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"CONÔRO", A FLAVOR ENHANCER WITH GOOD NUTRITIONAL POTENTIAL DISCOVERED IN CÔTE D'IVOIRE

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ABSTRACT

Biochemical, mineral and anti-nutritional compounds of "Conôro", fermented condiments formulated with powders from seeds of baobab, kapok tree and okra were assessed. Indeed, biochemical analyses carried out on these condiments showed an interesting high value of energy (389.20 - 414.46 Kcal/100g), proteins (28.07 - 31.99%), lipids (30.01 - 33.72%), fibres (12.01 - 16.35%), dry matter (77.88 - 86.56%) and ash (6.87 - 7.82%). In addition, the values of pH (5.31 - 6.51) recorded make "Conôro" the weakly acid condiments. For minerals, high levels of macro elements were found with calcium (106.32 - 473.58 mg/100 g), magnesium (584.38 - 670.59 mg/100g), phosphorus (1661.23 mg/100g) and potassium (1639.88 - 1897.82 mg/100g). As for trace elements, the relatively high levels in the "Conôro" were found with iron (11.73 - 17.96 mg/100g), iodine (6.12 - 12.36 mg/100g), zinc (5.52 - 15.87 mg/100g) and manganese (4.48 to 9.21 mg/100g). In terms of anti-nutritional factors, analyses revealed low levels of oxalates (6.67 - 10.73 mg/100g) and phytates (0.90 - 7.70 mg/100g). In short; biochemical and mineral properties assessed make "Conôro" good quality condiments to be incorporated into foods in order to enhance their nutritional values.

KEYWORDS: "Conôro"; Fermented condiments; Seeds of *Adansonia digitata*, *Ceiba pentandra* and *Abelmoschus esculentus*; Côte d'Ivoire.

1. INTRODUCTION

In Africa, there are many traditional food condiments made with local ingredients that have been used for centuries to enhance the taste of meals, also for their nutritional and therapeutic benefits. However, there is nowadays a shift from these traditional condiments by the populations to industrial broths (Dossou-Yovo *et al.*, 2016).

Industrial seasoning broths introduced in West Africa during the colonial era are currently found in all markets. The high uptake of these industrial broths is due on the one hand to changes in the nutritional behavior of Africans, which is linked to urbanization, and on the other hand to the lobbying developed around these broths. However, these products are not safe to consume for the benefit of the consumer's health. Indeed, the ingredients used in the formulation of industrial broths (sodium glutamate, sodium inosinate and sodium guanylate) all have a high sodium content of more than 40% (Dossou-Yovo *et al.*, 2016). Moreover, uncontrolled consumption of high sodium foods contributes to increase high blood pressure leading to cardiovascular disease and stroke. In addition, toxicity of monosodium glutamate, the dominant ingredient in industrial seasonings on some organs, has been demonstrated. It is neurotoxic, hepatotoxic and genotoxic (Ataseven *et al.*, 2016).

Based on this observation, many researchers have carried out studies on some traditional condiments without chemical ingredients, used in culinary preparations, in order to enhance their value. These condiments include "soumbala" "afitin", "iru", "netetu", condiments derived from the fermentation of nere (*Parkia biglobosa*) seeds, which are known for their role as blood pressure regulators and high protein content (Fatoumata *et al.*, 2016). In low-income families, they are sometimes used as a substitute for meat or fish (Fatoumata *et al.*, 2016). There is also "dikouanyouri", a fermented condiment produced from baobab seeds (*Adansonia digitata*), a protein concentrate which used to season sauces in Africa rural areas. As well, "kantong", a food seasoning obtained by fermenting kapok tree (*Ceiba pentandra*) seeds, is used by people in Ghana (West African country) in soups as a thickener and flavour enhancer. The kantong is also used to improve the diet of people in convalescence (Kpikpi *et al*., 2014). Studies have at the same time been conducted on fermented fish which are commonly used in several African countries under various names such as "lanhouin" in Benin (West African country), "guedj" in Senegal (West African country), "momoni" in Ghana, and "adjuevan" in Côte d'Ivoire (West African country) to enhance the taste and flavour of the dishes (Kouakou *et al*., 2013).

Although several scientific studies are being carried out on various traditional condiments in order to offer them added value for a much competitive market, many of these natural products are unknown or less widely used. Among these unknown condiments by scientific community, is the "Conôro" which is the subject of our work.

"Conôro" is a food condiment obtained by fermenting baobab (*Adansonia digitata*.), kapok tree (*Ceiba pentandra*) and okra (*Abelmoschus esculentus*) seeds. It is used by the populations of northeastern Côte d'Ivoire in order to enhance the taste of their sauces. These populations also used it, for the treatment of some diseases such as high blood pressure, diabetes and abdominal pain after childbirth (Yao *et al*., 2017). Despite of all the benefits that would devolve on the "Conôro", it has not benefited from any chemical characterization studies on the same basis as "soumbala" (Fatoumata *et al*., 2016) or "adjuevan" (Kouakou *et al*., 2013) much appreciated in sub-Saharan Africa and particularly in Côte d'Ivoire.

