# Physicochemical Characterization of African Aubergine *Solanum Aethiopicum Anguivi* (Solanaceae) from Northern Cote d'Ivoire

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***Abstract—*** *Solanum aethiopicum anguivi (Solanaceae) is a common vegetable widely used for food by population in Korhogo, northern Côte d'Ivoire. But this aubergine is not yet soundly utilized. The current study focuses the physico-chemical traits of this aubergine to fit more valorization. From the investigation, the aubergine showed higher moisture (90.73% to 92.71%). Oppositely, lower contents are recorded for crude proteins (1.44% to 1.64%), fats (0.12% to 0.16%), total carbohydrates (5.38% to 6.71%), and so for caloric energy value (28. 36 Kcal/100 g to 34.84 Kcal/100g). Besides, the aubergine is provided with significant fiber content (2.43% to 3.31%) and displayed antioxidants components such as vitamin C (6.25 mg/100 g to 6.74 mg/100g) and polyphenols (55.94 mg/100 g to 66.34 mg/100g). It also presents 0.36% to 0.76% of ash mainly constituted of potassium (4.52% to 5.42% DM), phosphorus (0.82% to 0.97% DM) and other oligoelements as iron (1.42 to 4.81 ppm), manganese (2. 06 to 2.33 ppm), zinc (0.22 to 0.32 ppm), and copper (0.01 to 0.02 ppm). Still, this vegetable records phytate (20.91 to 22.44 mg/100 g) and oxalate (28.69 to 38.83 mg/100 g) as main antinutrients components. Processed before consumption, Solanum aethiopicum anguivi constitutes a significant source of food fibre, natural antioxidant, and mineral elements for local population*.

***Keywords— Aubergine, Physico-chemical properties, Solanum aethiopicum anguivi.***

## I. INTRODUCTION

African aubergine is one of the most commonly grown and consumed fruit vegetables in tropical Africa. It's the third largely consumed vegetable after tomato, onion and okra. The annual production of the fruit is 60 000t in Côte d'Ivoire [1]. The aubergine Solanum aethiopicum anguivi is a vegetable plant of the Solanaceae family grown for its fruit, which are borne 3 to 5 months over planting [2], and consumed as vegetable. The interest of vegetable plants in food for populations is very widely recognized in the world [3, 4]. In Côte d'Ivoire, the aubergine fruits and leaves are eaten.

In Korhogo, northern Côte d'Ivoire, the species *Solanum aethiopicum anguivi* is grown in several areas like villages and usually sold on the markets. This aubergine is used by populations for feeding, for the preparation of sauces and consumed with rice and pounded meals such as local foufou or foutou.

Nevertheless, the aubergine Solanum aethiopicum anguivi is under-exploited and the incomes recovered by stakeholders, namely farmers and sellers from markets, are meager. Yet, significant amounts of aubergine still rot during the distribution channel before being purchased by the consumers. Conservation problems prevail at the level of the distribution chain, a better control of the physico-chemical and nutritive parameters could contribute to ensure a better profitability of the aubergine. In addition, the populations are not soundly aware of the nutrients provided by the aubergine. This work is a valorization of the species Solanum aethiopicum anguivi by the determination of its physicochemical properties.

## II. MATERIAL AND METHOD

### 2.1 Plant material

The study was performed on fruits of aubergine *Solanum aethiopicum anguivi* collected from Korhogo in northern Côte d'Ivoire.

### 2.2 Methods

#### 2.2.1 Sampling

The aubergine samples were purchased from three (3) main markets of Korhogo City: Sinistré market, Soba market, and Koko market. Per market, the aubergine samples were purchased from three various sellers, four (4) kg each. Thus, 12 kg of aubergine were gathered per market, leading to 36 kg for overall samples purchased. The samples were then conveyed into laboratory for further analyses.

#### 2.2.2 Physical Characterization of *Solanum aethiopicum anguivi*

Five (5) physical parameters were assessed on the aubergine fruits, namely length, circumference, weight, moisture, and ash.

The length and the circumference of the full fruit were estimated using a meter tape. The fruit's weight was measured using a 2 digits scale (Sartorius,).

