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Sensory, Micrographic and Physico-chemical Characterization of Kernel Almond Flour of Two Varieties of Mangoes Grown in Northern Côte d'Ivoire

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ABSTRACT

Fruit of mango tree (*Mangifera indica* L.) is most traded worldwide among Anacardiaceae. Kernels from mango processing units in northern Côte d'Ivoire are waste to be recovered to avoid environmental pollution. This work therefore aims to study sensory, micrographic and physico-chemical characteristics of almond flours from kernels of Kent and Keitt mangoes varieties. Kent mango stones were collected at drying factory Gninnangnon of Korhogo (Côte d'Ivoire). As for kernels of Keitt, they come from mangoes from orchards of Korhogo. These kernels were washed, dried at 50°C for 72 hours before extracting almonds which were reduced to flour by grinding. Sensory analysis showed that Kent (F_{Kent}) and Keitt (F_{Keitt}) flours were belgian, lightly scented and flavored, bland in taste, soft to touch and slightly astringent. Micrographic analysis of flours F_{Kent} and F_{Keitt} revealed cracked starches contained in cells of parenchyma, cracked starches isolated from parenchyma, fiber fragment, paracytic stomata, protective long twisted unicellular and fragment of endocarp. Concerning physicochemical parameters, results showed that moisture of flours F_{Kent} and F_{Keitt} were respectively 7.77±0.38% and 7.44±0.19% with ash contents of 2.50±0.01% and 2.25±0.01%. Their lipids contents of flours F_{Kent} and F_{Keitt} were respectively 18.74±0.24% and 21.54±0.31% while those of proteins revealed 10.54±0.05% and 8.31±0.02%. Flours F_{Kent} and F_{Keitt} contained respectively 60.43±0.64% and 60.48±0.48% of carbonates. Finally, fatty acid profile of flours F_{Kent} and F_{Keitt} revealed linoleic, oleic, stearic and palmitic acids. This study showed that flours F_{Kent} and F_{Keitt} could be used in cosmetics and animal feeding.

Keywords: Almond Flours, Kent And Keitt Varieties, *Mangifera Indica* L., Micrographic, Physico-Chemical, Sensory.

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I. INTRODUCTION

The mango tree (*Mangifera indica* L.) is a fruit tree, native to eastern India and Burma. It is believed to have been cultivated in India for more than 4000 years **[1]**. The mango tree is part of the Anacardiaceae family, which largely includes tropical species such as cashew and pistachio [2]. This family includes 73 genera including the genus Mangifera which includes 69 species. In Côte d'Ivoire, the main mango production region is in the North, one of the main cities of which is Korhogo, located about 650 km north of Abidjan. Other production areas exist, but they are still little exploited due to the high rainfall, conducive to the appearance of diseases (anthracnose). Many varieties of mangoes are produced, among them, the most marketed are Amelie and Kent. The mango is mainly consumed or marketed fresh. It does not keep very long after maturity. It can also be transformed into various products: frozen mango, canned products, dehydrated products or drinks. However, despite its consumption and industrial processing, this agricultural sector experiences enormous post-harvest losses [3].

The mango stone is an important part in the fruit, it represents about 20 % by weight of the mango. The deterioration of the fruit has no impact on the state of its stone. Inside there is an almond which, after extraction, gives mango butter containing fatty acids, polyols and antioxidants compounds. These virtues of the mango kernel are not widely known by consumers. However, its recovery can greatly contribute to the protection of the environment because the daily waste rate will decrease and rotten mangoes at harvest will also be valued. The mango kernel represents the largest part of these post-harvest losses because it is not consumed at all, only the pulp is consumed. It appears that the almond present in the mango kernel is a by-product rich in nutritional compounds, such as lipids, proteins, carbohydrates and amino acids [4]. It also contains a powerful antioxidant activity with relatively high phenolic contents such as polyphenols [5]. This study aims to determine the sensory, micrographic and physico-chemical characteristics of the flours of two varieties of mangoes grown in the north of Côte d'Ivoire (Korhogo) and finally to develop them into cosmetic products.