The current is part of a contribution to the development of "Conôro", traditional condiments produced and consumed by the populations of northeastern Côte d'Ivoire through the determination of their biochemical, mineral and antinutritional compounds.

2. MATERIALS AND METHODS

2.1. Study material

Biological material used to make "Conôro" is seeds of three (03) plants species. They include *Abelmoschus esculentus* (L.) Moench (okra), *Adansonia digitata* L (baobab) and *Ceiba pentandra* L (kapokier) (**Fig. 1**). The fruits of these species were harvested dry from fields on the localities of Bondoukou department (north-east of Côte d'Ivoire). The harvests were carried out dry on the plants from December 2016 to March 2017. The systematic identification and authentication of the different species were carried out respectively at the botany laboratory of Nangui Abrogoua University (Abidjan, Côte d'Ivoire) and at the National Floristic Center of Felix Houphouët Boigny University (Abidjan, Côte d'Ivoire).

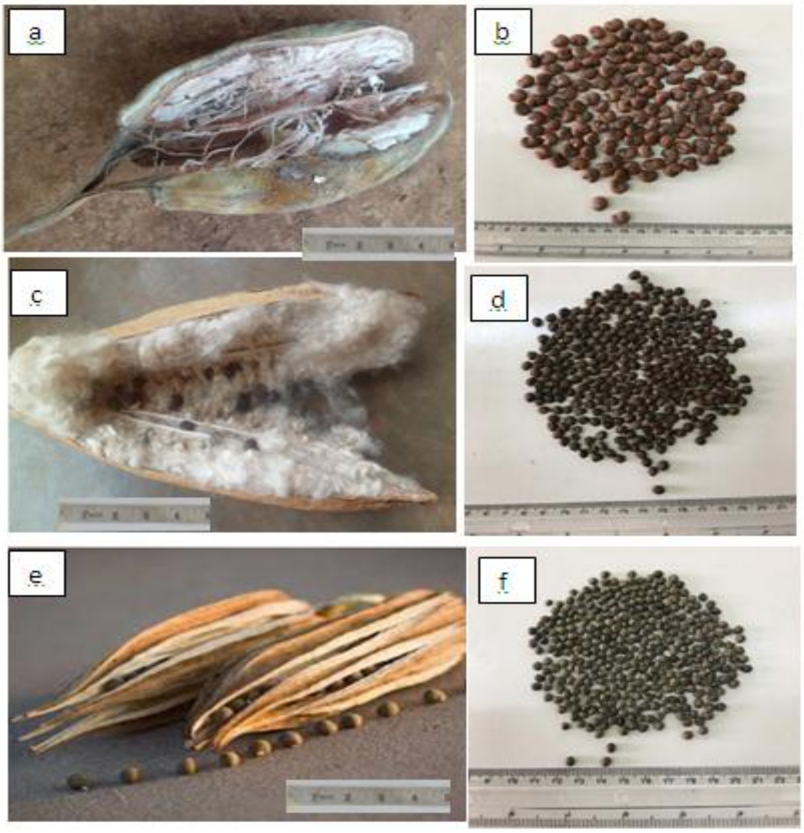

Fig. 1: Fruits and seeds of *Adansonia digitata* L. (a and b), *Ceiba pentandra* L. (c and d) and *Abelmoschus esculentus* (L.) Moench (e and f).

2.2 METHODS

2.2.1. Manufacturing of "Conôro" samples

The "Conôro" samples were manufactured according to the production diagram described by **Yao et al., 2017**, which was slightly modified (**Fig. 2**).

2.2.1.1. Powder production

Baobab, kapok tree and okra seeds were sorted to remove all rubbish. They were then washed in distilled water and 500g of each type of seed was weighed and dried in a ventilated oven (Biobase, China, Shandong) at 45 C for 24 hours. The dried seeds were milled with a mixer blender (Binatone BLG-555, China, Hong Kong). The shreds obtained were sieved using a mesh sieve (AFNOR NFX 11504, 500 µm). As a result, three single powders were obtained respectively from baobab, kapok tree and okra seeds. One part of these three single powders was used to formulate four mixed powders. Indeed, three mixed powders in a ratio 1/2:1/2 (baobab and kapok tree seeds powder, baobab and okra seeds powder, kapok tree and okra seeds powder) and one mixed powder in ratio 1/3:1/3:1/3:1/3 (baobab, kapok tree and okra seeds powder) were subsequently obtained. In total, seven types of powders have been obtained that will be used to produce seven samples of "Conôro".

