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PHYSICO-CHEMICAL CHARACTERIZATION AND NUTRITIONAL POTENTIAL OF MANGO (MANGIFERA INDICA) KERNEL BUTTER FROM THE NORTHERN REGION OF CÔTE D'IVOIRE

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ABSTRACT

This work focused on the physico-chemical characterization and nutritional potential of mango kernel butter (Mangifera Indica), from the northern region of Côte d'Ivoire, for its valorization. The results of yield, physico-chemical parameters and antinutritional factors are respectively; (7,5%); kernel moisture (58.8%); Melting point (29°C); Saponification index (186.53); Acid index (1.68) and Iodine index (38.91); Peroxide index (3); Tannins (0.45 mg/ml); Phytates (42.5 mg/100g); Oxalates (11 mg/100g). So, by its characteristics close to cocoa butter, this butter has potential for use in the food industry and can help to reduce high cholesterol levels in the body.

Keywords: Mangifera Indica, mango kernel, mango butter, physico-chemical characteristics.

1. INTRODUCTION

The mango tree, scientifically known as Mangifera indica, is native to India and Burma. It is a plant that comes from the same botanical family like cashew, the family of Anacardiaceae. The genus Mangifera contains several species that bear edible fruit. (Abdel-Razik, 2012; Nzikou et al., 2010). As with many fruits, the edible fleshly portion or pulp of mango fruit is relished to the extent of commercialization

(Abdel-Razik, 2012). Côte d'Ivoire produces an average of more than 180,000 tons of fresh mangoes annually and exports approximately 10% of this production (FIRCA, 2011). According to Fajriyati Mas'ud et al. (2020), considerable quantities of by-products, especially the kernel, result from use of the mango. However, considerable amounts of edible oil could be obtained from seeds according to El–Bastawesy et al (2007). El– Bastawesy et al (2007) revealed

that, mango seed had high content of oil (21.85% on dry basis) and the chemical properties of this oil was in the normal range of edible oils. Mohamed et Girgis (2005) reported that mango seed kernel oil can be utilized as a source of edible oil and they found that the fatty acids profile showed that stearic (27–46%) and oleic (40–48.3%) acids were the predominant fatty acids of the mango seed kernel fat, while palmitic, linoleic, linolenic, arachidonic and behenic acids were found in small amounts. However, the seed kernel of mango also contains antinutritional factors (Djobo, 2017; Kayode et al., 2013). Antinutritional factors are chemical compounds that affect absorption or use of nutrients by organism. These factors can have negative health effects, like digestive difficulties, deficiencies, intoxications or allergies. According to studies by Djobo (2017); Kayode et al. (2013), the main antinutritional factors in mango seeds are tannins, phytates, and oxalates. They are found in small quantities and do not limit the use of mango seed in food products. The results of immediate analysis of the physico-chemical parameters of mango kernel butter show a variation in its characteristics, due to the difference in the variety weighed balloon (P1). The oil obtained is weighed after evaporation of hexane under vacuum in the rotary evaporator (P2). Weights are expressed in grams:

$$TMG = \frac{P_2 - P_1}{P_E} \times 100$$

of plant, the growing climate, the stage of maturation and the extraction method used (Kittiphoom, 2012). Therefore, the objective of this study is to determine the physico-chemical parameters and the levels of antinutritional factors of mango kernel butter from the northern region of Côte d'Ivoire for its valorization.

1. MATERIALS AND METHODS

1.1.biological material

The biological material used in this study is the mango seed kernel Mangifera Indica, variety "Retard" from the northern region of Côte d'Ivoire.

1.2.Sampling

The fruits are collected in July 2021 at the Abobodoumé fruit market (batch 1) and at great market of Abobo (batch 2), at the proportion of two bags of about 52 kg each. Batch 1 comes from Korhogo town and batch 2 from Odiénné. The mangoes were sent to "Laboratoire de l'UPR Biochimie et Sciences des Aliments".

1.3.Pretreatment before oil extraction

After removing the pulp from the kernel, the seeds were removed. The resulting seeds were cut and dried in an oven at 50°C for 72 hours. Using a grinder (blender), the dried seeds were grinded and then conserved.

1.4.Procedure for the extraction of mango kernel butter

5g of seed powder (PE) was placed in a cartridge and the fat was extracted with hexane. The extraction was carried out continuously for 7 hours. The resulting oil was collected from the pre-

1.5. Physicochemical characteristics of mango kernel butter

The physico-chemical parameters determined are: kernel moisture (AFNOR, 1984); melting point (Hamilton and Rossel, 1986); saponification index (AOAC, 1997); acid index (AOAC, 1997); iodine index (AOAC, 1997) and peroxide index (AOAC, 1997).

