kayode et al. (2023), who reported an increase in beta-carotene content in dried pawpaw chips. There was a significant difference among the drying methods employed; sun-dried samples had the highest beta-carotene content, followed by microwave-dried samples, while hot-air-dried samples had the lowest value. Hor et al. (2019) also reported an increase in beta-carotene content of mango slices.

According to Ojo-kayode et al. (2023), higher temperatures have been shown to cause significant losses of carotenoids, which may enhance extraction yield and thereby increase carotenoid content. In a study conducted by Nyangena et al. (2019), increased beta-carotene levels ranging from 6.65 mg/100g to 40.88 mg/100g were

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observed among differently pre-treated and dried mango slices. An increase in beta-carotene content may be due to pre-treatment before drying.

However, a reduction in the beta-carotene content of mango slices after drying was reported by Tadlo and Tadesse (2021) across different drying methods. The value ranged from 91.05 mg/100g to 23.71 mg/100g. Solar-dried mango slices had higher retention of beta-carotene content with a value of 59.58 mg/100g, while lower retention was observed in oven-dried mango slices with a value of 18.57 mg/100g.

Lycopene

Lycopene is a carotenoid that belongs to the same group as beta-carotene; it has antioxidant properties and gives a red-coloured pigment in both fruits and vegetables (Suwanaruang, 2016). The lycopene contents of the samples are presented in Table 3.1. The values ranged from 1.15 mg/100g to 2.37 mg/100g. A significant ($p \leq 0.05$) increase was observed in all samples by different drying methods compared to the fresh sample (0.94 mg/100g). This result was in agreement with Ojo-kayode et al. (2023), who reported an increase in lycopene content of dried pawpaw chips. Samples dried with a microwave oven had the highest value of lycopene content, followed by samples dried with a hot-air oven, while sun-dried samples had the lowest value of lycopene content.

Phenolic compounds

Phenolic compounds are important plant constituents with redox properties, imparting antioxidant properties since hydroxyl groups in these compounds are responsible for facilitating free radical scavenging (Aryal et al., 2019). According to Ayele et al. (2022), they are believed to account for a major portion of the antioxidant capacity in many plants. From Table 3.1, the total phenolic contents of samples dried by different drying methods varied from 0.65 mg/100g to 1.54mg/100 g. A significant decrease ($p \leq 0.05$) was observed in all samples produced using the different drying methods compared to fresh mango (5.36 mg/100g).

This result is in line with the findings of Santos et al. (2014), who reported a decrease in total phenolic content of dried pear samples. The decline in phenolic content in the course of the drying period can be linked with the association of polyphenols with other compositions, like proteins, or the changes in the chemical formation of polyphenols that cannot be defined or extracted through existing methods (Izli et al., 2017). Also, Mohammed et al. (2020) reported a reduction of total phenolic content from mango and pineapples dried by different methods.

In this study, samples dried by the microwave drying method had the highest retention of total phenol content with a value of 1.54 mg/100g, followed by sun-dried samples with a value of 1.24 mg/100g, while hot-air dried samples had the least retention of total phenol content with a value of 0.65 mg/100g. This reduction could also be due to an increase in oxidative degradation under oxygen and ultraviolet radiation during processing. Polyphenol enzymatic degradation may occur during hot-air drying at high temperature, as well as photo-oxidation of some polyphenols due to the presence of oxygen during sun drying (ElGamal et al., 2023). In a study conducted by Izli et al. (2017) on the influences of distinct drying techniques on mango fruit samples 'antioxidant capacity and total phenol content, they concluded that microwave-dried samples had greater total phenol content among different drying methods used. This result may probably be due to the short drying time the phenolic compounds were exposed to, which caused less thermal effect.

Flavonoids

Flavonoids belong to a class of plant secondary metabolites having a polyphenolic structure. They are widely found in fruits, vegetables, and certain beverages. They have various favourable biochemical and antioxidant activities that are associated with various diseases such as cancer, Alzheimer's disease (AD), atherosclerosis, etc. (Panche et al., 2016). The total flavonoid content of the mango pastes produced by different drying methods is presented in Table 3.1. The values ranged from 10.50 mg/100g to 79.00 mg/100g. A significant difference was observed among the samples with different drying methods. When comparing fresh mango with mango paste samples, it was observed that different drying methods led to a decrease in the flavonoid content of hot-air and sun-dried mango paste samples, while the microwave-dried sample increased in flavonoid content. The sample processed by the hot-air drying method had the lowest retention capacity of flavonoid content, with a value of 10.50 mg/100g, followed by the sample processed by the sun-drying method; however, the samples

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processed by the microwave drying method had the highest retention capacity for flavonoid content, with a value of 79.00 mg/100g. The results obtained in this study are in line with the findings of Snoussi et al. (2021), who observed an increase in total flavonoid content of microwave-dried Myrtus communis L. leaves and a decrease in total flavonoid content of hot-air oven-dried Myrtus communis L. leaves. Generally, higher drying temperatures caused a significant reduction in the total flavonoid content of the processed mango paste.