2.2.1.2. Manufacturing methodology

In 100 g of each type of powder was added a quantity of distilled water proportional to the water absorption capacity. With a stainless steel whisk, the mixture was achieved for each powder in order to obtain homogeneous dough. Containers with the doughs were hermetically sealed and then placed in a dark room at the temperature of 25 to 30 °C during 72 hours for fermentation process. At the end of fermentation, the doughs were spread on stainless steel pans and kept in the oven at 45 °C to be dried for 72 hours. Fermented and dried doughs henceforth called "Conôro" are stored cold (-18 °C) in freezer bags for further analysis.

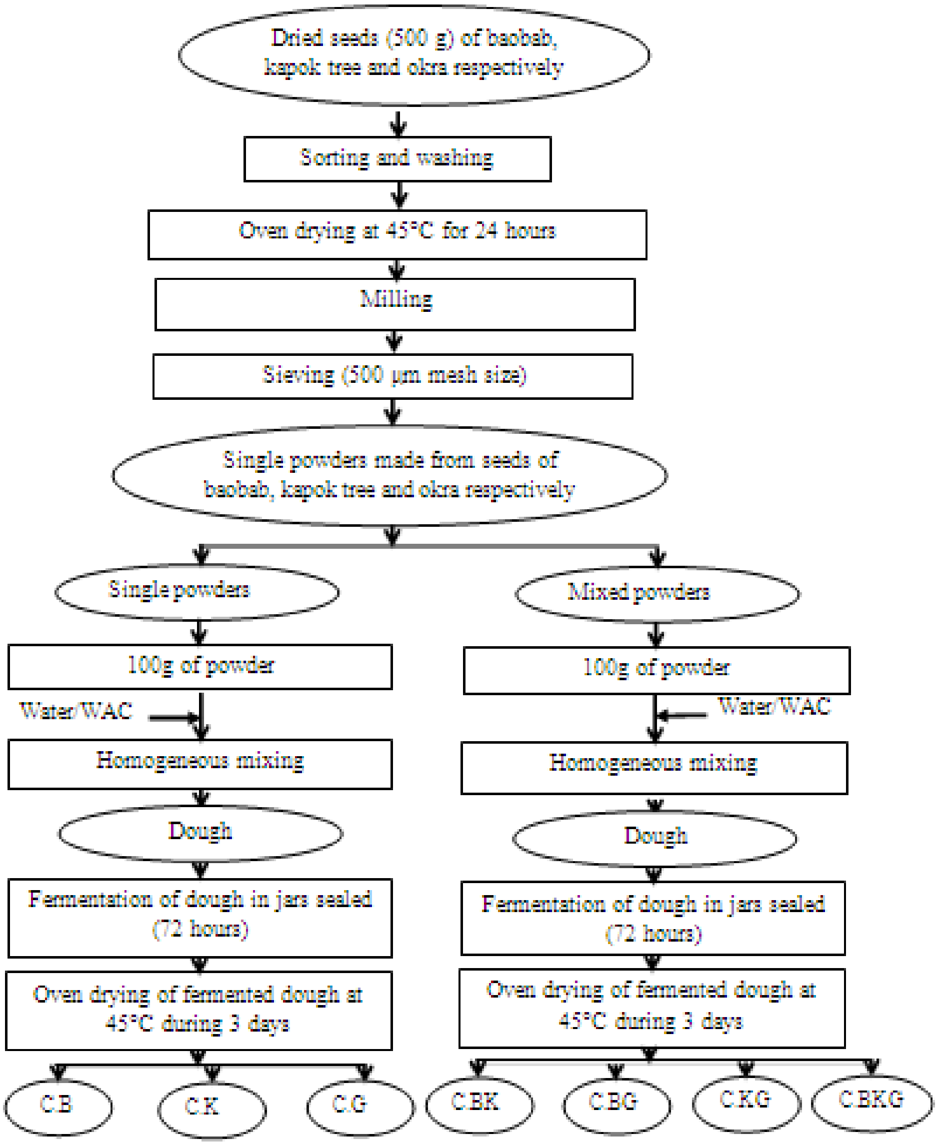

Fig. 2: Production diagram of different samples of "Conôro".

C.B "Conôro" made from single powder of baobab seeds; **C.K** "Conôro" made from single powder of kapok tree seeds; **C.G** "Conôro" made from single powder of okra seeds; **C.BK** "Conôro" made from mixed powders of baobab and kapok tree seeds in a ratio of 1/2:1/2; **C.BG** "Conôro" made from mixed powders of baobab and okra seeds in a ratio of 1/2:1/2; **C.KG** "Conôro" made from mixed powders of kapok tree and okra seeds in a ratio of 1/2:1/2; **C.BKG** "Conôro" made from mixed powders of baobab, kapok tree and okra seeds in a ratio of 1/3:1/3:1/3; **WAC** Water absorption capacity.

2.2.2. Analysis of biochemical, mineral and Anti-nutritional compounds of "Conôro" samples

The fermented condiments called "Conôro" made through the single and mixed powders from seeds of baobab (*Adansonia digitata* L), kapok tree (*Ceiba pentandra* L) and okra (*Abelmoschus esculentus* (L.) Moench) were used for subsequent analysis.

