

# Physico-chemical Properties of Fruits, Seed and Oil of Kapok (*Ceiba pentandra* Gaertn.) Tree of Different Provenances from the Northern Part of Cameroon

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**Abstract** – The physico-chemical properties of *C. pentandra* fruits from the northern regions of Cameroon were studied in the localities of Mbe (Adamawa), Pitoa (North) and Maroua (Far-North). The chemical properties of the seeds and the oil were determined by standard methods. Mbe fruits have values of physical parameters that are higher than those of other origins. The seed masses decrease depending on whether the fruit is from Mbe (18.93g), Maroua (16.42g) and Pitoa (14.32g). The fruits of the localities of Adamawa have more seeds and more kapok than the fruits of other two regions. The locality of Pitoa in the North produces fruits with a larger capsule mass. The water and lipid contents of the seeds of Mbe and Maroua are related to one another and all superior to those of Pitoa. Protein and sugar contents decrease grain-wise in Adamawa (32.68%, 21.65%), Far-North (31.72%, 20.58%) and North (31.11%, 19.39%) regions, respectively. The origin of the seeds has no significant influence on the iodine value. These results indicate that the fruits of Mbe (Adamawa) are more interesting in relation to the quantity of seeds and kapok, and the richness of the seeds in oil, proteins and sugars.

**Keywords** – *Ceiba pentandra* Gaertn., Extraction, Northern Regions of Cameroon, Oil, Physico-chemical Characteristics.

## I. INTRODUCTION

Kapok (*Ceiba pentandra* Gaertn.) tree is one of the many non-conventional oilseeds in the three northern regions of Cameroon. The fruits of this tree include a whitish, cottony fluff called kapok and brown seeds [1]. Oil from the seeds was once exploited for food purposes. Two main factors have diverted local inhabitants from the extraction of this oil. This mainly involves the establishment of "SODECOTON (Société de Développement du Coton)", in 1974, which uses conventional oilseeds (cotton and soybean) and the difficulty associated with the traditional extraction operations of this oil. However, seeds have 25 to 32% protein content [2, 3, 4], 12 to 25% sugar content [5, 2], 6 to 8% ash content [3, 4] and 23 to 29% fibres content [2, 4]. Moreover, the seeds contain a non-negligible proportion of oil (22 to 28%) [6, 7]. This oil is made up of

12 to 25% saturated fatty acids, 49 to 53% monounsaturated fatty acids and 26 to 29% polyunsaturated acids [7]. Like cottonseed oil, this oil can be an alternative source of lipids, especially in periods of tension in the oil sector. Indeed, this tree abounds in the northern part of Cameroon.

The richness of these seeds has aroused our interest in carrying out a first investigation [8]. But, to the best of our knowledge, the works on the fruits of the Grand North are almost non-existent. In addition, studies on fruits and oils were mainly conducted in other countries [2, 3, 4, 9]. Considering the wide geographical distribution of this tree, the objective of work is to study the variations in the physico-chemical characteristics of these fruits from different origins in the northern part of Cameroon.

## II. MATERIAL AND METHODS

### A. Biological Samples

The biological samples were dried *Ceiba pentandra* Gaertn. These fruits come from the three northern regions of Cameroon. For the Adamawa region, the fruits came from the locality of Mbe. In the North region, they came from the trees of Pitoa, and in the Far-North region fruits were picked from trees of Maroua. Kapok tree abounds in these localities. The fruits were then transported to the laboratory to Ngaoundere within 8 hours for those of Maroua and 4 hours for those of Pitoa. They were labelled and arranged according to regions of origin to avoid bias.

### B. Methods

#### B.1. Physical Characterisation of Fruits

The healthy fruits were sorted out manually. Then, the hull was also manually separated from the seeds and kapok by the means of stainless steel knife of Pradel brand. Electronic caliper of *Electronic Digital Caliper* brand (0,001mm) was used to measure the lengths and diameters of the fruits and seeds. The sample masses were determined by the use of a precision (0,0001g) balance of *Kern* brand. A manual crank mill was used to grind the seeds until a paste was obtained. This paste was then used to determine the chemical parameters of the seeds.

