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Evaluation of some Physico-chemical Properties of Mango (*Mangifera Indica* L.) Pulp in South-south, Nigeria.

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Abstract
Magnifera indica L. fruits possess various physiochemical properties which differs with changing temperature conditions and locations. Thus the physical property, proximate, mineral and ultimate analysis were conducted for four markets in south-south Nigeria using standard methods. A particular ripe cultivar was randomly collected, identified, authenticated, de-pulp and evaluated for these physical and chemical parameters. The following physiochemical parameters were highest in mango pulps collected from Oba market: width (11.60±0.02) mm, length (60.15±0.05) mm, bulk density (45.04±0.05) g/cm^3, thickness (18.41±0.12) mm, volatile matter (11.24±0.14) %, ash value (1.1.86±0.02), Moisture content (83.39±0.27) %, Zn (6.78±0.01) mg/100g, Na (294.63±0.34) mg/100g, Mg (113.30±0.29) mg/100g and Fe (3.56±0.10) mg/100g. This study showed that the pulp of mangoes collected from Oba market are physically different, rich in minerals and volatile matters that have a short shelf live.

Key words: Physico-Chemical Properties, Proximate analysis, Ultimate analysis, *Mangifera indica L* Pulp.

1. Introduction

Mangifera indica L. Family Anacardiaceae widely known as mango, has about 69 species in its genus (Kostermans and Bompard, 1993). It was widely cultivated in southern region and peninsula of Asia and now naturalized in most tropical countries (Kochummen, 1995). The ever green tree attains an average height of about 40 m at maturity, its dense foliage forms a dome shaped with heavy branches from a plucky trunk (Paull and Duarte, 2011). There is a wide difference in shape and size of its large fleshy fruit, with a thick yellow pulp or yellowish-red skin when ripe (Litz, 1997; Paull and Duarte, 2011). It is eaten fresh for its high fibre and made into juices while the unripe fruit can be used to flavour fish and meat dishes (Garrido and Valde, 2010).

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Different parts of the mango plant are used in folkloric medicine as an antimicrobial, astringent, tonic, laxative, diuretic, watery and bloody stool, vermifuge, haemorrhage and piles (Sairam *et al*., 2003), anaemia, bronchitis, elevation in blood pressure, sleep disorder, rheumatism, toothache, leucorrhoea, abscesses, broken horn, inflammation, snake and insect bite, heat stroke, miscarriage, mouth sores, ear pain, stomach pain and indigestion, liver diseases, polyuria, tetanus, cough and breathing difficulty (Ediriweera *et al*, 2017; Patarakijavanich *et al*., 2019; Singh *et al*., 2009). Different Ethno pharmacological activities has been evaluated for mango, which include anti-oxidant (Afifa *et al*., 2004), anti-diabetic (Patarakijavanich *et al*., 2019), anti-inflammatory (Marquez *et al*., 2010), analgesic (Tarkang *et al*., 2015), antiviral, anthelmintic, anti-allergenic, anti-parasitic, anti-bone resorption, anti-tumor (Nguyen *et al*., 2016), antispasmodic, antipyretic activity, immunomodulatory, anti-diarrhoeal, anti-bacterial, antifungal activity, hepato and gastro-protective (Shah *et al*., 2010).

These activities could be due to the presence of phytochemicals such as monoterpene (Li *et al*., 2017), phenols and polyphenols (Berardini *et al*., 2005), glycosides, terpenes, alkaloids, steroids, tannins and anthraquinone (Aiyelaagbe and Osamudiamen, 2009; Majumder and Paridhavi, 2016). These are distributed among the cultivars, different developmental stage and tissues of the fruits (Adedeji *et al*., 1992). They confer smell, colour and medicinal properties on the fruits. Examples include pinene, α-terpinolene, d-carvone, β-elemene, α-bourbonene, α and β-cubebene, aromadendrene, α-humulene, germacrene D and *cis*-caryophyllene (Rivera *et al*., 2017), thujene, β-caryophyllene, 3-carene, myrcene, ethyl butenaonate, and β-phellandrene (Correa, 2012), β-myrcene, *trans* and *cis*-ocimene, and limonene (Johna *et al*., 1999), (+)-3-carene, sabinene, α-phellandrene, γ-terpinene, α-pinene, and (−)-*trans*-caryophyllene (Musharraf *et al*., 2016). Mango is a rich source of water and fat-soluble vitamins, they include vitamins A to D, E and K. Regular and daily consumption offers the required dietary necessities for these vitamins (WHO/FAO, 2003). Though these vitamins are find in small quantities, their level depends on the cultivar. Vitamin E commonly occurs as α-, β-, λ-, and γ-Tocopherols and the corresponding α-, β-, λ-, and γ-Tocotrienol (Maldonado-Celis *et al*., 2019). Vitamin B complex includes thiamine, riboflavin, niacin, pantothenic acid, pyridoxine and folic acid, are involved in various metabolic activities in humans (Dar *et al*., 2016). Mangoes are also rich sources of minerals, which include Ca, Cu, Fe, K, Mg, Mn, Na, P, Se and Zn (Maldonado-Celis *et al*., 2019). Mango is an important fruit that is widely cultivated for its macronutrient, micronutrients and phytochemicals.