1.6. Determination of anti-nutritional factors

1.6.1. Phytate content

1 gram of dried and crushed seed is homogenized in 20 mL of hydrochloric acid 0.65 N. The mixture is agitated for 12 hours at room temperature. The solution is centrifuged for 40 minutes at 12000 rpm. To 0.5 mL of supernatant, 3 mL of Wade reagent is added. The final solution is incubated for 15 minutes and the optical density (OD) is read at 490 nm against a blank. A standard range is prepared from a sodium phytate solution (10 µg/mL) under the same conditions as the test to determine the quantity of phytate in the sample (Latta et Eskin, 1980).

$$\text{Phytates (mg/100g)} = \frac{DO_{490} \times 4}{0{,}033 \times m^{e}}$$

Calibration line: DO490 = 0.033; mass (µg) Phytate sodium; R2=0.99; me: mass (g) of the sample.

1.6.3. Oxalates content

Using 2 g of the sample and homogenizing the mixture in 25 mL of H2S04 (3M) with magnetic agitator for 1 hour. The solution was filtered using Whatman filter paper. Then, the filtrate was titrated at a high temperature with a 0.05 M solution of KMnO4 until a persistent pink color was obtained (Day et Underwood, 1986). The oxalate content level was determined using the following
expression:

$$\text{Oxalates (mg/100g)} = \frac{2{,}2 \times V_{eq} \times 100}{m}$$

Veq: volume (mL) of KMnO4 added for equivalence; me: The mass (g) of the sample.

2. RESULTS

2.1.Extraction yields

The yield of Mangifera Indica seed oil extract from the variety Retard studied is 7.5±0.1% (batch 1) and 7.56±0.05% (batch 2) (Table 1). The extracted oil has a solid texture at room temperature.

2.2.Physio-chemical characteristics of mango kernel butter

The average moisture content of Mangifera indica seed is 51.93±12.17% for batch 1 and 53.08±13.47% for batch 2. The melting point parameter of mango kernel butter for batches 1 and 2 is 29±1.73 and 32±2.64, respectively. The saponification value is approximately 186.53±0 mg KOH/g oil for each batch. Regarding the acid value of Mangifera indica seed butter, the recorded value is 1.68±0 (mg KOH/g oil) for both batches. The iodine value shows a value of 38.91±1.46 for batch 1 and 39.75±1.46 (g iodine/100g oil) for batch 2. The peroxide value found in this study is approximately 3±0 (meq O2/kg) for both batches (Table 1).

2.3. Anti-nutritional factors content

The antinutritional factor levels in the seed and butter of the Mangifera Indica kernel are in Table 2. The results in tannins, phytates and oxalates are respectively 0.99±0.07 mg/ml; 123.71±0.41 mg/100g and 286±0 mg/100g in seed flour, these values are identical for both batches. At the butter level the results obtained in tannins, phytates and oxalates are respectively 0.45±0.21 mg/ml; 42.52±0.44 mg/100g and 11±0 mg/100g, the values presented are identical for both batches.

Table 1: Physico-chemical characteristics

Physicochemical parameters	Batch 1	Batch 2
Yields (%)	7.5±0.1	7,56±0.05
Moisture of the core (%)	51,93±12,17	53,08±13,47
Point of Fusion (°C)	29±1,73	32±2.64
Sapnification index (mg of KOH/g of oil)	186.53±0	186.53±0
Acid index: (mg of KOH/g of oil)	1.68±0	1.68±0
Iodine index (gI_2/100 g of oil)	38.91±1,46	39.75±1.46
Peroxide index (meq O_2/Kg of oil)	3±0	3±0

**The values in this table were obtained from three repeated tests and their averages are statistically in the same group (P > 0.05).*

Table 2: Antinutritional factors

Antinutritional factors	Batch 1	Batch 2
Tannins (en mg/ml)	0,99±0,07 (seed) 0,45±0,2 (butter)	0,99±0,07 (seed) 0,45±0,21 (butter)
Phytates (en mg/100g)	123,71±0,41 (seed) 42,52±0,44 (butter)	123,71±0,41 (seed) 42,5±0,44 (butter)
Oxalates (en mg/100g)	286±0 (seed) 11±0 (butter)	286±0 (seed) 11±0 (butter)

**The values in this table were obtained from three repeated tests and their averages are statistically in the same group (P > 0.05).*