II. Materials and Methods

A. Plant Material

The experiments were conducted on two (2) varieties of mangoes purchased in the Poro region (Korhogo) which are: the Kent variety of large mangoes of more or less rounded shape, yellowish-red color at maturity (Fig. 1a) and the Keitt variety (Fig. 1b). These are medium-shaped mangoes with a yellow-green color when ripe. The mango kernel has an elongated shape of gray color wrapped in a membrane.

(a)

(b)

Fig. 1. Mango varieties: (a) Kent variety (b) Keitt variety.

B. Reagents and Chemicals

The chemicals used consist of organic solvents, namely: 100% distilled water, 100% methanol (MeOH), 100% dichloromethane (DCM), 100% ethyl acetate (AcOet), 100% hexane, and 100% ethanol. The reagents used are: hydrochloric acid, sulfuric vanillin, potassium hydroxide (KOH) and sodium hydroxide (NaOH).

C. Technical Materials

The technical equipment used during our various tests consists of: plastic jars, porcelain mortar, sieve, electronic scale (SATORIUS), heating plates, oven (BIOBASE 50 °C), filtration device, extractor hood (ASEM EN 14175, Italy), aluminum foil, forceps, scissors, knife, water bath (MEMMERT, Neo-Tech SA, Belgium), optical microscope, chromatograph, oven (MEMMERT UN110, Neo-Tech SA, Belgium) and soxhlet. With regard to glassware, Erlenmeyer flasks (150 mL, 250 mL), beakers (150 mL, 500 mL), test tubes, pasteur micropipettes, graduated cylinders (5 mL, 10 mL, 250 mL, 1000 mL), glass jars, pasteur pipettes and capillary tubes.

D. Production of Almond Flour from Two Mangoes Varieties

After purchase, mangoes were carefully cleaned before peeled and pitted using a stainless knife. The mango pits was cleaned to remove of adherent pulp and sun dry during one week. The kernel was then extracted and cutted into small pieces which were dried for at room temperature (25 °C) well-ventilated in laboratory for three weeks. After drying, the pieces of alomonds form each mango variety were pulverized using an electric grinder before sifting the sherdded material. The alomond flours of Kent (F_{Kent}) and Keitt (F_{Keitt}) varieties were stored separatly in hermetically sealed plastic jars.

E. Sensory Analysis of Flours

It consists of observing the preparation with the naked eye and noting the following points: appearance, taste, smell and color. Appreciated characters are general appearance, color, smell and flavor or taste. Appearance: It was determined by the touch and the desired characters were granulated or amorphous. The taste test: For this test, the "bland and sweet" character of the taste was sought. To do this, a pinch of powder was placed on the tongue, without swallowing for 30 seconds and spat out. Then you have to rinse your mouth and enjoy the taste. The smell test: It is carried out with a small quantity (approximately 5 g) of the powder taken with a spatula and placed in the palm. The released odoriferous constituents are tested slowly and repeatedly. In this test, two (2) parameters were sought, the intensity and the type of smell. For the intensity, the strong and weak parameters were sought, and for the type of odor, the fruity or aromatic odor was sought.

F. Micrographic Study of Flours

The purpose of microscopic analysis of flours is the characterization of elements which allow to check if they have not be contaminated with others plant drugs. This study will make if it possible to assign an identity card to the flour of mango kernels. In microscopic study, shape and characteristic elements were determined. Thus, on a slide was deposited a drop of KOH at 5% before sprinkled with a pinch of flour of mango almond. The slide was covered with a coverslip then subjected to observation under an optical microscope and focus was made at magnification (10x10) of objective before moving to magnification (10x40) of objective where microscopic reading is made. Microscopes were observed and then photographed using a tablet installed on optical microscope. The elements photographed were identified in the pharmacognosy, plant biology and cryptogamy laboratory of pharmaceutical and biological sciences faculty of Félix Houphouët-Boigny University in Abidjan (Côte d'Ivoire). The purpose of this microscopic analysis is the characteristic elements which allow the identification of the associated plant drugs.