Proximate compositions (ash, fat, crude fibres, proteins and dry matter) of the «Conôro» samples were evaluated using the **AOAC (1990)** method.

Carbohydrate and energy value were determined using the calculation method recommended by **FAO (2002)**.

Total sugars were determined according to the method described by **Dubois *et al*. (1956)** using phenol and concentrated sulfuric acid while the reducing sugars were determined according to the method of **Bernfeld (1955)** using 3,5 dinitrosalicylic acid (DNS).

Hydrogen potential (pH) of "Conôro" samples was determined using a pH meter (HACH Sension^{TM}+ MM340, Spain, Barcelona) as protocol described by **Nielsen (2003)**. Also, the determination of the titratable acidity was made according to the method of **Nielsen (2003)**.

Phytate contents were determined using the **Latta and Eskin (1980)** method. While the oxalate contents was determined using the method of **Day and Underwood (1986)** using potassium permanganate.

The minerals contents were determined on aliquots of the ash of "Conôro" using the Variable Pressure Scanning Electron Microscope (SEM) of the C.A.R.D. (MEB FEG Supra 40 VP Zeiss), equipped with an X-ray detector (OXFORD Instruments) connected to an EDS microanalyzer platform (Inca Dry Cool, without liquid nitrogen).

Calculation of the different molar ratios such as [phytate] / [calcium], [phytate] / [iron] and [oxalate] / [calcium] were used in the prediction of calcium and iron bioavailability (**Fergusson *et al*. 1988)**.

2.2.3. Statistical analysis

The results were subjected to variance analysis (ANOVA one way) performed with the software Stastica 7.1 (Statsoft Inc, Tulsa-USA Headquarters, 2005). Duncan's test at $p<0.05$ was used to determine significant differences between averages. All tests were performed in triplicate and the results are expressed as mean ± standard deviation.

3. RESULTS AND DISCUSSION

3.1. Biochemical compounds

Biochemical composition of the «Conôro» samples is shown in **Table 1**. Significant differences were noted between samples of "Conôro" with regard to their biochemical parameters ($p<0.05$).

Dry matter rate was ranged from 77.88 to 86.56%. The highest rate was obtained with "Conôro" C.G. and then "Conôro" C.K recorded the lowest value of dry matter. These high dry matter contents of "Conôro" samples would result to the drying process of the "Conôro" samples after production. Indeed, within the food processing and preservation strategy, drying is essential to reduce microbial load and extend the shelf life of food (**Bop *et al*., 2014**).

Regarding ash content, they ranged from 6.87 to 7.82%. The highest ash content was observed with the "Conôro" C.K and the lowest with that of C.G. Ash content determination is a prerequisite for immediate analysis to nutritional evaluation of food. Ash is composed of minerals complex. So, ash concentration in a food is an indicator of the food's richness in minerals. Ash content of the "Conôro" samples studied are much higher than those of "soumbala" (2.8 to 4.93%), "ugba" (2.1 to 2.9%), "ogiri" (2.1 to 2.38%) and "kantong" (4.30 %) obtained respectively from fermented seeds of *Parkia biglobosa*, *Penthaclethra macrophylla* Benth, *Ricinus communis* and *Ceiba pentandra* (**Fatoumata *et al.*, 2016**).

Concerning proteins contents, "Conôro" C.BKG reported the highest content (31.99%) while the lowest content was obtained with the "Conôro" C.K (28.07 %). Proteins are essential macro-nutrients for humans and play an important role in the development and body maintenance. Protein contents of the "Conôro" samples are significantly higher than those indicated by **Nwachukwu *et al*. (2018)** on "ugba" (15.91 to 17.63%). The high protein contents in the "Conôro" could be justified by the effect of fermentation. Compared to the estimated value (12%) of protein-rich plants (**Abdou *et al.*, 2012**), all "Conôro" samples submitted for analysis would constitute very good sources of protein accessible to underprivileged populations.

As for fat, their contents in the samples of "Conôro" fluctuated between 30.01 to 33.72%. The highest content was obtained with "Conôro" C.KG. However, "Conôro" C.G. reported the lowest fat content. Fat contribute to increase the energy density of foods and possess sensory functions that contribute to improving the palatability of foods. The fat levels of the "Conôro" samples are considerably higher than those obtained by **Ibrahim *et al.* (2011)**, who have studied fermented condiments like "dawadawan botso" (17.17 to 21%). Using different "Conôro" in meals could improve their palatability.

Fibre contents of the "Conôro" samples ranged from 12.01 to 16.35%. The highest content was obtained with the "Conôro" C.B (16.35%) and the lowest with C.G (12.01%). These values are above those obtained in "iru" (7.4%), a fermented condiment made from *Parkia biglobosa* (**Ibeabuchi *et al.*, 2013)**. Fibre is an important component foodstuff due to its crucial contribution to the proper functioning of intestinal transit. They improve digestion, reduce the risk of cardiovascular disease and help regulate blood sugar levels. High fibre contents in "Conôro" samples would be beneficial to consumers during food digestion, also to prevent obesity, colopathy and cancer of the colon or colorectal.

