Journal of Basic Physical Research ISSN: 2141-8403 Prints, 2141-8411 Online
Vol.13, August, 2024, pp. 61 - 69. Available online at www.jbasicphyres-unizik.org

EVALUATION OF FATTY ACID AND PHOSPHATIDE COMPOSITION OF MANGO (*MANGIFERA INDICA*) FRUIT PULP GROWN IN THE FEDERAL CAPITAL TERRITORY OF NIGERIA AT DIFFERENT DEGREE OF RIPENESS

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Abstract
Mango (Mangifera indica) is a tropical fruit consumed world-wide because it is a good natural source of many nutrients. The lipid composition of Mangifera indica fruit pulps grown in the Federal Capital Territory (FCT) of Nigeria was evaluated at different degree of ripeness using standard analytical techniques. The most prominent saturated fatty acid found in the fruit pulps was palmitic acid (16:0) with percentage concentrations of 25.76, 21.78 and 23.60 for unripe (UR), about to ripe (AR) and ripe (RP) fruit pulps respectively. Oleic acid (18:1) was the major unsaturated fatty acid found in the fruit pulps with percentage concentrations of 25.58, 27.54 and 26.36 for UR, AR and RP fruit pulps respectively. The result showed that unsaturated fatty acids were the most dominant in all the fruit pulps, with the mono-unsaturated fatty acid as their major constituent. Ripe mango fruit pulp (RP) can be regarded as the most nutrient rich Mangifera indica because it contained the highest total essential fatty acids with concentrations 20.64 %. The most prominent phosphatides in the fruit pulps are phosphatidylethanolamine which was > phosphatidylcholine > phasphatidic acid > diphosphatidylglycerol. The phosphatide content of Mangifera indica fruit pulps increased as the fruit pulp ripened suggesting that the AR and RP fruit pulps can be used as ingredients for functional enriched food. The results equally showed that Nigerian Mangifera indica is a potential antioxidant at all the ripeness level examined.
Keywords: *Lipid, Mangifera indica, fruit pulp, fatty acids, phosphatides, ripeness*

Introduction

Mango (*Mangifera indica*) belongs to the Anacardiaceae family. It is a tropical fruit bearing plants of Asian origin which is considered as the king of fruits [1, 2]. Mango fruits are very popular world-wide with India having the highest production followed by China, Thailand, Mexico, Pakistan, Indonesia, the Philippines, Nigeria and Brazil [3]. The fruit of mango is a fleshly drupe which is somewhat kidney-shaped or oval. It ranges from 5 to 15 cm in length, greenish, yellowish or reddish in colour and contains a large flattened stone. Mango skin colour is important for its role in the perception of overall quality [4] and can be used for determining the appropriate maturity for harvesting, processing and consumption [5]. The loss of green colour is an obvious sign of fruit ripening in many mango cultivars though some species retain green colour in ripe fruit. Depending on the cultivar, skin colour can change from dark to olive green, sometimes reddish, orange-yellow or yellowish hues appear from the base colour [5]. *Mangifera* indica is a good natural source of many nutrients such as protein, carbohydrates, vitamins (A, B_2, C, E, and K), minerals (calcium, iron, magnesium, phosphorus, sodium, zinc, copper, manganese and selenium), lipids and amino acid [6].

Fatty acids are the building blocks of fats in our bodies and the food we eat [7]. The body breaks down fats into fatty acid during digestion, which can be absorbed into the blood. Fatty acids are not found in a free state in nature, they commonly exist in combination with glycerol in the form of triglyceride [8]. Fatty acids are important components of lipids in plants, animals and microorganisms [7]. Fatty acids can be divided into four general categories namely: saturated, monounsaturated, polyunsaturated, and trans fats. Saturated fatty acids and

trans fats are associated with an increased risk of coronary heart disease while monounsaturated and polyunsaturated fatty acids are associated with a decreased risk of coronary heart disease [8]. Omega-3 fatty acids which are a type of polyunsaturated have been found to be potential therapy for a variety of medical conditions because of their suspected anti-inflammatory properties [8].