### B.2. Chemical Characterisation of *C. Pentandra* Gaertn. Seeds

The AFNOR method [10] was used to determine the water and the ash contents of the seeds. The total protein content was carried out using AOAC method [11]. The proportioning of sugar content was done by using the colorimetric method of Dubois *et al.* [12]. The extraction of oil was carried out according to the UICPA method [13]. The oil content (H) is given as a percentage of dry matter based on the following formula:

$$H = \frac{(S * 100)}{DM}$$

Where H is percentage by mass of oil after extraction and DM the dry matter content of seeds used for the extraction

### B.3. Characterisation of Extracted Oil

The iodine and saponification index of the oils were determined on the seed powder according to UICPA methods [13].

### B.4. Statistical Analysis

The tests were done in triplets. ANOVA was done on the results obtained using Statgraphics for Windows Plus 3.0 software [14]. The difference between means was detected using the multiple comparison test of DUNCAN at 5%.

## III. RESULTS AND DISCUSSION

### A. Physical Characteristics of Fruits

Table 1 shows the physical characteristics of fruits, capsule, seeds and kapok. Generally, it is observed that the fruits from the Adamawa region have values of physical parameters superior to those of others origins. Northern fruits have the shortest length. The seed masses decrease

according to the direction of Mbe (18.93g), Maroua (16.42g) and Pitoa (14.32g) fruits. It is also noted that the fruits of Mbe and Pitoa contain the kapok in similar proportions, followed by the fruits of Maroua. The fruit of Pitoa has a slightly lower proportion of seeds than the fruits of other origins. The fruits of Pitoa and Maroua have capsules proportions higher than those of Mbe.

The difference between the length and mass of northern fruits and those of other regions is due to agro-climatic conditions. Indeed, rainfall and temperatures are more favourable in the Adamawa region, and fruits from a locality in this region will have a greater length and mass. Moreover, the need for high exposure to the sun for young plants [15] could explain the second rank of the fruits from the Far-North region. The length values obtained are related to those of the literature [1, 3] which are between 10 and 30 cm. The fruits of Mbe have a mass closer to that of 59.55% obtained by [9]. As far as the masses of seeds are concerned, our values are higher than those found by [3] (13.35g) and [9] (13.87g).

Agro-climatic conditions could also explain variations in the capsule, kapok and seed proportions by fruit and region. These variations show that the fruits of the localities of Adamawa have more seeds and more kapok compared to the fruits of the other two regions. This region is immediately followed by that of the Far-North. On the other hand, the locality of Pitoa in the North produces fruits with a larger capsule mass and therefore emptier than those of the localities of the other regions.

These results suggest that seed and kapok exploitation of *C. pentandra* would be more beneficial in Adamawa, Far-North and North regions, respectively.