G. Physico-chemical Analysis of Flours

Moisture content is determined according to method of AOAC[6]. It consists in eliminating the water contained in the sample by drying it in an oven. The empty capsules are dried beforehand at 60 ° C for 15 to 30 min and weighed (m_1). Then, 5 g of test portion (m_s) of each sample are placed in each empty capsule. Then, the capsules containing the samples are placed in an oven (SELECT A) at 105 ° C. for 24 h. After removal of the water, the capsules containing the samples are weighed (m_2). The water or moisture content is determined using Equation (1):

$$Moisture\ (\%) = \frac{(m_1 - m_2)}{m_s} \times 100 \quad (1)$$

with
m_s: wet sample weight (g);
m_1: capsule and wet sample weight (g);
m_2: capsule and dry sample (g).

Total proteins content is determined by the AACC method [7]. The nitrogen content is determined by titration, using 0.2 mol.L^{-1} sulfuric acid, after mineralization of 100 mg of sample. Distillation is carried out using a semi-automatic Kjeldhal apparatus (GERHARDT, Paris, France). Total protein content is calculated using Equation (2) with conversion factor 6.25 [7].

$$Total\ protein\ (\%) = \frac{(V_1 - V_0)\times 14 \times 6{,}25 \times N}{m_s} \quad (2)$$

with
V0: volume (mL) of sulfuric acid solution for test tub;
V1: volume (mL) of sulfuric acid solution for test tub (sample);
N: normality of sulfuric acid solution (0.01N);
m_s: sample weight (g).

Lipids content is carried out by weight difference after Soxhlet extraction. The lipids contained in 2 to 3 g of powder (packaged in small filter paper bags previously dried for 1 hour in an oven at 105°C and cooled in a desiccator) are extracted for 8 hours with hexane, using a Soxhlet extractor. After extraction, sachets containing delipidated powders are dried for approximately 1 hour in an oven and then weighed. The lipid content is calculated with Equation (3) and represents difference in weight of sachet before and after extraction [8].

$$Lipids\ (\%) = \frac{(m_1 - m_0)100}{m_s} \quad (3)$$

with
m_0: empty balloon weight (g);
m_s: sample weight (g);
m_1: balloon and sample lipids weight (g) after solvent evaporation.

Ash content is determined according to the official AACC standard [9] by mineralization of 3 to 5 g of powder (contained in previously dried porcelain crucibles) in a NAGAT oven (Tignac, France). The vacuum digestion crucible is first cleaned, dried and weighed (m_o). The crucible containing the wet product (3 to 5 g) is weighed again (m_1) and placed in an oven at 105 °C for 3 hours. After drying, the dish is removed from the oven, then cooled in a desiccator (P_2O_5) before being weighed (m_e). Once weighed, the crucible is introduced into the oven at 550 °C for approximately 6 h, cooled in the desiccator and weighed again. The ash content is determinated using Equation (4) and represents the mass of flour remaining in the crucible after mineralization related to total dry mass of flour.

$$Ash\ (\%) = \frac{(m_1 - m_0)}{m_e} \times 100 \quad (4)$$

with
m_0: empty crucible weight (g);
m_e: sample weight (g);
m_1: crucible and ash weight (g) after incineration of flour.

Total carbohydrates content is determined by difference of the total matter to the other biochemical compounds according to method of FAO [10] with Equation (5).

$$C(\%) = 100 - [P(\%) + L(\%) + H(\%)] \quad (5)$$

with C: Carbohydrates; P: Proteins; L: Lipids; H: Moisture.