The method of determining moisture is that proposed by AOAC [5]. The moisture was assessed by drying 5 g of aubergine into an oven at 105 °C till constant weight resulted after 24 h.

The ash content was measured by incinerating five (5) g of oven-dried aubergine into a muffle furnace at 550 °C for 12 h [5].

#### 2.2.3 Chemical trend of the aubergine fruits

***A. Acidity***

The acidity traits (pH and titratable acidity) were measured using **AOAC** method [5]. Ten (10) grams of crushed sample are slurried in 100 mL of distilled water. The solution obtained is filtered on filter paper (Whatman). The pH measurement is carried out directly by immersing the previously calibrated pH meter (HANNA) electrode in the filtrate obtained. Then, 10 mL of the filtrate are taken and this test sample is titrated with a solution of NaOH (0.1 N) in the presence of phenolphthalein until turning pink. The titratable acidity is given in mEq/100g of dried sample.

***B. Total soluble carbohydrates and reducing carbohydrates contents***

Ethanosoluble carbobydrates were extracted from 1 g of ground dried aubergine with 20 mL of 80% (v/v) ethanol, 2 mL of 10% (m/v) zinc acetate and 2 mL of 10% (m/v) oxalic acid, according to the method of Agbo *et al*. [6]. The extract was centrifuged at speed of 3,000 rpm for 10 min. The ethanol residue was evaporated from the extract upon a hot sand bath.

Then, the extracted total soluble carbohydrates were measured out using the method of Dubois *et al*. [7]. The operation consisted in adding 0.9 mL of distilled water, 1 mL of 5 % (m/v) phenol, and 5 mL of 96% sulfuric acid into 100 µL of extract, then measuring the absorbance at 490 nm with a spectrophotometer (PG instruments). For the reducing sugars, 1 mL of extract was processed with 0.5 mL of distilled water and 0.5 mL of 3, 5- dinitrosalycilic acid [8] prior to the recording of the absorbance from the final solution at 540 nm with a spectrophotometer (PG instruments).

Calibrations were performed with standard solutions of glucose and sucrose for recovering the final total carbohydrates and reducing carbohydrates contents in the studied samples.

***C. Lipids content***

Lipids were quantified from 10 g of ground dried aubergine sample by solvent extraction using 300 mL of n-hexane reagent and a Soxhlet device for 7 h [9]. The hexan-oil mixture resulted from the extraction was recovered and separated with a rotavapor apparatus (Heidolph). The difference between the sample weight before and after the experiment allowed the estimation of the lipids content.

***D. Proteins content***

Crude proteins content was determined as the total nitrogen using the Kjeldhal method [5]. Thus, 1 g of aubergine mash was mineralized at 400 °C for 2 h, with adding of concentrated sulfuric acid ($H_2SO_4$) and potassium sulfate ($K_2SO_4$) catalyst. The mineralizate was diluted and distilled for 10 min. Thereafter, the distillate collected into a flask containing boric acid and methylen bromocresol reagents ion, was titrated for the total nitrogen using ammonium sulfate ($(NH_4)_2SO_4$). The crude protein content of the aubergine was deduced from the nitrogen level using 6.25 as conversion coefficient.

### *E. Fibers content*

The determination of the crude fibers content consisted in treatment of 2 g of ground aubergine sample with 50 mL of 0.25 N sulfuric acid and 50 mL of 0.31 N sodium hydroxide and filtration of the resulting solution upon Whatman paper. The residue was dried for 8 h at 105 °C then incinerated at 550 °C for 3 h into ovens [10]. The final residue was weighed as crude fibers and expressed in percentage.

### *F. Total carbohydrates content and energy value*

Total carbohydrates and energy values were determined using calculation formulas [11] accounting the moisture, fat, protein, ash contents and the energy coefficients for macromolecules.