**Table 1:** Physical characteristics of *C. pentandra* fruits

| Physical characteristics                    | Provenances               |                           |                           |
|---|---------------------------|---------------------------|---------------------------|
|   | Maroua (FN)               | Pitoa (ND)                | Mbe (AD)                  |
| Length of fruit (cm)                        | 20.23±1.57 <sup>a</sup>   | 18.50±1.07 <sup>b</sup>   | 20.59±0.64 <sup>a</sup>   |
| Median diameter of fruit (cm)               | 4.34±0.11 <sup>b</sup>    | 4.06±0.23 <sup>c</sup>    | 5.29±0.26 <sup>a</sup>    |
| Seed diameter (cm)                          | 0.44±0.05 <sup>a</sup>    | 0.44±0.05 <sup>a</sup>    | 0.43±0.05 <sup>a</sup>    |
| Average number of seeds per fruit           | 220.25±34.16 <sup>b</sup> | 194.50±31.41 <sup>b</sup> | 324.88±21.10 <sup>a</sup> |
| Mass of fruit (g)                           | 50.67±1.14 <sup>b</sup>   | 45.64±1.39 <sup>c</sup>   | 55.66±1.41 <sup>a</sup>   |
| Mass of kapok (g)                           | 10.05±0.90 <sup>b</sup>   | 9.36±0.78 <sup>b</sup>    | 11.73±0.51 <sup>a</sup>   |
| Mass of seeds (g)                           | 16.42±1.48 <sup>b</sup>   | 14.32±0.83 <sup>c</sup>   | 18.93±0.56 <sup>a</sup>   |
| Mass of the capsule (g)                     | 23.56±1.13 <sup>a</sup>   | 21.17±1.00 <sup>b</sup>   | 24.17±1.28 <sup>a</sup>   |
| Mass of kapok/mass of fruit ratio (%)       | 19.81±1.35 <sup>b</sup>   | 20.48±1.31 <sup>ab</sup>  | 21.07±0.60 <sup>a</sup>   |
| Mass of seeds/mass of fruit ratio (%)       | 32.37±2.28 <sup>ab</sup>  | 31.36±1.00 <sup>b</sup>   | 34.00±0.60 <sup>a</sup>   |
| Mass of the capsule/mass of fruit ratio (%) | 46.47±1.25 <sup>a</sup>   | 46.39±2.08 <sup>ab</sup>  | 43.39±1.41 <sup>b</sup>   |

FN: Far-North; ND: North; AD: Adamawa

The values in the rows with the different letters in the exponent are significantly different ( $p < 0.05$ )

### B. Chemical Characteristics of Seeds

Table 2 presents the chemical properties of seeds from different localities in the Grand North. The water contents of the seeds of Mbe and Maroua are similar and all superior to that of the seeds of Pitoa. The same applies to the lipid content. On the other hand, the results on total proteins and total sugars show that the values decrease

from the seeds of Adamawa, Far-North to those of the North. Thus, for the protein content 32.68%, 31.72% and 31.11% are obtained, respectively. For the sugar content, 21.65%, 20.58% and 19.39% are obtained, respectively. As for the total ashes, the locality of the seeds does not have a significant influence on the values, although that of Mbe is slightly weak.

The differences between the chemical characteristics of the seeds in the different localities of origin could be due to the agro-climatic conditions of the said localities. The water contents of seeds from Mbe (9.49%), Maroua (9.42%) and Pitoa (9.39%) are similar to that of 9.4% obtained by [2]. However, all our values are higher than that obtained by [4] (7.10%), [7] (6.0%) and by [9] (7.88%). These differences could also be explained by the techniques used by these authors. Some of them like [7] have not clearly described the determination method of water content.

The oil content corroborates with the content of 22 to 28 % mentioned by [6, 7]. However, our values are higher than that obtained by [4] (8.77%) and by [9] (23.10%). As far as the sugar content is concerned, the values are well in the average of 12 to 25% obtained by [5]. But, our values are lower than those found by [2] (23%), [7] (41.3%) and [9] (26.25%). This difference could be explained by the techniques used and the climatic conditions of the different countries under study. Indeed, these authors determined

the sugar content by difference.

As for protein contents, our values are similar to those of 32.4% and 31.97% found by [2] and [4], respectively. They are also lower [9] or higher [3, 7] than in the literature. The slight weakness of the ash content of the Mbe seeds could be explained by the fact that the soil of the Adamawa region is not as richer in minerals than those of the North and the Far-North regions [16, 17, 18]. The ash contents are also higher than 7.51%, 5.62% and 5.87% obtained by [3], [4] and [9], respectively. The climatic conditions in each country could explain these differences.

These results show that in the North region, seeds contain more dry matter than in other regions. However, the duration of exposure to the temperature of a locality can have a non-negligible influence on the water contents of the seeds. Protein and sugar contents belonging to the important food classes, a *C. pentandra* exploitation of the seeds of is more advantageous to the localities of the Adamawa regions.