Phosphatides also known as phospholipids are components of lipids and consist of alcohol (glycerol) combined with fatty acids and a phosphate ester. The phosphate groups can be modified with simple organic molecules such as choline, ethanolamine or serine [9]. Phosphatidylcholine was the first phosphatide identified by a French chemist and pharmacist in 1847. It is the major component of lecithin and also a choline source in the synthesis of acetylcholine in cholinergic neutrons [10]. Phospholipids are key component of cell membranes and can form lipid bilayers because of their amphiphilic characteristic. The major phosphatides that constitute the biomolecules include phosphatidylcholine, phosphatidylethanoalamine, phosphatidylglycerol and phosphatidylinositol [11]. Metabolic intermediates of phosphatides such as phosphatidic acid, diacylglycerols and free fatty acids are also present in the membrane in lower amounts [12]. Purified phospholipids are produced commercially and are applied in nanotechnology and materials science [9]. The majority of the phosphatides are removed from oil during the degumming and refining operations [8].

Fruits generally, are not rich in lipids with the exception of avocado and olives that store large amount of triacylglycerols [11]. A lot of work has been done on the lipid composition of mango seed nut but no investigation to our knowledge has been done on the lipid composition of mango fruit pulp. The research work therefore, is to evaluate the fatty acid and phosphatide composition of *Mangifera indica* grown in the Federal Capital Territory of Nigeria at different level of ripeness, with the aim of contributing to the actualization of the Sustainable Developmental Goals (SDGs) of 2030 and obtaining information on the health potential of unripe (UR), about to ripe (AR) and ripe (RP) mango fruit pulps.

MATERIALS AND METHODS

Collection of Samples

Mango (Mangifera indica) fruits was harvested from FCT, Abuja, Nigeria, based on visual observation of colour, texture and flavor, the fruits were categorized into unripe (UR), about to ripe (AR) and ripe (RP). The fruits were sliced horizontally into halves with a sharp knife and their seed nuts removed. The categorized and sliced fruit pulps were taken to the medicinal Department of National Institute of Pharmaceutical Research and Development (NIPRD) Idu, Abuja, Nigeria for further treatment and analysis.

Preparation of Samples

The categorized and sliced *Mangifera indica* fruit pulps were weighed, homogenized using a domestic blender (Model MU-176, Japan) filtered using a cheese cloth and freeze-dried using AMSCOFNN-AQUA LYOVAC GT2GT2-E freeze drier. The freeze-dried samples were stored in an air tight sample bottles and used for analysis.

Extraction of Oil

Soxhlet apparatus with redistilled hexane of Analar grade (British Drug houses, London) was used to extract oil from the freeze-dried samples and for the recovery of undiluted oils as described by Yilmaz & Toledo [13]. The crude oil extract was made to be free of water by filtering through anhydrous sodium sulphate salt. The hexane was removed from the oil hexane mixture using rotary evaporator (Hedolph, Germany).

Fatty Acid Analysis

The fatty acid was converted to methyl ester using the method described by [14; 15]. Crude fat (0.2 g) was added to 2 mls of n-hexane solution followed by 0.1 ml methanolic potassium hydroxide solution. The mixture was shaken thoroughly for 30 sec. On addition of potassium salt of glycerol and water, fatty acid methyl ester (FAMEs) was recovered by extraction with 2 mls of hexane. The fatty acid methyl esters were analyzed using a HP 6890 gas chromatograph powdered with HP Chemstation Rev. A 09.01 [1206] software fitted with a flame ionization detector and a computing integrator. Nitrogen was used as the carrier gas. The column initial temperature was 250 ^{o}C rising at 5 ^{o}C/min to a final temperature of 310 ^{O}C while the injection port and the detector were maintained at 310 ^{o}C and 320 ^{o}C respectively. A polar (HP INNO Wax) capillary column (30m × 0.25 mm × 0.25 µm) was used to separate the esters. The peaks were identified by comparison with standard fatty acid methyl esters obtained from Sigma Chemical Co. (St. Louis, MO, USA).

Phosphatide Analysis

The phosphatide content of the fruit pulps was determined according to American Oil Chemists' Society [16] Official Method and supported by Ortutu & Aremu [15]. Each categorized sample (0.05 g) was dissolved in 10 ml of the test mobile phase. Mobile phase was made up of hexane, 2-propanol and acetate buffer in the ratio of 80:19, 5:0.5 v/v and initially degassed with Fisher band ultrasonic bath FB15056. Test sample (10 µl) was injected into the column at a flow rate of 1ml/min using HPLC mobile phase/propanol (80:20 v/v). The instrument used was HPLC-Shimadzu LC-64 coupled with a UV detector at wavelength of 206 nm. Each peak was identified using software Azur version 5.0.

$$Phosphatide\ (\%) = \frac{Individual\ phosphatide\ area}{Total\ phosphatide\ area} \times 100$$

Statistical Analysis

The statistical calculation included percentage value, grand mean, standard deviation and coefficient of variation. These determinations were carried out on the oil samples and significant difference was determined at $P < 0.05$.