This study intend to evaluate some of these parameters by determining the physical characteristics, proximate analysis, mineral content and ultimate parameter from the pulps of mango fruits collected from four markets in South-south, Nigeria.

2. Materials and Methods

All chemicals and reagents used in this study were of analytical grade: Anhydrous calcium chloride, Barium sulphate, Barium chloride, Copper (II) oxide, Potassium hydroxide, Sulphuric acid, hydrochloric acid, Sodium hydroxide, Magnesium oxide, Anhydrous Sodium carbonate, boric acid, distilled water and Ammonia, Flame photometer (Jenway), Atomic Absorption Spectrophotometer (Buck 210 model 200), Spectronic 20 (Gallenkamp, UK), Vernier caliper, Oven, Muffle Furnace, Filter paper, Crucible, Measuring cylinder, Porcelain boat, Combustion tube, U-tube glass, Bottle, Thermometer, Kjeldahl flask, Kjeldahl catalyst, fume cupboard, volumetric flask (100 ml), Conical flask (200 ml).

2.1 Collection and Preparation of Plant Materials

Ripe mangoes of the same cultivars (*Mangifera indica* L. via Saigon) were purchased from four markets in South-South region in Nigeria. Oba market in Edo state (OE), Igbudu Market in Delta State (ID), Kaima Market in Bayelsa State (KB) and Igwuruta Market in Rivers State (IR). The samples was identified and authenticated by Adeyemo A. of Forestry Research Institute of Nigeria (FRIN) herbarium and specimen number FHI-112897 was assigned. The fruits were carefully washed and cleaned with a dry cotton cloth, cut with a knife to separate the pulp from the seed.

2.2 Physical Properties

Length, width, thickness, sphericity, roundness, porosity, mass, true and bulk densities were the physical properties determined in this study. Vernier caliper (reading to 0.01 mm) was used to measure the length, width and thickness of each pulp. EPA 528 Water displacement method was utilized to achieve the true density. The size distribution for the samples were determined by classifying the fruits into large, medium and small, after which the percentage average length, width, mass and pulp thickness was ascertained for each class. Bulk density was determined using the A.O.A.C (2000) recommended method. Sphericity was calculated by using the data from geometric mean diameter and length for each fruits:

$$Ø= \frac{(lW)^{1/3}}{L}, \quad (1)$$

where L = maximum Length, l= maximum width, W= maximum thickness.

The porosity (ε) was calculated using the values of bulk density and true density

$$\text{Porosity} = \frac{\text{TD}-\text{BD}}{\text{TD}} \times 100, \quad (2)$$

where TD= true density, BD= bulk density

$$Roundness = \frac{Ap}{Ac}, \quad (3)$$

where A_P =Largest projected area of fruit in natural rest position, A_C = Area of smallest circumscribing circle.

2.3 Proximate Analysis

Proximate analysis was conducted based on the methods described in A.O.A.C (2000) and the following analysis were evaluated: Moisture content, crude protein, crude fat, crude fiber, ash content, volatile matter and fixed carbon.

2.4 Ultimate Analysis

The ultimate analysis was used to evaluate the range of major organic elementary constituents of coal such as Carbon, Hydrogen, Oxygen, Sulphur and Nitrogen.