**Table 2:** Chemical characteristics of fruit seeds of *C. pentandra*

| Chemical characteristics | Provenances             |                         |                         |
|--------------------------|-------------------------|-------------------------|-------------------------|
|                          | Maroua (FN)             | Pitoa (ND)              | Mbe (AD)                |
| Water content (%)        | 9.42±0.10 <sup>a</sup>  | 9.39±0.19 <sup>b</sup>  | 9.49±0.10 <sup>a</sup>  |
| Ash content (% DM)       | 8.77±0.18 <sup>a</sup>  | 8.67±0.29 <sup>a</sup>  | 8.54± 0.17 <sup>a</sup> |
| Protein content (% DM)   | 31.72±0.20 <sup>b</sup> | 31.11±0.09 <sup>c</sup> | 32.68±0.70 <sup>a</sup> |
| Sugar content (% DM)     | 20.58±0.37 <sup>b</sup> | 19.39±0.40 <sup>c</sup> | 21.65±0.67 <sup>a</sup> |
| Oil content (% DM)       | 28.06±0.66 <sup>a</sup> | 27.13±0.2 <sup>b</sup>  | 27.50±0.77 <sup>a</sup> |

DM: Dry Matter; FN: Far-North; ND: North; AD: Adamawa

The values in the rows with the different letters in the exponent are significantly different ( $p < 0.05$ )

### C. Chemical Characteristics of Oil

Table 3 shows iodine and saponification values of the oil extracted from the seeds of fruits of different origins of the Grand North. It is observed that the origin does not have a significant influence on the iodine values. The saponification value decreases from the locality of Mbe (194.01) to that of Maroua (181.39), through Pitoa (189.81).

The results of the iodine values are closer to that of 94 obtained by [19]. However, they remain higher than that of 76.80 found by [9]. The same applies to the saponification

value for which [19] found 193, similar to ours and [9] a value of 179.77, lower than ours. The difference could be explained by the climatic differences that exist between the countries of origin of the fruits. Indeed, these foreign countries that are Nigeria (Kaduna State) and India could have rainfall different from those of the northern regions of Cameroon. The non-significant of the iodine values show that the oil of the three regions has a close unsaturation degree.

**Table 3:** Iodine and saponification values of oil extracted from the seeds of *C. pentandra*

| Values               | Provenances              |                           |                          |
|----------------------|--------------------------|---------------------------|--------------------------|
|                      | Maroua (FN)              | Pitoa (ND)                | Mbe (AD)                 |
| Iodine value         | 94.06±16.64 <sup>a</sup> | 90.03±7.60 <sup>a</sup>   | 91.20±9.71 <sup>a</sup>  |
| Saponification value | 181.39±6.63 <sup>b</sup> | 189.81±7.10 <sup>ab</sup> | 194.01±0.81 <sup>a</sup> |

FN: Far-North; ND: North; AD: Adamawa

The values in the rows with the different letters in the exponent are significantly different ( $p < 0.05$ )

## IV. CONCLUSION

The objective of this work was to determine the physicochemical properties of fruits, seeds and oil in the regions of the Grand North of Cameroon. Adamawa (Mbe) has physical parameter values higher than those of other provenances. The seed masses decrease according to whether the fruit is Mbe (18.93g), Maroua (16.42g) and

Pitoa (14.32g). The fruits of the localities of Adamawa have more seeds and more kapok than the fruits of the other two regions. The locality of Pitoa in the North produces fruits with a larger capsule mass. It is also noted that the water and lipid contents of the seeds of Mbe and Maroua are close and all superior to that of the seeds of Pitoa. The protein and sugar contents decrease in the direction of the seeds of Adamawa, Far-North and North.

Finally, the source of the seeds does not have a significant influence on the iodine values.

These results indicate that the exploitation of the seeds and kapok of *C. pentandra* could be interesting in the Adamawa region. This region is also advantageous if the desire is to use the richest seeds in terms of protein and sugar contents. The values of the iodine indices suggest that the oil of the three regions have a similar degree of unsaturation.

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