Result and Discussion

Table 1: Fatty acid composition (%) of mango at different degree of ripeness

Fatty Acid (%)	*UR*	*AR*	*RP*	*Mean*	*SD*	*CV (%)*
Capylic Acid (C8:0)	0.00	0.00	0.00	0.00	0.00	0.00
Capric Acid (C10:0)	0.00	0.00	0.00	0.00	0.00	0.00
Lauric Acid (C12:0)	0.00	0.00	0.00	0.00	0.00	0.00
Myristic Acid (C14:0)	0.04	0.02	0.03	0.03	0.01	33.33
Palmitic Acid (C16:0)	25.76	21.78	23.60	23.71	1.99	8.39
PalmitoleicAcid (C16:1)	26.52	28.02	26.84	27.14	0.77	2.84
Margaric Acid (C17:0)	0.05	0.05	0.03	0.04	0.01	2.50
Stearic Acid (C18:0)	1.84	2.94	2.45	2.41	0.55	22.82
Oleic Acid (C18:1)	25.58	27.54	26.36	26.49	1.00	3.78
Linoleic Acid (C18:2)	12.55	10.76	12.12	11.81	0.93	7.87
Linolemic Acid (C18:3)	7.52	8.78	8.50	8.27	0.66	7.98
Arachidic Acid (C20:0)	0.00	0.00	0.00	0.00	0.00	0.00
Arachidonic Acid (20:4)	0.03	0.03	0.02	0.03	0.01	33.33
Behenic Acid (22:0)	0.03	0.03	0.02	0.03	0.01	33.33
Erucic Acid (22:1)	0.02	0.02	0.01	0.02	0.01	50.00
Lignoceric Acid (24:0)	0.03	0.04	0.02	0.03	0.01	33.0

Table 2: Differences in fatty acid composition (%) of mango at different degree of ripeness

Fatty Acid (%)	*UR - AR*	*UR - RP*	*Mean*	*SD*	*CV(%)*
Capylic Acid (C8:0)	0.00(0%)	0.00(0%)	0.00	0.00	0.00
Capric Acid (C10:0)	0.00(0%)	0.00(0%)	0.00	0.00	0.00
Lauric Acid (C12:0)	0.00(0%)	0.00(0%)	0.00	0.00	0.00
Myristic Acid (C14:0)	0.02(50%)	0.01(25%)	0.02	0.01	50.00
Palmitic Acid (C16:0)	3.98(16%)	2.16(8.4%)	3.07	1.29	42.02
Palmitoleic Acid (C16:1)	-1.5(-5.7%)	-0.3(1.2%)	0.86	0.83	96.51
Margaric Acid (C17:0)	0.00(0%)	0.02(40%)	0.01	0.01	100.00
Stearic Acid (C18:0)	-1.1(-60%)	-0.61(33%)	0.86	0.35	40.70
Oleic Acid (C18:1)	-1.96(-8%)	-0.78(-3%)	1.37	0.83	60.58
Linoleic Acid (C18:2)	1.79(14.3%)	0.43(3.4%)	1.11	0.96	86.49
Linolenic Acid (C18:3)	-1.28(-17%)	-0.98(-13%)	1.12	0.20	17.86
Arachidic Acid (C20:0)	0.00(0%)	0.00(0%)	0.00	0.00	0.00
Arachidonic Acid (C20:4)	0.00(0%)	0.01(33%)	0.01	0.01	100
Behenic Acid (C22:0)	0.00(0%)	0.01(33%)	0.01	0.01	100
Erucic Acid (22:1)	0.00(0%)	0.01(33%)	0.01	0.01	100
Lignoceric Acid (C24:0)	-0.01(33%)	0.01(33%)	0.00	0.01	0.00

- UR = Unripe; AR = About to ripe; RP = Ripe; SD = Standard deviation; CV = Coefficient of variation

Table 3: Distribution of fatty acids of mango at different levels of ripeness according to saturation and unsaturation