2.5 Determination of Carbon and Hydrogen

This was estimated using the Liebig's method, briefly 5 g mass of *Mangifera indica L*. pulp samples were taken in a porcelain boat, placed in the combustion tube and strongly heated. The organic compounds were oxidized by cupric oxide to CO_2, H_2O and NO_2. The combustion products first pass through the U-tube containing anhydrous calcium chloride (absorption of H_2O) and then through the caustic potash bottle (absorption of CO_2). The U-tube and caustic potash bottle were weighed after cooling them to ambient temperature.

2.6 Determination of Sulphur

The Mott and Wilkson (1953) means of determining high sulphur contents using Eschka method was adopted for this study with slight modifications. 10 g of the mango pulp was heated with Eschka mixture (which consists of 2 parts of MgO and 1 part of anhydrous $NaCO_3$) at 800 ^{O}C. The sulphate formed was precipitated as $BaSO_4$ (by treating with $BaCl_2$) and the Sulphur in mango pulp was computed as follows:

32 grams Sulphur in the mango pulp will give 233 grams $BaSO_4$

Amount of sulphur in mango pulp $= \frac{32y}{233} = 0.1374y$

Percentage of sulphur in mango pulp = $\frac{0.1374yx100}{X}$, where: x = weight of mango seed and pulp sample taken and y = weight of $BaSO_4$ precipitate formed.

2.7 Determination of Nitrogen

MicroKjeldahl method was used to determine the nitrogen content of the pulp samples (AOAC, 2000), 0.205 g of the samples was weighed into a Kjeldahl flask and a tablet of Kjeldahl catalyst (Sedenium catalyst) was added to the sample along with 10 cm^3 of concentrated H_2SO_4. The flask was gently placed in the digester, housed in a fume cupboard. The set-up was heated continuously until a clear solution was obtained. These was cooled, poured into a 100 cm^3 volumetric flask and made up to the mark with distilled water. 10 cm^3 of the resulting mixture was placed into the distillation unit containing an alkaline mixture of 5 cm^3 of 2 % boric acid with two drops of mixed indicator. The liberated ammonia was trapped in the boric acid solution and about 50 cm^3 of the solution was collected into the conical flask. The solution in the flask was titrated with 0.01 M HCl until the first permanent colour change was observed and result calculated.

2.8 Determination of oxygen

This was deduced indirectly as follows:

Percentage (%) of oxygen in kola seed = 100 – (% of C + H + N + S + ash) (5)

2.9 Determination of Mineral Composition

Dry ash method was used on samples prior to analysis for suspected minerals present in the samples. The samples where heated in a muffle furnace at 550^{o}C. The ash produced were dissolved in 10 % hydrochloric acid solution to determine mineral content of the sample by using Jenway flame photometer for sodium and potassium. Atomic absorption spectrophotometer (Buck 210 model 200) for Aluminum, Calcium, Copper, Iron, Magnesium, Silicon and Zn. While phosphorus was determined calorimetrically by Spectronic 20 (Gallenkamp, UK) using the phosphovanado molybdate method (AOAC, 2000).

3. Result and Discussion

From table 1, the ranges of the width varies from (11.60±0.02) to (8.37±0.01) mm, length (60.15±0.05) mm to (38.31±0.15) mm, sphericity (22.40±1.25) mm to (18.32±0.02) %, roundness (50.72±0.13) to (42.92±0.01) % and bulk density (45.04±0.05) to (37.24±0.17) g/cm^3 varies between Oba and Igrwuta markets. The range of the mass (8.28±0.12) to (7.34±0.02) g and true density (97.37±0.02) to (83.45±0.05) g/cm^3 varies from Igrwuta and

Igbudu markets. Thickness of the mango varies from (18.41±0.12) to (16.98±0.01) mm in Oba and Kaima markets. The colour of the pulp ranges from pale yellow through yellow to green.

Table 1: Physical properties of *Mangifera indica L*. pulp from four selected markets in South-South Nigeria.