$TCC (\%) = 100-[P(\%) + M(\%) + F(\%)+A(\%)]$ $CEV (kcal/100g) = [(4\times P) + (9\times F) + (4\times C)]$

*With: TCC, total carbohydrates content; CEV, caloric energy value; P, protein content; M, moisture content; F, fat content; A, ash content; C, total carbohydrates content*

### *G. Vitamin C content*

The vitamin C was evaluated from the aubergines using 2,6- dichlorophenol-indophenol (DCPIP) reagent [12]. Ten (10) grams of ground dried aubergine sample were dissolved into 40 mL of metaphosphoric acid-acetic acid solution (2%, w/v). The resulted mixture was centrifuged at 3,000 rpm for 20 min. Thus, the supernatant was recovered, added with boiled distilled water for 50 mL, and titrated with 2, 6- DCPIP solution (0.5 g/L) previously calibrated with a pure vitamin C solution.

### *H. Oxalates content*

The oxalate content was determined with the standard AOAC method [5]. Two (2) grams of ground dried aubergine sample were homogenized into 200 mL of distilled water and added with 20 mL of 6N hydrochloric acid (HCl). The mixture was heated in boiling water bath for 1 h, cooled, and filtered. Fifty (50) mL of the filtrate were then homogenized into 20 mL of 6 N HCl, and filtered again. The 2nd filtrate was treated with methyl red (0.1%, w/v), concentrated ammonia, heated, and filtered. The 3rd filtrate was boiled, treated with calcium chloride (5%, w/v) for the formation of calcium oxalate crystals, and then filtered once more. The residues deriving from the filtration steps were successively washed with distilled boiling water, dried into an oven; dissolved into 10 mL of diluted sulfuric acid, and titrated with 0.05N potassium permanganate solution.

### *I. Phytates content*

The phytates were measured according to the method processed by Mohammed *et al*. [13]. A slight ground aubergine sample (0.5 g) was treated with 25 mL of TCA solution at 3% (w/v) and centrifuged at 3,500 rpm for 15 min. Five (5) mL of the supernatant was removed, treated with 3 mL of ferric chloride 1% (w/v) reagent, heated in a boiling water bath, cooled and also centrifuged at 3,500 rpm for 10 min. The 2nd supernatant was treated with 5 mL of 0.5N hydrochloric acid, 5 mL of 1.5N sodium hydroxide, heated in a boiling water bath and centrifuged once more at 3,500 rpm for 10 min. Thus, 1 mL of the final supernatant was added with 4.5 mL of distilled water and 4.5 mL of orthophenantroline reagent and then measured for the absorbance at 470 nm with a spectrophotometer against standard Mohr salt solution treated likewise and taken as phytates ferric control.

### *J. Polyphenols contents*

The phenol compounds were extracted from aubergine with methanol reagent. One gram of dried aubergine sample was homogenized in 10 mL of methanol solution 70% (v/v). The resulting mixture was centrifuged at 1,000 rpm for 10 min. The pellet was recovered and treated likewise. The deriving supernatants were thus gathered into a marked flask and added with distilled water at 50 ml.

The total polyphenols content was measured using Folin-ciocalteu reagent, sodium carbonate solution (20% w/v) and distilled water [14]. Essays were measured for their absorbance at 745 nm with a spectrophotometer against standard gallic acid solutions taken as polyphenols control.

The tannins content was deducted from the total polyphenols using vanillin reagent [15]. Essays were measured for their absorbance at 500 nm with a spectrophotometer against standard tannic acid solutions taken as tannins control.

Flavonoids content was also determined from the total polyphenols using aluminum chloride (10% w/v), potassium acetate (1 M) and distilled water [16]. Essays were measured for their absorbance at 415 nm with a spectrophotometer against standard quercetin solutions taken as flavonoids control.

#### *K. Determination of mineral elements*

The determination of the mineral elements was performed according to the IITA method [17]. Finely ground aubergine sample (0.4 g) previously oven dried at 60 ° C was incinerated into a muffle furnace at 550 °C for 3 h. The resulting gray-white ash was cooled, added with 2 mL of half-diluted HCl, placed on a sand bath at 120 °C until full evaporation, and then ovened at 105 °C for a 1 h. The final dry extract was recovered with 2 mL of half-diluted HCl, filtered, and the resulting filtrate added with distilled water, and lanthanum chloride. The mineral elements in the solution were then measured using Atomic Absorption Spectrometry (AAS 20 type VARIAN).