As for the carbohydrate content of the "Conôro" samples, they ranged from 12.00 to 22.95%. The highest rate was observed with C.G sample. However, "Conôro" C.BKG had the lowest carbohydrate value. These values are lower than that determined for condiment made from fermented seeds of *Acacia nolitica* (30.80%) (**Yabaya, 2006**). The samples of "Conôro" are not important carbohydrate sources. Therefore, the consumption of these products could be recommended for people on a hypoglycemic diet.

The estimated energy values (EV) for the samples of "Conôro" were between 389.20 to 414.46 Kcal/100g. The highest value was obtained with the "Conôro" C.KG while the lowest energy value was recorded with the "Conôro" C.B. The "Conôro" samples rates are comparable to those reported by **Fatoumata *et al* (2016)** in "soumbala", a fermented condiment made from *Parkia biglobosa* seeds and sold in markets of Cote d'Ivoire (330.19 to 512.96 Kcal). Considering these values, "Conôro" could be classified as a high-energy food that could be consumed to cover the energy needs of consumers.

The pH values (5.31 to 6.51) of the "Conôro" samples are within the range of slightly acidic products. The acidic pH values obtained could be linked to the degradation of carbohydrates leading to a high production of acid compounds during fermentation (**Ouoba *et al.*, 2003)**. Acidic environments are unfavorable to the development of spoilage microorganisms. Indeed, the various "Conôro" studied could be conserved for a long time without any risk of microbial alterations.

Table 1: Biochemical composition of "Conôro" samples.

Biochemicals parameters	Samples of "Conôro"						
	C.B	**C.K**	**C.G**	**C.BK**	**C.BG**	**C.KG**	**C.BKG**
Dry matter (%)	84.52 ± 0.01 [f]	77.88 ± 0.05 [a]	86.56 ± 0.03 [g]	78.51 ± 0.01 [b]	83.91 ± 0.03 [e]	81.89 ± 0.07 [c]	82.20 ± 0.02 [d]
Ash (%)	7.58 ± 0.08 [c]	7.82 ± 0.19 [d]	6.87 ± 0.08 [a]	7.81 ± 0.30 [d]	7.42 ± 0.01 [c]	7.18 ± 0.10 [b]	7.57 ± 0.05 [c]
Proteins (%)	28.69 ± 0.03 [c]	28.07 ± 0.03 [a]	28.16 ± 0.02 [b]	30.56 ± 0.03 [f]	29.35 ± 0.02 [e]	28.92 ± 0.01 [d]	31.99 ± 0.02 [g]
Fat (%)	31.26 ± 0.34 [b]	31.92 ± 0.81 [c]	30.01 ± 0.04 [a]	31.76 ± 0.89 [c]	30.25 ± 0.38 [a]	33.72 ± 0.55 [e]	33.20 ± 0.45 [d]
Fibres (%)	16.35 ± 0.11 [e]	14.97 ± 0.06 [d]	12.01 ± 0.18 [a]	14.12 ± 0.08 [c]	12.56 ± 0.13 [b]	12.91 ± 0.28 [b]	15.24 ± 0.37 [d]
Carbohydrates (%)	16.12 ± 0.17 [b]	17.22 ± 0.96 [c]	22.95 ± 0.08 [d]	15.75 ± 0.99 [b]	20.42 ± 0.29 [c]	17.27 ± 0.34 [c]	12.00 ± 0.38 [a]
EV (Kcal/100 g DM)	389.20 ± 2.31 [a]	397.14 ± 3.43 [b]	401.83 ± 0.54 [c]	396.63 ± 4.12 [b]	397.71 ± 2.26 [b]	414.46 ± 3.46 [d]	398.78 ± 3.36 [b]
TS (mg/100g DM))	3505.20±0.88 [g]	2668.70±0.68 [c]	3303.93±0.41 [e]	2770.09±1.25 [d]	3317.39±1.05 [f]	2616.68±0.46 [b]	2534.40±0.95 [a]
RS (mg/100g DM)	613.86±0.92 [f]	504.94±0.93 [c]	516.81±0.99 [e]	486.92±1.13 [b]	514.31±1.06 [d]	505.65±1.08 [c]	382.23±0.23 [a]
pH	5.91±0.01 [d]	6.51±0.03 [g]	5.31±0.01 [a]	6.44±0.02 [f]	5.73±0.01 [c]	6.34±0.02 [e]	5.66±0.01 [b]
TA (%)	0.73±0.12 [b]	0.47±0.10 [a]	0.93±0.13 [d]	0.73±0.12 [b]	0.87±0.12 [c]	0.73±0.09 [b]	0.77±0.06 [b]