S/N	Parameters	OE	ID	KB	IR
1	Width (mm)	11.60±0.02	10.32±0.01	9.59±0.23	8.37±0.01
2	Length (mm)	60.15±0.05	45.23±0.05	40.21±0.10	38.31±0.15
3	Thickness (mm)	18.41±0.12	17.25±0.14	16.98±0.01	17.02±0.13
4	Sphericity (%)	22.40±1.25	19.45±0.40	19.21±0.35	18.32±0.02
5	Roundness (%)	50.72±0.13	49.46±0.02	45.23±0.01	42.92±0.01
6	True density (g/cm3)	93.34±0.01	83.45±0.05	90.23±0.13	97.37±0.02
7	Colour	yellow	Pale yellow	green	Green
8	Mass per pulp (g)	8.14±0.02	7.34±0.02	7.86±0.15	8.28±0.12
9	Bulk density (g/cm3)	45.04±0.05	43.96±0.16	39.34±0.18	37.24±0.17

OE= Oba market, Edo state; ID= Igbudu market, Delta State; KB= Kaima market, Bayelsa State; IR= Igrwuta market, Rivers State. Each value represented Mean±SD. n=3, ND = Not Detected.

From table 2, Ash content for the mangoes ranges from (1.86±0.02) % for Oba market to (0.46±0.01) % in Kaima market. Igbudu and Igrwuta markets recorded values of (0.69±0.01) % and (0.58±0.03) % respectively. Percentage fixed carbon for the markets vary widely from Oba (33.28±0.04) % to Kaima (96.36±0.17) %, however, Igbudu and Igrwuta markets recorded (55.29±0.01) % and (52.26±0.01) % respectively. Volatile matter in mangoes was considered to be highest in Oba market (11.24±0.14) % while the lowest percentage volatile matter was seen in Igrwuta market (2.52±0.04) %. Igbudu and Kaima markets showed percentage volatile matter to be (2.81±0.16) % and (2.63±0.03) % respectively. Mango pulp from Oba market (3.31±0.10) % showed the highest percentage of fibre while Kaima market (1.49±0.08) % showed the lowest percentage of fibre. Igbudu and Igrwuta markets showed percentage fibre content of (3.03±0.04) % and (2.78±0.10) % respectively. The percentage of fat in mangoes collected from Igrwuta market was considered to be the highest (11.06±0.45) % while those from Igbudu market (4.56±0.01) % were considered to be the lowest. This shows a wide range of difference between the markets.

Also, Oba and Kaima markets showed percentage fat (9.62±0.24) % and (4.72±0.02) % respectively. Data from a study conducted on Colombia mango (Fibre content 0.26 %) (Shah, 2010) showed that mangoes from three of these markets had fibre content that are higher, showing that these mangoes will aid digestion. Moisture content of (83.39±0.27) %, (77.93±0.10) %, (69.91±0.03) % and (79.72±0.01) % was obtained for Oba, Igbudu, Kaima and Igrwuta markets respectively. Mangoes from Oba market had highest percentage of moisture while mangoes Kaima market had the lowest percentage of moisture. There was wide variation of the protein content of the mangoes from the markets. Kaima market showed the highest percentage of crude protein (7.03±0.05) %, while the lowest percentage was exhibited by mangoes from Igbudu market (2.39±0.03) %, Oba and Igrwuta market gave the percentage crude protein (3.38±0.02) % and (5.72±0.21) % respectively.

Table 2: Result of Proximate analysis of *Mangifera indica L.* pulp from four selected markets in South-South Nigeria.

S/N	Parameters	OE	ID	KB	IR
1	Ash content (%)	1.86±0.02	0.69±0.01	0.46±0.01	0.58±0.03
2	Volatile matter (%)	11.24±0.14	2.81±0.16	2.63±0.03	2.52±0.04
3	Fixed carbon (%)	96.36±0.17	55.29±0.01	33.28±0.04	52.26±0.01
4	Fibre (%)	3.31±0.10	3.03±0.04	1.49±0.08	2.78±0.10
5	Fat (%)	9.62±0.24	4.56±0.01	4.72±0.02	11.06±0.45
6	Moisture content (%)	83.39±0.27	77.93±0.10	69.91±0.03	79.72±0.01
7	Crude protein (%)	3.38±0.02	2.39±0.03	7.03±0.05	5.72±0.21

OE= Oba market, Edo state; ID= Igbudu market, Delta State; KB= Kaima market, Bayelsa State; IR= Igrwuta market, Rivers State. Each value represented Mean±SD, n=3, ND = Not Detected.