Fatty acid profile was carried out with the aim of examining the influence of storage conditions and duration on the fatty acids of the kernel fat. It consists of an unequal retention of the methyl esters to be separated by the stationary phase in the crossing of the column. The constituents then move with different speeds and are eluted from the column one after the other and gradually detected by the detector. About 40 mg of fat, to which 1 ml of petroleum ether is added, is introduced into a screw tube. After stirring for 2 seconds, 0.2 mL of methanolic NaOH (2N) is introduced. The tube is quickly stoppered and the mixture is stirred for 10 seconds before being brought to a water bath for 1 minute. Stirring for 10 seconds is carried out before adding 0.2 mL of methanolic HCl (2N). The preparation is slightly agitated and left to decant. Gas chromatography (GC) analysis can then be performed directly. The chromatograph used is a Varian 1400 series instrument equipped with: a manual injector; a flame ionization detector (FID); a column filled with fused silica 1.5 m long, 0.125 mm in diameter; 2 mm thick and a Spectra Physics SP4100 integrator. The isothermal temperatures of the column and the injector are respectively 190 °C and 240 °C. The carrier gas is nitrogen (15 mL/min). The manual injection of 1 µL of sample is done after rinsing the micro-syringe at least five times with petroleum ether [11].

H. Statistical Analyzes

All the tests were carried out in triplicate and the results are expressed as mean ± standard deviation. The analysis of variance (ANOVA) was performed using the StatPlus 2009 software. The Fischer test at the 95 % threshold was used to determine the significant differences between the means.

III. Results

A. Sensory Aspect of Mangoes Almonds Flours

The mangoes almonds flours of Kent (F_{Kent}) and Keitt (F_{Keitt}) are showed respectively on Fig. 2a and 2b. F_{Kent} is belgian, slightly fragrant, bland in taste and soft to the touch while F_{Keitt} is belgian, slightly flavored, bland and slightly astringent in taste and soft to the touch.

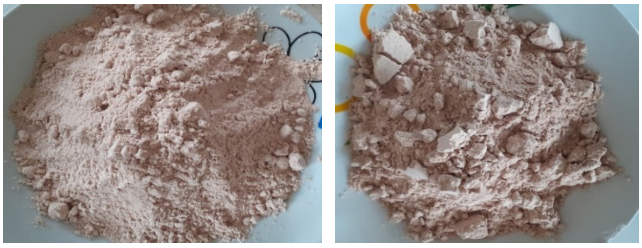
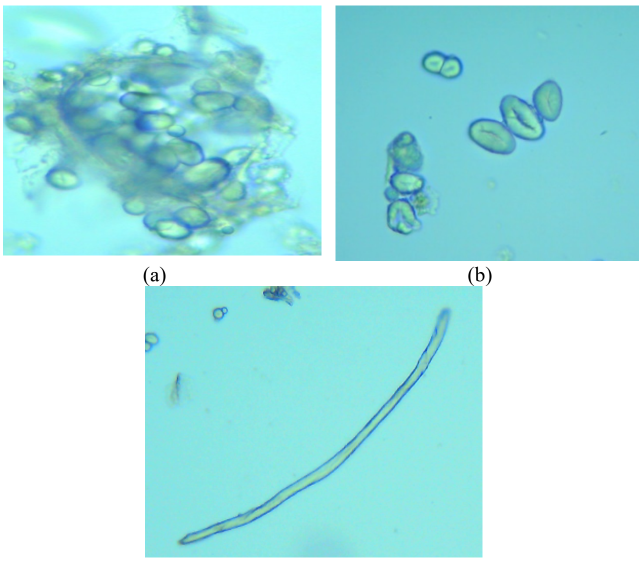

(a) (b)

Fig. 2. Kent and Keitt mangoes varieties almonds flours: (a) Kent flour (F_{Kent}); (b) Keitt flour.

B. Micrographic Characteristic of Mangoes Almonds Flours

Micrographic properties of flours F_{Kent} and F_{Keitt} are presented on Fig. 3 and 4.