Fatty Acid (%)	*UR*	*AR*	*RP*	*Mean*	*SD*	*CV (%)*
TFA	100.00	100.00	100.00	100.00	0.01	0.01
TSFA	27.74	24.86	26.16	26.25	1.44	5.49
TUFA	72.26	75.14	73.84	73.75	1.44	1.95
TMUFA	52.17	55.57	53.21	53.65	1.75	3.26
TPUFA	20.10	19.57	20.64	20.10	0.53	2.64
TEFA	20.10	19.57	20.64	20.10	0.53	2.64
∑n-3PUFA	7.55	8.81	8.51	8.29	0.66	7.96
∑n-6PUFA	12.55	10.76	12.12	11.81	0.93	7.87
∑n-6PUFA/∑n-3PUFA	1.66	1.22	1.42	1.44	0.22	15.27
O/L ratio	2.04	2.56	2.18	2.26	0.27	11.95

Table 4: Differences in the distribution of fatty acids composition of mango at different maturation stages according to saturation and unsaturation

Fatty Acid (%)	*UR-AR*	*UR-RP*	*Mean*	*SD*	*CV(%)*
TFA	0.00(0%)	0.00(0%)	0.00	0.00	100.00
TSFA	2.88(10%)	1.58(5.7%)	2.23	1.44	41.26
TUFA	-2.88(-4%)	-1.58(-2.2%)	2.23	0.92	41.26
TMUFA	-3.40(-6.5%)	-1.04(-2.0%)	2.22	1.67	75.23
TPUFA	0.53(2.6%)	-0.54(-2.7%)	0.01	0.01	100.00
TEFA	0.53(2.6%)	-0.54(2.7%)	0.01	0.01	100.00
∑n-3PUFA	-1.26(-16.7%)	-0.94(-12.7%)	1.11	0.21	18.92
∑n-6PUFA	1.79(14.3%)	0.43(3.4%)	1.11	0.96	86.49
∑n6PUFA/∑n3PUFA	0.44(26.5%)	0.24(14.5%)	0.34	0.14	41.18
O/L ratio	-0.52(-25.5%)	-0.14(-6.9%)	-0.33	0.27	81.82

- *TFA = Total fatty acid; TSFA = Total saturated fatty acid; TUFA = Total unsaturated fatty acid; TMUFA = Total monounsaturated fatty acid; TPUFA = Total polyunsaturated fatty acid; TEFA = Total essential fatty acid; ∑n-3PUFA = Total omega-3 PUFA; ∑n-6PUFA/∑n-3PUFA = Total omega-6 PUFA; ∑n-6PUFA/∑n-3PUFA = Ratio of omega-6 to omega-3;*

O/L = Ratio of oleic to linoleic acid.

Table 5: Phosphatide composition (mg/100g) of mango at different level of ripeness

Phosphatide	*UR*	*AR*	*RP*	*Mean*	*SD*	*CV (%)*
Phosphatidylethanolamine	4.29	5.38	5.17	4.95	0.58	11.72
Phosphatidylcholine	3.46	4.14	3.88	3.83	0.34	8.88
Phosphatidylglycerol	0.81	1.01	1.05	0.96	0.13	13.54
Phosphatidylserine	1.46	1.72	1.71	1.63	0.15	9.20
Phosphatidylinositol	1.61	1.86	1.75	1.74	0.13	7.47
Diphosphatidylglycerol	2.93	3.37	3.11	3.14	0.22	7.01
Phosphatidic acid	3.01	3.46	3.44	3.30	0.25	7.58

Table 6: Differences in phosphatide composition (mg/100g) of mango at different level of ripeness

Phosphatide	*UR-AR*	*UR-RP*	*Mean*	*SD*	*CV (%)*
Phosphatidylethanolamine	-1.09(-25.4%)	-0.88(-20.5%)	0.99	0.15	15.15
Phosphatidylcholine	-0.68(-19.7%)	-0.42(-12.1%)	0.42	0.16	42.86
Phosphatidylglycerol	-0.2(-24.7%)	-0.24(-29.6%)	0.22	0.03	13.64
Phosphatidylserine	-0.26(-17.8%)	-0.25(-17.1%)	0.26	0.01	3.85
Phosphatidylinositol	-0.25(-15.5%)	-0.14(-8.9%)	0.20	0.08	40.00
Diphosphatidylglycerol	-0.41(-15.0%)	-0.18(-6.14%)	0.31	0.18	58.06
Phosphatidic acid	-0.45(-15.0%)	-0.43(-14.3%)	0.44	0.01	2.27