Table 3 showed that Si and Al are absent in mango collected from all the markets. Highest level of Na, Mg and P were obtained from Oba market (294.63±0.34) mg/100g, (113.30±0.29) mg/100g, (40.11±0.04) mg/100g while lowest level were obtained in Kaima market (196.09±0.01) mg/100g, (89.04±0.02) mg/100g, (32.54±0.02) mg/100g. Highest level of Ca and Zn while recorded in Igrwuta market (22.83±0.02) mg/100g, (6.78±0.01) mg/100g, while the lowest were recorded in Kaima market (19.27±0.02) mg/100g, (1.82±0.32) mg/100g. Igrwuta and Igbudu recorded the highest (173.62±0.03) mg/100g and lowest (72.46±0.05) mg/100g level of K. Kaima market recorded the highest level of Cu (0.82±0.02) mg/100g and Fe (3.56±0.10) mg/100g while Igbudu (0.49±0.01) mg/100g and Oba (2.53±0.09) mg/100g markets recorded the lowest.

Table 3: Mineral analysis of *Mangifera indica L.* Pulp in four different markets in South-South, Nigeria (mg/100g)

S/N	Parameters	OE	ID	KB	IR
1	Potassium	92.81.63±0.26	72.46±0.05	165.12±0.02	173.62±0.03
2	Sodium	294.63±0.34	227.12±0.34	196.09±0.01	200.36±0.02
3	Magnesium	113.30±0.29	103.81±0.09	89.04±0.02	101.94±0.11
4	Phosphorus	40.11±0.04	36.26±0.02	32.54±0.02	36.98±0.25
5	Calcium	20.55±0.48	21.31±0.17	19.27±0.02	22.83±0.02
6	Copper	0.60±0.01	0.49±0.01	0.82±0.02	0.73±0.02
7	Iron	2.53±0.09	ND	3.56±0.10	3.42±0.02
8	Silicon	ND	ND	ND	ND
9	Aluminum	ND	ND	ND	ND
10	Zinc	5.79±0.01	5.06±1.01	1.82±0.32	6.78±0.01

OE= Oba market, Edo state; ID= Igbudu market, Delta State; KB= Kaima market, Bayelsa State; IR= Igrwuta market, Rivers State. Each value represented Mean±SD, n=3, ND = Not Detected.

From table 4, the highest total carbon content was obtained for Igrwuta market (45.89±0.15) % while the lowest total carbon content was obtained from Kaima market (30.26±0.05) %. Total carbon content for both Oba and Igbudu markets are (38.08±0.25) % and (31.77±0.01) % respectively. Hydrogen content ranges from (0.45±0.04) % for Igbudu market to (0.26±0.04) % for Igrwuta market, while Oba and Kaima markets showed hydrogen contents of (0.40±0.01) % and (0.35±0.03) % respectively. The percentage of oxygen ranges from (59.04±0.03) % for Oba market to (4.47±0.02) % from Igrwuta market, while percentage oxygen content in Igbudu and Kaima markets are (19.45±0.06) % and (13.28±0.07) % respectively. The percentage Sulphur content ranges from (0.12±0.50) % for Oba market to (0.11±0.02) % for Igbudu market, while the percentage Sulphur content for Kaima and Igrwuta markets are (0.02±0.10) % and (0.09±0.06) % respectively.

Table 4: Ultimate analysis of *Mangifera indica* L. pulp in four markets in South-South Nigeria.

S.N	Parameters	OE	ID	KB	IR
1	Total carbon	38.08±0.25	31.77±0.01	30.26±0.05	45.89±0.15
2	Hydrogen	0.40±0.01	0.45±0.04	0.35±0.03	0.26±0.04
3	Oxygen	59.04±0.03	19.45±0.06	13.28±0.07	4.47±0.02
4	Sulphur	0.12±0.50	0.11±0.02	0.02±0.10	0.09±0.06

OE= Oba market, Edo state; ID= Igbudu market, Delta State; KB= Kaima market, Bayelsa State; IR= Igrwuta market, Rivers State. Each value represented Mean±SD, n=3, ND = Not Detected.