The values are mean ± SD. [a–g] Mean values in the rows with different superscript lowercase letters are significantly different (p<0.05), as analyzed by the Duncan's post hoc test. **C.B** "Conôro" made from single powder of baobab seeds; **C.K** "Conôro" made from single powder of kapok tree seeds; **C.G** "Conôro" made from single powder of okra seeds; **C.BK** "Conôro" made from mixed powders of baobab and kapok tree seeds in a ratio of 1/2:1/2; **C.BG** "Conôro" made from mixed powders of baobab and okra seeds in a ratio of 1/2:1/2; **C.KG** "Conôro" made from mixed powders of kapok tree and okra seeds in a ratio of 1/2:1/2; **C.BKG** "Conôro" made from mixed powders of baobab, kapok tree and okra seeds in a ratio of 1/3:1/3:1/3, **DM** dry matter, **EV** energy value, TS: Total sugar, RS: Reducing sugar, TA: Titrable acide, pH: Hydrogen potential.

3.2. Mineral compounds

Minerals are important components of the diet owing to their physiological and metabolic function for the body. Regarding macro and trace elements, a significant difference was noted between the "Conôro" samples (p<0.05) (**Table 2**).

Calcium, magnesium, phosphorus and potassium were the most important macro elements in the "Conôro" samples. Indeed, potassium plays a protective role against increased blood pressure and cardiovascular risks. It contributes, as well as sodium, for maintaining the ionic balance necessary for muscular and cardiac function and nervous transmission. Potassium levels recorded in the sample of "Conôro"(1639.88 to 1897.82 mg/100g) are higher than that reported by **Wafar *et al.* (2017)** for fermented kapok tree seeds (*Ceiba pentandra*) (102.590 mg/100g). K/Na ratios of the "Conôro" samples (147 to 2911) are above those recommended, which should be greater than or equal to 5 (**Szentmihalyi *et al.*, 1998**). Thus, consumption of "Conôro" would be able to solve health problems related to sodium, which is likely to increase the risk of cardiovascular diseases and mortality (**Dossou-Yovo *et al.*, 2016**). Calcium is used in body for blood coagulation, bones and teeth formation and nervous system (**Ijarotimi and Keshinro 2012**). The calcium levels observed in the "Conôro" samples (106.32 to 473.58 mg/100 g) are significantly higher than those obtained by **Ogunyinka *et al* (2017)** in fermented (1.97 mg/100g) and delipidated (9.15 mg/100g) *Parkia biglobosa* seeds. In view of these calcium levels, "Conôro" samples studied could be recommended to pregnant and lactating women and children to respond to their increasing calcium requirements. Regarding phosphorus, it is a mineral necessary for the synthesis of nucleic acids and some proteins. Phosphorus deficiencies manifest by muscular weakness, tingling of the extremities, irregular breathing or decreased reflexes. Phosphorus levels in "Conôro" samples are very high (1491.28 to 1661.23 mg/100g) compared to "ugba" samples (102.48 to 117.23 mg/100g) obtained from fermented seeds of *Penthaclethra macrophylla* Benth (**Nwachukwu *et al*., 2018**). Magnesium is a component that is involved in the metabolism of carbohydrates and fats. It also helps to regulate the body's acid-base balance, maintain normal muscular and nervous function and the body's defence mechanisms against microbial and viral infections (**Mebdoua, 2011**). Magnesium contents obtained in the "Conôro" samples (584.38 to 670.59 mg/100g) are higher than that obtained by **Nwachukwu *et al*. (2018)** on "ugba" (226.19 to 235.14 mg/100g). According to the previous results, consumption of "Conôro" would protect body against infections and prevent cardiovascular diseases.

Concerning trace elements, such as iron, zinc, manganese and iodine, they had higher levels in the "Conôro" samples. Iron is involved in the synthesis of red blood cells, DNA and oxygen transport. Iron deficiency pregnant and nursing increases the risk of anemia, asthenia, pallor, free radical formation and tumours (**Nwachukwu *et al*., 2018**). Iron levels in "Conôro" samples ranged from 11.73 to 17.96 mg/100g. These values are comparable to those obtained by **Nwachukwu *et al*. (2018)** in "ugba" (11.74 to 12.50 mg/100g). The recommended daily intake for iron is 8 mg/day for men, 18 mg/day for women and 3.9 to 21.8 mg/day for children (**Njogu *et al*., 2014**). Iron contents determined in the "Conôro" suggest that the "Conôro" would be a good source of iron able to prevent the anemia problem that women (pregnant and nursing) are prone in developing countries (**Sinh *et al*., 2017**). Manganese fights against free radicals, very harmful to health (**Abdou, 2009**). Manganese levels (4.48 to 19.21mg/100g) in the "Conôro" samples are significantly higher than that reported by **Olasupo *et al*. (2016)** in fermented *Pentaclethra macrophylla* Benth seeds (1.56 to 2.77 mg/100g). Zinc contributes to the growth, development and maintenance of immune function (**Walker *et al*., 2005**). Zinc deficiencies are usually observed in populations with a low animal protein diet. According to **Alais *et al*. (2008)**, the recommended minimum nutritional intake for zinc is 1.6 to 3.6 mg/day for children and 4 to 5 mg/day for adults. Compared to recommended zinc levels, the various "Conôro" studied would be very good sources of zinc (5.52 to 15.87 mg/100g) and could be substituted for expensive meat products. Iodine biological roles are attributed to thyroid hormones that contribute to the growth, development and control of some metabolic processes in the body (**Delange, 1994**). Iodine levels observed in "Conôro" samples (6.12 to 12.36 mg/100g) are significantly higher than those obtained by **Ijeh *et al*. (2010)** on *Treculia africana* seeds subjected to different traditional processing methods (0.02 - 0.06 mg/100g). This suggests that, various "Conôro" studied could be used as food additives to improve the nutritional quality of iodine-free foods.