### 2.2.4 Statistical analysis

All chemical analyses and essays were performed in triplicate. The data were statistically analyzed using Statistical Program for Social Sciences software (SPSS 22.0, USA). The statistical treatment consisted in a one-way analysis of variance (ANOVA-One way) according to market of perception of the aubergine taken as source of variation at 95% significance. Then, the means were compared using Student Newman Keuls post-hoc test.

## III. RESULTS

### 3.1 Physical characteristics of *Solanum aethiopicum anguivi*

The aubergine S. aethiopicum anguivi displays an oval shape. Both aubergines show invarious medium circumference (7.91 cm), length (4.38 cm) and weigh (9.05g) general average contents. Oppositely, table I shows higher moisture (92.71%) for aubergine from Koko market compared to the respective 90.73% and 91.86% moisture of aubergine from Sinistré and Soba market and higher ashes (0.76%) for aubergine from Sinistré market compared to the respective 0.39% ash and 0.36% ash for aubergine from Soba and Koko market.

**TABLE 1**
**SOME PHYSICAL PARAMETERS OF *SOLANUM AETHIOPICUM ANGUIVI***

| Parameters | Sinistré market | Soba market | Koko market | $F_{-value}$ | $P_{-value}$ | GA |
|---|---|---|---|---|---|---|
| Shape (cm) | Oval | Oval | Oval | - | - | - |
| Length (cm) | 4.30±0.40$^{a}$ | 4.46±0.40$^{a}$ | 4.38±0.24$^{a}$ | 0.163 | 0.853 | 4.38±0.29 |
| Circumference (cm) | 7.64±0.49$^{a}$ | 8.25±1.57$^{a}$ | 7.83±0.39$^{a}$ | 0.300 | 0.751 | 7.91±0.84 |
| Mass (g) | 8.35±0.08$^{a}$ | 9.97±2.14$^{a}$ | 8.84±0.05$^{a}$ | 1.349 | 0.328 | 9.05±1.22 |
| Moisture (%) | 90.73±0.45$^{c}$ | 91.86±0.08$^{b}$ | 92.71±0.05$^{a}$ | 41.15 | **<0.001** | |
| Ashes (%) | 0.76±0.02$^{a}$ | 0.39±0.01$^{b}$ | 0.36±0.01$^{c}$ | 577.8 | **<0.001** | |

***Per raw, values with various lower scripts are different at 5% significance. $P_{-value}$, statistical value of the probability test; F-value, statistical value of the Ficher test; GA, general average***

### 3.2 Chemical characteristics of *Solanum aethiopicum anguivi*

Except for the pH, where aubergines from Koko market provide more value (8.60), the main chemical traits show that aubergine from Sinistré market provide more acidity value (0.98 mEq/100 g), more protein (1.64%), lipid (0.16% w/w), total carbohydrates (6.71% w/w), total fiber (3.31% w/w), total sugar (2.97% w/w), reducing sugar (0.13% w/w) contents and more energy value (34.84 Kcal/100g) (Table II).

### 3.3 Main micronutrients, polyphenols compounds and antinutrients of *Solanum aethiopicum anguivi*

The aubergines studied from the three markets show invarious contents in vitamin C, phosphorus, potassium, calcium, magnesium, sodium, magnesium, zinc, copper, phytates, with respective general average of 6.55 mg, 0.88% DM, 4.93% DM, 0.48% DM, 0.52% DM, 6.49 ppm, 2.20 ppm, 0.27 ppm, 0.02 ppm, and 21.58 mg. Oppositely, the table III shows higher contents in total polyphenols (66.34 mg), tannins (51.75mg), flavonoids (0.55mg), iron (4.81ppm), oxalates (38.83 mg) for aubergine collected from Sinistré market.