The physical properties appraised in this research were observed to vary from market to market. This might be attributed to different agricultural system, soil condition, application of fertilizer and weather condition of the various farms where the mangoes were sourced. Adequate supply of the basic need for plant growth such as water, sunlight and nutrient required for photosynthesis would lead to increased fruit size, length, density and mass. These were seen with mangoes collected from Oba market, showing that these mangoes were properly managed. The yellow colour of mango has been ascribed to carotenoids in the fruits, such as provitamin A, lutein, α-carotene, and β-carotene in the mesocarp of the fruit (Lauricella *et al*., 2017). The presence of low molecular weight phytochemicals in samples with high vapour pressure can be assessed from the volatile matters content (Sharifi and Ryu, 2018), these are mainly present in small quantities (Pandit *et al.*, 2010). From the result, it was observed that mango from Oba market had the highest volatile matter content compared to other markets, this may be due to increased level of phytochemical constituents in this mango sample.

Fibres in fruits reduces the rate of breakdown and absorption of glucose in the gastrointestinal system. This has the advantage of enhancing digestion and reducing the blood sugar level. It has also reduce incidence of colon cancer, hypertension and obesity (Ilodibia *et al*., 2014; Ogungbenle and Omosola, 2015). The level of fibres in these market were observed to vary, but within acceptable range for fruits except for mangoes obtained from Kaima market, which were considered to be low. Mangoes from these markets are rich in fat and their quantity vary widely. Fats are known to act as insulator against cold condition, in animals they are the product of storage of carbohydrate and also the medium for fat soluble vitamins, The low level of fat observed in Igbudu and Kaima markets compared to Oba and Igrwuta markets could be due to increased metabolism in the pulp and may be sign that the fruit is experiencing spoilage. It may indicate low of vitamins in the mangoes from such markets. The fat constituents in mango can be exploited as raw in the manufacture of drug and food items.

Pulps generally have high moisture content, implying that they may be more prone to microbial attack. This study shows that mangoes from Oba market are likely to get spoil faster than other markets while mangoes from Kaima market will likely stay longer on the shelve than others. Protein content of different cultivar of mangoes showed that mango pulps are low in protein, for example mango pulp collected from Peru (1.5 to 5.5 %), Java (1 to 2 %) and India (0.5 to 1 %) (Dar *et al*., 2016). This study showed 2-7 % variation in protein content, thus low in content but it implies a wide variation in the percentage of protein from this cultivar of mangoes collected from these markets. The high protein content in fruits indicate that such a fruit can be eaten to encourage the growth of lean muscle, enhance metabolism and immunity.

The pulps of mangoes are also rich in minerals, which are relevant for healthy living in humans. Lack or short supply of these minerals could result in disorder or malnutrition (Mosha and Gage, 1999). Although it is not possible to have a fruit that contains all the required nutrients, at the recommended quantity, but a blend of different fruits or fruit and foods could give the required nutrients that the body may need. Mangoes from four markets (Oba, Igbudu, Kaima and Igrwuta) were analysed for Ca, K, Zn, Al, Si, Fe, Cu, P, Mg and Na by flame photometry. It is found that Si and Al are absent in the pulps, while Na, Mg and K were very high, P and Ca were moderate and Zn, Fe and Cu were low. This result shows that the pulp of mangoes have an array of nutrients which help the body to function properly: transmit stimulus within the cell, aid in the formation of the hemoglobin responsible for the transportation of oxygen in the body, boost the body defense against infection, maintain the osmotic balance and assist in bone and teeth formation. Lack, short or excess of these minerals could result in hypertension, anemia, sluggishness, reduce immunity and affect the functioning of vitamins.

Apart from the minerals which are inorganic in nature, mango is made up of organic compounds that have basically, carbon (C), hydrogen (H) and oxygen (O), but due to the presence of volatile compounds, elements such Sulphur (S) and nitrogen (N) may also be present. The high carbon content observed with mangoes from Igrwuta market showed higher energy content than mangoes from other markets.

4. Conclusion

This study showed how important mango is in our diet, it can contain both micronutrients and macronutrients that may be prone to degradation. Mangoes obtained from Oba market showed the highest level of fat, fibres and volatile matter. Also the width, length, density and thickness were also higher than those from other markets. Most of the minerals evaluated were observed to be above the figure obtained from other markets. These showed that Oba market mangoes gotten from various parts of Edo state can act as better source of macronutrient and micronutrients. This study have contributed to knowledge by providing important physico-chemical parameters for mangoes (Saigon variety) from these studied area.