3. DISCUSSION

The extraction yield indicates a low oil content of approximately 7.5% for both batches (1 and 2) of the Mangifera indica variety Retard studied, compared to an average of 40% for oilseeds (Kassi, 2013; Gossé et al., 2002). Conventional oilseeds generally have a water content of between 3 and 9%, depending on the species and variety. The moisture content of Mangifera Indica seeds in batches 1 and 2 is 51.93±12.17 and 53.08±13.47, respectively. This elevated value favours water activity, which is the factor responsible for the alteration reactions, but a good preservation treatment is necessary before storing the seeds. The melting index represents a characteristic property of solid crystalline substances. This is the temperature of transition from solid to liquid. Mangifera Indica kernel butter melt index is 29±1.73°C and 32±2.64°C for Batches 1 and 2, respectively. While shea butter is between 34 - 35°C and cocoa butter has special melting characteristics because its melting temperature is ranging from 13 to 34°C (Foubert et al, 2011; Foubert et al., 2005; Krysiak, 2011). The saponification index measures the length of the carbon chains in the oil's fatty acids and also calculates the average molecular weights of the fatty acids and triglycerides present (Hamsi, 2007). This index characterizes a fatty acid in terms of its chain length (Baaziz et al., 2005). The saponification index for the butter of Mangifera indica kernel is similar to that of shea butter and cocoa butter, which have values of 178-193 and 188-200 mg of KOH/g of oil, respectively. The saponification index of Mangifera indica kernel butter are the same for batches 1 and 2 with a value of 186.53 0 mg KOH/g oil. This saponification value is higher than the average saponification value. (≥109 mg of KOH/g of oil) (Kassi, 2013). The oil's quality is determined by the acid index. In fact, it characterizes the purity and stability of oils at room temperature. The acid value also reflects the free fatty acid content of the oil. Its value is equivalent to an acidity rate in percent. The acid value of Mangifera indica kernel butter is similar for both batches with a value equal to 1,68±0. The acid index for the batches is lower than that of shea butter (17,06 mg of KOH/g of oil). However, this index is in accordance with that of cocoa butter (≤ 1,00 mg of KOH/g of oil). This acid index value shows that mango kernel butter is practically free of hydrolytic rancidity and could be used directly in the industry without additional

neutralization, according to Saiprabha and Goswami-Giri, 2011. The iodine value indicates the degree of unsaturation of the oil. Unsaturated fatty acids are ethylene acids with one or more double bonds. The iodine values for batches 1 and 2 are 38,91±1,46 and 39,75±1,46 gI2/100g of oil, respectively. These values for the two batches are close to cocoa butter (33-42) but lower than shea butter (57–66 gI2/100 g oil). We can conclude that the butter from the Mangifera Indica kernel contains a significant percentage of unsaturated compounds. The peroxide index is measured to evaluate the degree of oxidation of the oil, it is a parameter of the quality of edible fats. It is associated with conservation conditions and extraction methods. It is a very useful test and has a sufficient sensitivity to detect the first stages of oxidative deterioration (Gossa et Mekchiche, 2014). The peroxide values for Batches 1 and 2 are identical and equal to 3±0. The peroxide value of both batches is relatively close to that of shea butter (4,35 meq O2/kg of oil), and cocoa butter (≤ 5.00 meq O2/kg of oil) (Kassi, 2013).

Knowing the levels of phytate and oxalate in a food is useful because high levels of these anti- nutritional compounds can have negative effects on digestibility. In fact, phytate and oxalate may complex with essential minerals, making them unavailable to the organism. The research conducted by Adeola et al., (2014) showed that the eating of oxalate-containing foods may contribute to renal problems. Moreover, the levels of these anti-nutritional factors are clearly high in the seed and low in the butter. The tannin, phytate, and oxalate contents of Mangifera Indica seed flours are 0.99±0.07 mg/mL, 123.71±0.41 mg/100g and 286±0 mg/100g, respectively, in both batches (1 and 2). For butter, the levels of anti-nutritional factors in the two batches (1 and 2) are similar, the respective values for tannins, phytates and oxalates are 0.45±0.21 mg/ml; 42.52±0.44 mg/100g and 11±0 mg/100g. The considerable decrease in the content of anti-nutritional factors can be attributed to the techniques used to transform seed into butter. There are many methods of detoxifying seed, like soaking and boiling. In fact, the two techniques mentioned reduce significantly the content of anti- nutritional factors in mango kernels (Djobo, 2017; Diarra et al., 2011). In view of the content of phytates and oxalates in the butter of the mango kernel butter, much lower than the lethal dose of oxalate in a food 2000-5000 mg d'oxalate/100 g of food (Agiang et al., 2010), and because of its similarity to cocoa butter, Mangifera indica kernel butter could be used as alternative in food applications because of its antioxidant properties, in view of the emergence and development of new industry such as chocolate, cookies and candy. As for the non-edible use of Mangifera Indica kernel butter, particularly in cosmetics and pharmaceuticals, Mangifera indica kernel butter has the potential to be used as a cosmetic ingredient, the butter can be used in hair care products for its emollient properties (Dokalahy, 2017). In fact, Mangifera indica kernel butter would preserve the hydration of the skin, in pharmacy, it can be used as a medicinal agent and to prevent cardiovascular diseases (Bird, 2009; Sivkishen, 2014). The statistical analysis of the results obtained made it possible to compare the results of the two batches (1 and 2). This statistical analysis showed homogeneity of results for each analysis performed at P-value>0.05.

4. CONCLUSION

Mango kernel butter (Mangifera Indica) from the northern region of Côte d'Ivoire has similar index values for both batches 1 and 2. The characteristics of this butter are similar to those of cocoa and shea butter.

The anti-nutritional factors measured are very low and do not represent a major constraint for use of this butter in the food. This indicates that mango kernel butter can be used as a substitute or supplement cocoa butter and shea butter in the food and cosmetic industries. Therefore, it would be interesting to valorize this butter in the food industry, but also in the cosmetic and pharmaceutical industry. However, other work is necessary to better valorize this butter. Consequently, it would be desirable to determine the unsaponifiable fraction, make a fatty acid profile and make a microbiological analysis.

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