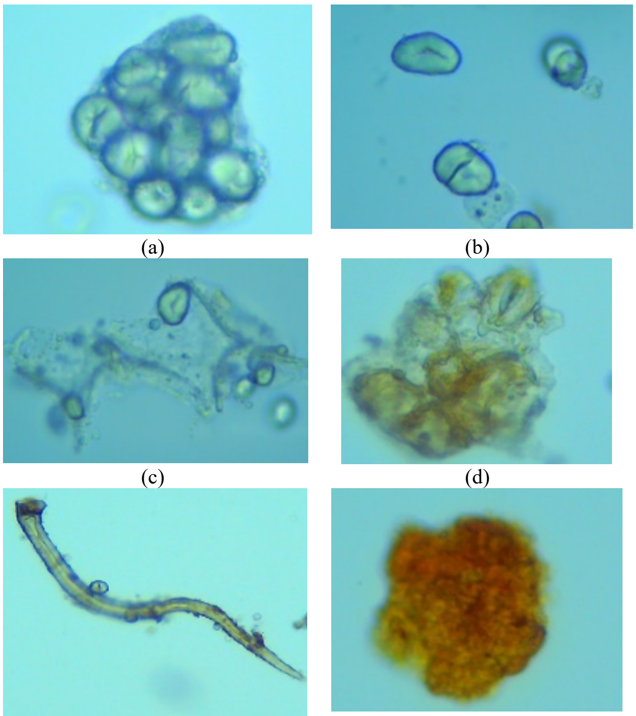

(a) (b)

(c)

Fig. 3. Microscopic characteristics of mango Kent almond flour (Gx400): (a) Cracked starches contained; (b) Cracked starches in parenchyma cells isolated from parenchyma; (c) Fiber fragment.

A. Physicochemical Parameters of Flours

Table I shows humidity, proteins, lipids, ashes, carbohydrates contents of the two mango almond flours F_{Keitt} and F_{Kent}. The results show that there are significant difference at the 5% threshold for proteins and lipids contents of the two flours. Flour F_{Kent} has a higher lipid content than flour F_{Keitt}. Protein of F_{Keitt} is less abundant compared to F_{Kent} flour. For carbohydrates, moisture and ash contents there are no significant difference (P>0.05) between the almonds flours of the two mangoes varieties. But carbohydrates are very abundant in both flours F_{Kent} and F_{Keitt}.


(a) (b)

(c) (d)

(e) (f)

Fig. 4. Microscopic characteristics of mango Keitt almond flour (Gx400): (a) Clumps of cracked starch; (b) Clumps of cracked grains of pulpy parenchyma starch grains; (c) Clumps of cracked starch; (d) Paracytic stoma grains of parenchyma; (e) Long,twisted unicellular; (f). Fragment of endocarp protective hair.

TABLE I: Physico-chemical Parameters of Almonds Flours of Kent (F_{Kent}) and Keitt (F_{Keitt}) Mangoes Varieties

Physico-chemicals parameters	Flour F_{Keitt}	Flour F_{Kent}
Moisture%	7,78±0,39^a	7,44±0,19^a
Ash %	2,50±0,01^a	2,25±0.01^b
Lipids%	18,74±0,24^b	21,54±0,31^a
Protéin%	10,55±0,050^a	8,32±0,03^b
Carbohydrates%	60,45±0,64^a	60,44±0,49^a

Values in table are means of three tests, affected by the standard deviations. The statistical differences between these mean values at the 95% level of confidence are indicated on the same line by the different letters a and b in superscript.

B. Fatty Acid Composition of Flours

The fatty acid contents of mango almonds flours F_{Keitt} and F_{Kent} are shown in Table II. Results reveal that the majority of fatty acids are present in flour F_{Kent} with moderate concentrations. These acids are linoleic acid, oleic acid, stearic acid, palmitic acid linoleic acid, oleic acid. Compared to flour F_{Kent}, stearic acid, palmitic acid are not detected in the flour F_{Keitt}.