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References

Adedeji, J., Hartman, T. G., Lech, J. and Ho, C.T. (1992): Characterization of glycosidically bound aroma compounds in the African mango (*Mangifera indica* L.). *Journal of Agriculture and Food Chemistry*. **40**, 659-661.

Afifa, K., Kamruzzaman, M., Mahfuza, I., Afzal, H., Arzina, H. and Roksana, H. (2014): A comparison with antioxidant and functional properties among five mango (*Mangifera indica* L.) varieties in Bangladesh. *International Food Research Journal*. **21**, 1501–1506.

Aiyelaagbe, O. O. and Osamudiamen, P. M. (2009): Phytochemical screening for active compounds in *Mangifera indica* leaves from Ibadan, Oyo State. *Plant Science Research*. **2**(1), 11-13.

Association of Official Analytical Chemists. Washington (AOAC) (2000): Official methods of analysis of Analysis of International 17th Edition, AOAC International, Gaithersburg, M.D, USA.

Association of Official Analytical Chemists. Washington (AOAC) (2005): Official Methods of Analysis of International 18th Edition, AOAC International, Gaithersburg, M.D, USA.

Bbosa, G.S., Kyegombe, D.B., Ogwal-Okeng, J., Bukenya-Ziraba, R., Odyek, O. and Waako, P. (2007): Antibacterial activity of *Mangifera indica* (L.). *Africa Journal of Ecology*. **45**, 13-16.

Berardini, N., Fezer, R., Conrad, J., Beifuss, U, Carle, R. and Schieber, A. (2005): Screening of mango (*Mangifera indica* L.) cultivars for their contents of flavonol O- and xanthone C-glycosides, anthocyanins, and pectin. *Journal of Agricultural and Food Chemistry*. **53**, 1563-1570.

Ediriweera, M. K., Tennekoon, K. H. and Samarakoon, S. R. (2017): A Review on Ethno pharmacological applications, pharmacological activities, and bioactive compounds of Mangifera indica (Mango). *Evidence Based Complementary and Alternative Medicine*. **2017**, Article ID 6949835, 1-24.

Garrido, G. and Valdes, M. (2012): Advances in Pharmacological and toxicological investigations with the aqueous extract of the bark of the mango tree (*Magnifera indica* L.). *Review Pharmacological de Chile*. **5** (2), 63-93.

Garcia, M. G., Laime, S. G., Leon, A. A., Montalvo, A. R., Garrido, G. G. and Selles, A. J. N. (2004): Ethnomedical uses of *Mangifera indica* L. stem bark extract in Cuba. Rev. *Cuba Plant Medicine*. **9**, 27-32.

Ilodibia, C.V., Ugwu, R.U., Okeke, C.U., Azeabara, C.A., Okeke, N.F., Akachukwu, E.E. and Aziagba, B.O. (2014): Determination of Proximate Composition of various parts of Dracaena Species. *International Journal of Botany*. **10**(1), 37-41.

Johna, K. S., Raob, L. J. M., Bhata, S. G., Raoa, U. J. S. P. and Rao, P. (1999): Characterization of aroma components of sap from different Indian mango varieties. *Phytochemistry*. **52**, 891–894.

Kochummen, K. M. (1996): *Anacardiaceae* in Soepadmo E. Wong, K.M., Edition. The Tree Flora of Sabah and Sarawak. **2**: Kepong, Sarawak; FRIM.

Kostermans, A. J. G. H. and Bompard J. P. (1993): *The Mangoes, Their botany, nomenclature, horticulture and utilization*. International Board for Plant Genetics Resources and Linnean Society of London. London, UK: Academic Press.

Lauricella, M., Emanuele, S., Calvaruso, G., Giuliano, M. and D'Anneo, A. (2017): Review: Multifaceted Health Benefits of Mangifera indica L. (Mango): The Inestimable Value of Orchards Recently Planted in Sicilian Rural Areas. *Nutrient*. **9**, 525, 1-14.

Litz, R. E. (1997): *The mango, botany, production and uses*. Wallingfond, CAB International, UK.