Discussion

The fatty acid composition of *Mangifera indica* fruit pulp at different level of ripeness was presented in Table 1. The result showed that the same fatty acids were present in all the fruit pulps studied but with different concentrations. The most prominent fatty acid in the fruit pulps was palmitoleic acid with concentrations (%) of 26.57, 28.02 and 26.84 for UR, AR and RP samples respectively with mean values of 27.14 ± 0.77. This was followed by oleic acid with values (%) of 25.58, 27.54 and 26.36 for UR, AR, RP respectively with mean values of 26.49 ± 1.00, palmitic acid with mean of 23.71 ± 1.99, linolenic acid with mean of 8.27 ± 0.66 and stearic acid with mean of 2.41 ± 0.55. These observations are in agreement with Chivandi *et al* [12] who stated that the major fatty acids in fruits are palmitic, stearic, palmitoleic, oleic, linoleic and linolenic acids. The percentage of palmitoleic, oleic, palmitic and stearic acid present in *Mangifera indica* fruit pulp is comparable to that found in *Psidium guajava* (27.75 %, 26.99 %, 24.61 % and 2.02 %) respectively [15]. The percentage of oleic and stearic acid in *Mangifera indica* fruit pulp is low when compared to that found in the seed nut (43.7% and 40.1%) as reported by Wu *et al.* [17]. Myristic, margaric, arachidonic, behenic, erucic and lignoceric fatty acids were found in all the fruit samples but with percentages less than 1%. Capylic, capric, lauric and arachidic were not detectable by the gas chromatography.

Table 2 showed that the concentration of palmitoleic, stearic and oleic acid increased as the fruit pulps ripened, the concentration of myristic, palmitic and linoleic acid decreased, while the concentration of arachidonic, behenic and erucic acid remained constant at the unripe (UR) and about to ripe (AR) stage, but decreased slightly at the ripe stage. At $P < 0.05$, there was no significant difference in the fatty acid concentration of the fruit pulps as they ripened.

The fatty acid distribution of *Mangifera indica* fruit pulp into saturated and unsaturated fatty acids (Table 3) showed that the total saturated fatty acid (%) was 27.74, 24.86 and 26.16 for UR, AR and RP samples respectively, with a mean value of 26.25 ± 1.44. These values are comparable to TSFA mean value of 26.77 ± 1.52 found in *Psidium guajava* fruit pulp as reported by Ortutu & Aremu [15]. However, it was lower than 47.2% found in *Mangifera*

indica seed [17] and higher than 20.17% and 15.26% for germinated and non-germinated *Sorgbum bicolor* [18]. The result showed that *Mangifera indica* fruit pulp at all the ripeness level consists mainly of unsaturated fatty acids with total unsaturated fatty acid (TSFA) concentration (%) of 72.26, 75.14 and 73.84 for UR, AR and RP respectively with a mean value of 73.75 ± 1.44. These values are high when compared to that found in Taiwan *Mangifera indica* seed nut (51.3%) [19]. Unsaturated fatty acids have been found to improve blood cholesterol levels (HDL), ease inflammation, stabilize heart rhythms and play a number of other beneficial roles [19]. The high percentage of TUFA at all the ripeness level investigated suggest their ability to perform these functions.The total polyunsaturated fatty acid (TPUFA) ranged from 19.57% in about to ripe (AR) sample to 20.64% in ripe (RP) sample with a mean value of 20.10 ± 0.53. TPUFA has been found to be important for nerve function, blood clotting, brain health and muscle strength [20]. The high percentage of TPUFA in *Mangifera indica* at all levels of ripeness suggest that they are important for these functions. The ratio of oleic/linoleic (O/L) has been associated with high stability and potentiality of the oil for deep frying [21]. The O/L ratio were 2.04%, 2.56% and 2.18% for UR, AR and RP samples respectively, with a mean value of 2.26 ± 0.27. These values are higher than the O/L for peanut oil (1.48%) [22], germinated Sorghum oil (0.82%) [21] and shea pulp (1.67%) [23]. This suggest that the quality of oil in *Mangifera indica* fruit pulp at all the ripeness level investigated may be useful for frying. The ratio of MUFA/SFA ranged from 1.88% in the unripe sample to 2.24% in the about to ripe sample while the ratio of PUFA/SFA ranged from 0.73% in the unripe sample to 0.79% in the about to ripe sample. These ratios are important in the determination of detrimental effect of dietary fats. The higher the PUF/SFA ratio, the more nutritionally useful is the oil [24]. Hornstra, [25] reported that the severity of atherosclerosis disease condition is closely associated with the proportion of total energy supplied by PUFA and SFA.