Table 2: Mineral Contents of "Conôro" Samples.

"Conôro"	Macro-elements (mg /100 g DM)					
	Sodium	**Calcium**	**Magnesium**	**Phosphorus**	**Potassium**	**Sulfur**
C.B	2.64 ±0.36 ^{c}	396.33±2.54 ^{e}	670.59±1.19 ^{g}	1650.26±0.43 ^{f}	1639.88±3.11 ^{a}	32.67±1.17 ^{d}
C.K	0.83 ±0.04 ^{a}	473.58± 2.84 ^{g}	566.41±0.98 ^{a}	1628.86±1.60 ^{d}	1845.85±2.98 ^{d}	43.34±0.70 ^{f}
C.G	0.61±0.04 ^{a}	106.32± 2.04 ^{a}	603.83±1.10 ^{d}	1491.28±1.42 ^{a}	1776.13±2.91 ^{b}	12.08±0.92 ^{a}
C.BK	12.58±0.14 ^{f}	466.35 ± 4.73 ^{f}	612.84±1.35 ^{e}	1661.23±1.70 ^{g}	1854.33±3.24 ^{e}	37.65±0.46 ^{e}
C.BG	1.94 ±0.03 ^{b}	250.58 ± 0.99 ^{b}	644.05±1.19 ^{f}	1562.77±2.86 ^{c}	1817.29±2.49 ^{c}	20.70±0.26 ^{b}
C.KG	5.37 ±0.35 ^{d}	283.32±2.70 ^{c}	584.38±1.22 ^{b}	1523.48±0.65 ^{b}	1866.24±2.27 ^{f}	28.29±0.57 ^{c}
C.BKG	9.53 ±0.34 ^{e}	342.45 ±2.31 ^{d}	593.25±1.21 ^{c}	1638.28±2.21 ^{e}	1897.82±6.93 ^{g}	28.80±0.62 ^{c}
	Trace elements (mg /100 g DM)					
	Manganese	**Iron**	**Zinc**	**Iodine**	**Copper**	**Selenium**
C.B	4.48±0.31 ^{a}	12.21±0.70 ^{a}	5.52±0.27 ^{a}	6.12±0.11 ^{a}	1.41±0.47 ^{e}	0.09±0.00 ^{a}
C.K	19.21±1.53 ^{e}	11.73±0.82 ^{a}	15.87±0.81 ^{e}	11.20±0.05 ^{e}	0.38±0.25 ^{a}	0.22±0.02 ^{c}
C.G	5.50±0.06 ^{a}	17.96±0.27 ^{d}	10.08±0.50 ^{c}	12.36±0.36 ^{g}	1.26±0.31 ^{d}	1.06±0.01 ^{g}

C.BK	11.83±0.02 [c]	11.96±0.02 [a]	10.28±0.24 [c]	8.63±0.04 [b]	0.92±0.21 [b]	0.15±0.05[b]
C.BG	4.95±0.05 [a]	13.46±0.44 [b]	8.34±0.47 [b]	9.23±0.03 [c]	1.38±0.20 [e]	0.29±0.0[d]
C.KG	14.94±1.36 [d]	14.66±0.35 [c]	12.25±0.23 [d]	11.73±0.04 [b]	0.91±0.31 [b]	0.71±0.1[f]
C.BKG	9.73±0.03 [b]	13.65±0.35 [b]	10.67±0.22 [c]	9.89±0.02 [c]	1.16±0.09 [c]	0.49±0.10[e]

The values are mean ± SD. [a–g] Mean values in the column with different superscript lowercase letters are significantly different (p<0.05), as analyzed by the Duncan's post hoc test. **C.B** "Conôro" made from single powder of baobab seeds; **C.K** "Conôro" made from single powder of kapok tree seeds; **C.G** "Conôro" made from single powder of okra seeds; **C.BK** "Conôro" made from mixed powders of baobab and kapok tree seeds in a ratio of 1/2:1/2; **C.BG** "Conôro" made from mixed powders of baobab and okra seeds in a ratio of 1/2:1/2; **C.KG** "Conôro" made from mixed powders of kapok tree and okra seeds in a ratio of 1/2:1/2; **C.BKG** "Conôro" made from mixed powders of baobab, kapok tree and okra seeds in a ratio of 1/3:1/3:1/3, **DM** dry matter.