Maheshwari, B., and Reddy, S. Y. (2005): Application of kokum (*Garcinia indica*) fat as cocoa butter improver in chocolate. *Journal of Science and Food Agriculture*. **85**, 135–140.

Majumdar, P. K. and Sharma, D. K. (1985): *Mango: Fruits of India: Tropical and subtropical*. 1st Edition. Kolkata, India: Naya Prokash.

Maldonado-Celis, M. E., Yahia, E. M., Bedoya, R., Landázuri, P., Loango, N., Aguillón, J., Restrepo, B. and Ospina, J. C. G. (2019): Chemical Composition of Mango (*Mangifera indica* L.) Fruit: Nutritional and Phytochemical Compounds. *Frontera of Plant Science*. **10**, 1-21.

Masibo, M. and He, Q. (2009): Mango Bioactive Compounds and Related Nutraceutical Properties-A Review. *Food Review International*. **25**, 346-370.

Márquez, L., Pérez-Nievas, B. G., Gárate, I., García-Bueno, B., Madrigal, J. L., Menchén, L., Garrido, G., and Leza, J. C. (2010): Anti-inflammatory effects of Mangifera indica L. extract in a model of colitis. *World Journal of Gastroenterology*. **16**, 4922–4931.

Mott, R. A. and Wilkinson, H. C. (1953): The use of the Eschka methods for the determination of high Sulphur contents. *Journal of Applied Chemistry*. **3**, 218-223.

Nguyen, H. X., Do, T. N., Le, T. H., Nguyen, M. T., Nguyen, N. T., Esumi, H. and Awale, S. (2016): Chemical Constituents of *Mangifera indica* and Their Anti austerity Activity against the PANC-1 Human Pancreatic Cancer Cell Line. *Journal of Natural Product*. **79**, 2053-2059.

Patarakijavanich, P., Sato, V. H. and Kongkiatpaiboon, S. (2019): A Review of the antidiabetic potential of *Mangifera indica* leaf extract. *Songklanakarin Journal of Science and Technology*. **41** (4), 942-950.

Paull, R.E. and Duarte, O. (2011): *Tropical Fruits*. 2nd Ed., CAB International, London. 1-10.

Sairam, K., Hemalatha, S., Kumar, A., Srinivasan, T., Ganesh, J., Sarkar, M. and Venkataraman, S. (2003): Evaluation of anti-diarrhoeal activity in seed extracts of *Mangifera indica*. *Journal of Ethnopharmacology*. **84**, 11-15.

Dar, M. S., Oak, P., Chidley, H., Deshpande, A., Giri, A., & Gupta, V. (2016): *Nutrient and favor content of mango (Mangifera indica L.) cultivars: An appurtenance to the list of staple foods*. In Nutritional composition of fruit cultivars. Academic Press, Switzerland. 445–467.

Simmonds, M. S. J. and Preedy, V. R. (2015): *Nutritional composition of fruit cultivars*. Chapter 19. 1st Edition. Academic Press, Switzerland.

Shah, K.A., Patel, M.B., Patel, R.J. and Parmar, P.J. (2010): *Mangifera Indica* (Mango). *Pharmacognosy Review*. **4**(7), 42-48.

Singh, A. K., Sharma, V. K., Kumar, Y., Kumar, S. S. and Sinha, S. K. (2009): Phytochemical and pharmacological investigations on mangiferin. *Herba Polon*. **55**(1), 126-139

Tarkang, P. A., Okalebo, F. A., Siminyu, J. D., Ngugi, W. N., Mwaura, A. M., Mugweru, J. and Guanti, A. N. (2015): Pharmacological evidence for the folk use of Nefang: antipyretic, anti-inflammatory and anti-nociceptive activities of its constituent plants. *BMC Complementary and Alternative Medicine.* **15**, 174.

Thambi, P.A., John, S., Lydia, E., Iyer, P. and Monica, S. J. (2016): Antimicrobial efficacy of mango peel powder and formulation of recipes using mango peel powder (*Mangifera indica* L.). *International Journal of Home Science*. **2**, 155-161.

WHO/FAO, Diet, nutrition and prevention of chronic diseases. (2003): Report of a join WHO/FAO expert consultation. WHO technical report series 916. World Health Organization. Geneva, Switzerland, 1-149.