Table 4 showed that TUFA, TMUFA, n-3PUFA and O/L ratio increased as the fruit pulp ripened while TSFA, TPUFA, n-6PUFA and n-6/n-3 PUFA ratio decreased as the fruit pulp ripened.

The phosphatide result (Table 5) showed that phosphatidylethanolamine was the most prominent phospholipids with concentrations (mg/100g) of 4.29, 5.38 and 5.17 for UR, AR and RP samples respectively and a mean value of 4.95 ± 0.58. This was followed by phosphatidylcholine, phosphatidic acid and diphosphatidylglycerol with values ranging from 2.93 in diphosphatidylglycerol (UR) to 4.14 in phosphatidylcholine (AR). The minor phosphatide in *Mangifera indica* fruit pulps were phosphatidylinositol, phosphatidylserine and phosphatidylglycerol with concentrations ranging from 0.81 in phosphatidylglycerol (UR) to 1.86 in phosphatidylinositol (AR). The result of this work is in agreement with the report of Wirtz [26], who stated that phosphatidylethanoalamine and phosphatidylcholine were among the abundant phosphatide in animals and plants, often amounting to almost 40% to 45% of the total and as such contribute in building the membrane bilayer. The value of phosphatidylethanoalamine in *Mangifera indica* fruit pulps is comparable to that found in *Psidium guajava* (5.06 ± 0.20 mg/100g) and harms seed (4.30 ± 0.7 mg/100g) as reported by Ortutu & Aremu [15] and Ajayi *et al.* [27] respectively and lower than that found in harms seed (28.81 ± 3.6 mg/100g) and *Sorghum bicolor* (11.78 ± 3.62 mg/100g) as reported by Ajayi *et al.* [27] and Aremu *et al.* [21] respectively. Phosphatides could bind prooxidative metals,

produce antioxidative compounds through Maillard reactions during lipid oxidation, alter the location of other antioxidants and regenerate primary antioxidants such as tocophenols [28]. Phosphatidylserine supplementation promotes a desirable hormonal balance for athletes and might reduce the physiological deteriorations that accompanies over training and/or overstretching [29]. Phosphatidic mediates cellular functions through different mode of action such as membrane tethering, modulation of enzymatic activities and structural effects on cell membranes. Processes in which phosphatidic plays a role include; signaling pathways in cell growth, proliferation, reproduction and responses hormones in biotic and abiotic stress [26]. The consumption of *Mangifera indica* fruit pulp at all the ripeness level may participate well in these functions.

Table 6 which is the result of differences in phosphatide composition of *Mangifera indica* fruit pulp at different level of ripeness showed that the phosphatide composition increased as the fruit pulp ripened. The increase ranged from 6.14% for diphosphatidylglycerol to 25.4% for phosphatidylethanoalamine. This observation is in agreement with the phospholipid content of *Psidium guajava* fruit pulp which also increased as the fruit pulp ripened as reported by [13]. The coefficient of variation (CV) ranged from 2.27 in phosphatidic acid to 58.06 in diphosphatidylglycerol.

Conclusion

The research on lipid composition of *Mangifera indica* fruit pulp grown in the Federal Capital Territory of Nigeria at different degree of ripeness, showed that the total unsaturated fatty acid (TUFA) was higher than the total saturated fatty acid (TSFA) at all the ripeness level investigated. This suggest that *Mangifera indica* fruit pulp at all ripeness level is good for human health as it could reduce low-density lipoprotein (LDL) and increase high-density lipoprotein (HDL). The quality parameters such as n-3PUFA, n-6PUFA and O/L ratio are beneficial for heart health. *Mangifera indica* fruit pulp at all the ripeness level contain high quality phosphatide (phosphatidylethanoalamine and phosphatidylcholine) and could be applied to many food products for its wide-ranging functional properties, including antioxidant activity. The fatty acid and phospholipid result at the about to ripe level suggest that 'about to ripe' *Mangifera indica* is the healthiest low fat food compared to the unripe and ripe fruit pulp.

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