TABLE II : Fatty acid Contents (mg/100 g) of Almonds Flours of Kent (F_{Kent}) and Keitt (F_{Keitt}) Mangoes Varieties

Fatty acids	Flour F_{Keitt}	Flour F_{Kent}
Linoleic acid	0,2648±0,0034^b	0,5163±0,0075^a
Oleic acid	0,0639±0,0008^b	0,1287±0,0018^a
Stearic acid	nd	0,0075±0,0001^a
Palmitic acid	nd	0,0331±0,0004^a

Values in table are means of three tests, affected by the standard deviations. The statistical differences between these mean values at the 95% level of confidence are indicated on the same line by the different letters a and b in superscript. NB: not detected (nd).

IV. Discussion

Sensory characteristics revealed that almonds flours from kernels of mangoes Kent (F_{Kent}) and Keitt (F_{Keitt}) varieties collected in Korhogo city were of belgian color, granulated appearance, fruity and aromatic smell with a bland flavor. Our results are different from those obtained by Kouamé [12] who studies on characterization of cashew apple flour showed that a sour sweet flavor with acidic pH.

Micrographic study of almonds flours F_{Kent} and F_{Keitt} revealed the presence of cracked starch contained in the parenchyma cells, fiber fragments, clusters of cracked starch grains of pulpy parenchyma, paracytic stomata, long twisted unicellular protective hair and twisted and the fragment of the endocarp. Our results are different from those of Salimata [13] who noted presence of fragment of spiral or spiral-punctuated xylem, fibers, oil droplet, mesocarp and endocarp cell in pulp flour from fruits of *Adansonia digitata* L. (baobab). This difference could be explained by nature of fruits studied. These identified botanical elements could be interesting for standards of quality control to avoid falsifications and contamination by foreign elements.

Physico-chemical properties study indicated that the two mangoes varieties almonds flours F_{Kent} and F_{Keitt} have a low moisture content. These flours moisture contents being less than 10% could prevent appearance of molds which guarantees their good and long shelf life. The moisture content of F_{Kent} and F_{Keitt} recorded during this study agrees with that obtained (6.57%) by Barakat and Gbazal [14] who also worked *on Moringa olifera* flour. But, this moisture content is lower than that of Touré et *al*. [15] which is 10.61% obtained during study of cashew apple flour in the Korhogo region. This difference could be explained by the nature of the fruits studied. Then, flours F_{Kent} and F_{Keitt} are very rich in carbohydrates, lipids and less rich in proteins. These results are in concordance with those of Touré et *al*. [15]. Indeed, these authors obtained values of 63.010% and 18.453% respectively for carbohydrates and proteins in a study conducted with flour from mango peelings. However, protein levels recorded in our study were lower than those obtained by these authors. Almonds flours F_{Kent} and F_{Keitt} also revealed a low level of ash consisting of a total mineral.

Fatty acids contents of flours F_{Kent} and F_{Keitt} revealed presence of oleic acids and linoleic acids in all samples. In addition, stearic acids and palmitic acids were found only in flour F_{Kent}. Despite a high lipid content, it seems that fatty acids composition may have some specificities depending on samples and more specifically on their unsaturated fatty acids contents. Two studies have been carried out on fatty acids composition in *A. digitata* [16, 17]. Some of levels of flours F_{Kent} and F_{Keitt} are similar to those described by these authors (stearic acid, oleic acid). Unlike, they detected only linoleic acid with low concentration.

V. Conclusion

This research work is a contribution to valorization of two mangoes varieties used in Korhogo. Mangoes almonds flours of Kent and Keitt varieties have a high nutritional potential. They contain proteins, lipids and carbohydrates which are essential for proper functioning of body. Carbohydrates and proteins participate in construction of tissues, improve vision or could meet the energy needs of consumers. The low moistures will favor the best conservation of mangoes almonds flours. Fatty acids are less abundant in mango almonds flours. The presence of fatty acids (linoleic, oleic, stearic and palmitic acid) find applications in cosmetics and food industries. This study could give informations on botanical characteristics of mangoes almonds flours of Kent and Keitt varieties. The botanical data allow us to reassure ourselves of identity of different mangoes varieties.