Effect of Drying Methods on Mineral Content of the Mango Paste

Table 3.2 shows the effect of drying methods on the mineral contents of mango paste samples. Potassium content of the mango paste and fresh mango ranged from 188.80 mg/100g to 501.45 mg/100g, iron content ranged between 9.49 and 7.40 mg/100g, magnesium ranged between 32.65 and 64.95 mg/100g, Calcium ranged between 15.79 and 41.55 mg/100g, and Phosphorus ranged between 1.52 and 3.44 mg/100g. The results of mineral content showed that the samples were significantly different ($p<0.05$).

Table 3.2: Effect of Drying Methods on Mineral Contents of Mango Paste

Drying Methods	K (mg/100g)	Fe mg/100g)	Mg (mg/100g)	Ca (mg/100g)	P (mg/100g)
Fresh mango	188.80 ± 0.99^{a}	7.40 ± 0.71^{a}	32.65 ± 0.92^{a}	15.79 ± 0.01^{a}	3.44 ± 0.00^{d}
Hot-air	372.05 ± 0.49^{b}	9.49 ± 0.03^{c}	63.65 ± 0.21^{c}	26.65 ± 0.21^{b}	1.52 ± 0.01^{a}
Microwave	462.60 ± 0.42^{c}	7.85 ± 0.00^{b}	59.45 ± 0.78^{b}	41.55 ± 0.08^{d}	1.79 ± 0.00^{b}
Sun	501.45 ± 0.07^{d}	7.45 ± 0.00^{a}	63.70 ± 0.28^{c}	36.60 ± 0.28^{c}	1.90 ± 0.01^{c}

Mean values in the same columns bearing the same superscript are not significantly different ($p<0.05$).

It was observed from this study that potassium content increased after drying, and the sun-dried sample had the highest value of 501.45mg/100g, followed by the microwave-dried sample with the value of 462.20 mg/100g, and the hot-air-dried sample with 372.05 mg/100g. However, the fresh mango sample had the lowest value of 188.80 ± 0.99 mg/100g.

An increase in magnesium and calcium content was also observed after drying, with the sun-dried sample having the highest value of 64.95 ± 1.49 mg/100g, and the microwave-dried sample had the highest value of 41.55 ± 0.08 mg/100g. Iron content of mango samples also followed a similar increased pattern, with the hot-air dried sample recording the highest value of 9.49 mg/100g, followed by the microwave dried sample (7.85 mg/100g).

The increase in the potassium, magnesium, iron, and calcium content of the mango paste compared to the fresh mango could be due to the increased dry matter content of the product. The findings in this study were similar to the observation of Ozkan et al. (2021), who reported an increase in mineral contents (Ca, K, Na, P, Mg, Fe, Zn, Cu, and Mn) of pumpkin fruit leather after drying. Suna et al. (2014) also reported an increment between fresh fruit and sun, vacuum, and microwave dried apricot pits in terms of K, Ca, Mg, and Zn contents. However, in this study, phosphorus exhibited a decreasing trend after drying. Sun-dried sample retained phosphorus content more than the other drying methods, with the sun-dried sample having a value of 1.90mg/100g, followed by the microwave-dried sample (1.79 mg/100g), while the hot-air-dried sample had the lowest value of phosphorus content (1.52 mg/100g). The decline in phosphorus may be associated with reduced extractability or degradation of phosphorus-containing compounds during drying.

CONCLUSION

The findings demonstrate that drying methods exert a substantial influence on the nutritional and functional properties of mango paste. Microwave drying showed superior retention and enhancement of bioactive compounds, particularly lycopene and flavonoids, while also maintaining appreciable mineral content. Sun drying favoured retention of vitamin C and potassium, but was less effective for moisture reduction, causing greater degradation of heat-sensitive phytochemicals. Overall, microwave drying appears to be the most suitable technique for preserving the bioactive compounds and mineral content of mango paste.

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1. **Ethical Approval**
   There is no ethical approval because the research doesn't involve human subjects oranimals.
2. **Conflict of Interest**
   No conflict of Interest

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ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XV, Issue V, May 2026

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