3.3. Anti-nutritional factors and molar ratios anti-nutritional/mineral of "Conôro" samples

Anti-nutritional compounds are natural substances that interfere with the bioavailability of nutrients, inhibiting their absorption into the gastrointestinal tract. Phytates and oxalates are among those anti-nutritional compounds that chelate some minerals by forming insoluble complexes with divalent cations and reduce their absorption (**Ijarotimi and Keshinro, 2012**). Anti-nutritional contents (oxalates, phytates) and molar ratios (Phytate/Calcium, Phytate/Iron Oxalate/Calcium) differed significantly (*p*<0.05) between the samples of "Conôro" (**Table 3**).

The molar ratios of Phytates/Calcium, Phytates/Iron and Oxalates/Iron have been proposed as an indicator of the bioavailability of calcium and iron. Indeed, according to **Woldegiorgis *et al.* (2015)**, critical molar ratios of Phytates/Calcium ≤ 0.24; Phytates/Iron ≤ 0.15 and Oxalates/Calcium ≤ 1, indicate good calcium and iron bioavailability. The values of the molar ratios Phytates/Calcium (0.00013 to 0.00153), Phytates/Iron (0.00654 to 0.04775) and Oxalates/Calcium (0.00823 to 0.04494) obtained in this study are below the recommended critical values. Therefore, the calcium and iron contained in the various "Conôro" analyzed would be bioavailable for the body's proper functioning.

Table 3: Anti-nutritional factors and molar ratios anti-nutritional/mineral of "Conôro" samples.

"Conôro"	Anti-nutritional factors (mg/100g DM)		Molar ratios		
	Phytates	Oxalates	Phytates/Calcium	Phytates/Iron	Oxalates/calcium
C.B	6.62±0.06 [f]	8.87±0.12 [b]	0.00102±0.00001 [d]	0.04589±0.00002 [f]	0.00997±0.00001 [c]
C.K	0.90±0.09 [a]	8.73±0.12 [b]	0.00013±0.00002[a]	0.00654±0.00003 [a]	0.00823±0.00002 [a]
C.G	2.64±0.05 [b]	10.73±0.12 [d]	0.00153±0.00001 [f]	0.01245±0.00005 [b]	0.04494±0.00002 [g]
C.BK	5.16±0.19 [d]	10.33±0.42 [c]	0.00067±0.00001 [b]	0.03652±0.00004 [d]	0.00986±0.00001 [b]
C.BG	6.06±0.01 [e]	8.80±0.20 [b]	0.00147±0.00017 [f]	0.03808±0.00001 [e]	0.01309±0.00002 [f]
C.KG	4.26±0.02 [c]	6.67±0.12 [a]	0.00094±0.00002 [c]	0.02458±0.00001 [c]	0.01048±0.00003 [d]
C.BKG	7.70±0.75 [g]	10.07±0.12 [c]	0.00138±0.00005 [e]	0.04775±0.00001 [g]	0.01564±0.00002 [e]

The values are mean ± SD. [a–g] Mean values in the column with different superscript lowercase letters are significantly different (p<0.05), as analyzed by the Duncan's post hoc test. **C.B** "Conôro" made from single powder of baobab seeds; **C.K** "Conôro" made from single powder of kapok tree seeds; **C.G** "Conôro" made from single powder of okra seeds; **C.BK** "Conôro" made from mixed powders of baobab and kapok tree seeds in a ratio of 1/2:1/2; **C.BG** "Conôro" made from mixed powders of baobab and okra seeds in a ratio of 1/2:1/2; **C.KG** "Conôro" made from mixed powders of kapok tree and okra seeds in a ratio of 1/2:1/2; **C.BKG** "Conôro" made from mixed powders of baobab, kapok tree and okra seeds in a ratio of 1/3:1/3:1/3; **DM** dry matter.

4. CONCLUSION AND RECOMMENDATION

This study showed very interesting biochemical and mineral properties of locally fermented condiments called "Conôro". The "Conôro" samples have high fibres levels that would be an advantage for consumers in the prevention of obesity and colon cancer. The high levels of minerals and proteins in the "Conôro" could be useful for several biological functions. "Conôro" samples studied are considered as energy sources. Indeed, their consumption could cover the energy needs of consumers, particularly for breastfeeding mothers who lose a lot of energy during childbirth. In addition, taking into account its low carbohydrate content, "Conôro" could be recommended for people on a hypoglycemic diet. Low levels of phytates and oxalate would not interfere with the bioavailability of the minerals from "Conôro". This would improve the assimilation of these minerals.

In short, all these biochemical and mineral potentials make "Conôro" a good quality food source to be popularized and incorporated into food products in order to improve their nutritional value.

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CONflICT OF INTEREST

The authors declare that they have no conflict of interest.

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