Conflict of Interest

Authors declare that they do not have any conflict of interest.

References

[1] Arvind SY, Pandey DC. Geographical perspectives of mango production in India. *Imperial Journal of Interdisciplinary Research*. 2016; 2(4): 257-265. http://www.onelinejournal.in.

[2] Dambreville A. Growth and development of the mango tree (Mango tree indica L.) in natura - Experimental approach and modeling of the influence of an exogenous factor, temperature, and endogenous architectural factors. Thesis, Monpellier II University of Sciences and Techniques; 2012.

[3] Diomandé M, Koko AC, Kouamé KB, Beugré GA, Bohoua LG. Evaluation of the functional properties and antioxidant activity of mango kernels produced in Côte d'Ivoire. *International Journal of Advancements in Research and Technology.* 2017; 6(11): 6-29.

[4] Kittiphoom S. Utilization of Mango seed. *International Food Research Journal.* 2012; 19(4): 1325-1335.

[5] Ashoush IS, Gadallah MGE. Utilization of Mango peels and seed kernels powder as sources of phytochemicals in biscuit. *World Journal of Dairy and Food Sciences.* 2011; 6(1): 35-42.

[6] AOAC (Association of Official Analytical Chemists). Official Methods of Analysis, Association of Official Analytical Chemists. K. Helrich (ed.), Fifteenth edition. Virginia (USA), 1990, pp 963-964.

[7] AACC. AACC approved methods. American Association of Cereal Chemists, 8ème édition, St Paul, Minnesota, USA, 1990.

[8] AFNOR. Compendium of French Standards for "essential oils", AFNOR. Paris, 1986; 57 p.

[9] AACC (American Association of Cereal Chemist). Approved Methods of the AACC: Method 30-25, approved 1983; Method 54-30; Method 44-15 approved October 1983. The Association: St Paul, MN, 1995.

[10] FAO. Reference Proteins and Food Standards, Report of the 20th Session of the Codex Committee on Food and Foods for Special Diets, FAO/OMS, ALINORM, 1998; 105p.

[11] International Olive Council. Preparation of fatty acid methyl esters of olive oil and olive pomace oil. T.20/Doc., Nº 24, 2001.

[12] Kouamé KPK. Phytochemical study and evaluation of the antioxidant properties of cashew apple flour (Anacardium occidental L.) grown in the department of Dabakala (Centre-Nord of Côte d'Ivoire). Master's Degree, Peleforo Gon Coulibaly University, 2021.

[13] Salimata D. Phytochemical study and anti-free radical activity of the fruit pulp of *Adansonia digitata* L. (Bombacaceae), used in the management of diarrhea in children in Mali. Doctoral thesis. University of Sciences, Techniques and Technologies of Bamako, 2020.

[14] Barakat H, Chazal G. Physicochemical Properties of Moringa oleifera Seeds and Their Edible Oil Cultivate at Different Regions in Egypt. *Food and Nutrition Sciences*, 2016; 7(4): 472-484.

[15] Touré A, Zoro AF, Touré N, Sall F, Soro YR, Coulibaly A. (2020). Physicochemical and nutritive properties of by-products flours from cashew (*Anacardium occidentale*) and mango (*Mangifera indica*) for

ruminants feeding in Poro region (Northern Côte d'Ivoire). EAS *Journal of Nutrition and Food Sciences*, 2020; 2(2): 44-48.
[16] Glew R, Vanderjagr DJ, Laeken C, Griveui L, Smith G, Pastuszyn A et *al*. Amino acid fatty acid and mineral composition of 24 indigenous plants of Burkina Faso. *Journal of Food Composition and Analysis.* 1997; 10:205-217
[17] LP Sena, DJ Vanderjagt, C Rivera, AT Tsin, I Muhamadu, O Mahamadou O et *al*. Analysis of nutritional components of eight famine foods of the Republic of Niger. *Plant Foods for Human Nutrition.* 1998; 52(1): 17-30. Doi: 10.1023/a: 1008010009170.

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