**TABLE 2**
**MAIN CHEMICAL COMPOSITION OF *SOLANUM AETHIOPICUM ANGUIVI***

| Parameters | Sinistré Market | Soba Market | Koko Market | $F_{-value}$ | $P\text{-}_{value}$ |
|---|---|---|---|---|---|
| pH | $6.17\pm 0.01^c$ | $7.37\pm0.02^b$ | $8.60\pm 0.01^a$ | 36336.4 | <0.001 |
| Acidity | $0.98\pm 0.00^a$ | $0.00\pm 0.00^b$ | $0.00\pm 0.00^b$ | $2.921.10^{33}$ | <0.001 |
| Proteins (%w/w) | $1.64\pm 0.04^a$ | $1.56\pm 0.01^b$ | $1.44\pm 0.04^c$ | 33.23 | 0.001 |
| Lipids (%w/w) | $0.16\pm 0.01^a$ | $0.14\pm 0.01^b$ | $0.12\pm 0.00^c$ | 18 | 0.003 |
| Total carbohydrates (% w/w) | $6.71\pm 0.40^a$ | $6.07\pm 0.05^b$ | $5.38\pm 0.11^c$ | 22.6 | 0.002 |
| Total fiber (%w/w) | $3.31\pm 0.33^a$ | $3.32\pm 0.1^a$ | $2.43\pm 0.09^b$ | 19.34 | 0.002 |
| Total sugars (%w/w) | $2.97\pm 0.16^a$ | $2.66\pm 0.06^b$ | $2.23\pm 0.06^c$ | 37.95 | <0.001 |
| Reducing sugars (%w/w) | $0.13\pm 0.01^a$ | $0.10\pm 0.01^b$ | $0.06\pm0.01^c$ | 52 | <0.001 |
| Energy value (Kcal/100g) | $34.84\pm1.47^a$ | $31.78\pm0.27^b$ | $28.36\pm0.36$ | 40.329 | <0.001 |

***Per raw, values with various lower scripts are different at 5% significance. P-value, statistical value of the probability test; F-value, statistical value of the Ficher test***

## IV. DISCUSSION

The moisture content of the aubergine Solanum aethiopicum anguivi is high. This percentage is close to the moisture value of tomato variety ‘’Tounvi’’ (94.97%) reported by **Dossou *et al.* [18]**, and higher than that of mango (83-85%) found by Touré and Kibangou-Nkembo [19]. The higher moisture content of aubergine forecasts a rapid change in post-harvest state such as rotting [20].

For the physicochemical composition of the aubergine studied, there was a slight difference between the levels according to the markets. This is due to the slight difference in moisture content; the higher the moisture, the lower the contents in proteins, lipids, carbohydrates, ashes, etc. The protein content (1.44 to 1.66%) is greater compared to the 0.18% found from the ginger starch [21]. The lipid content (0.12 to 0.14%) is close to that recorded in cooked carrot (0.1%) and cucumber (0.11%) by Ciqual [22]. The total carbohydrate content (5.38 to 6.71%) is lower compared to the 18.9% carbohydrates values of potato [23].

Ultimately, the aubergine contains macromolecules (carbohydrates, lipids, proteins) essential for life, albeit in small quantities. It could be recommended for persons against gain of weight. The percentage of fiber (2.42 to 3.31%) is close to that of the fresh dough of young shoots tubers of *Borassus aethiopum* (3.92%) [24]. Aubergine may be a significant source of dietary fiber that is removed more slowly from the stomach and improves bowel movement. These dietary fibers are absolutely essential to the balance of the digestive tract and that of the body. They represent a factor of good health. Studies have shown an inverse correlation between dietary fiber consumption and colon cancer.

**TABLE 3**
**POLYPHENOLS, MICRONUTRIENTS AND ANTINUTRIENTS OF *SOLANUM AETHIOPICUM ANGUIVI***

| Parameters | | Sinitré Market | Soba Market | Koko Market | $F_{-value}$ | $P_{-value}$ | General average |
|---|---|---|---|---|---|---|---|
| Polyphenols compounds (mg/100g) | Total phenols | 66.34±0.55[a] | 64.47±1.23[b] | 55.94±0.15[c] | 150.596 | **<0.001** | |
| | Tannins | 51.75±1.78[a] | 34±.71±1.00[b] | 30.91±0.21[c] | 264.414 | **<0.001** | |
| | Flavonoids | 0.55±0.01[a] | 0.39±0.01[b] | 0.34±0.02[c] | 206.467 | **<0.001** | |
| Vitamin and mineral elements | Vit C (mg/100g) | 6.74±0.30[a] | 6.66±0.51[a] | 6.25±0.34[a] | 1.340 | 0.330 | 6.55±0.36 |
| | P (%DM) | 0.97±0.16[a] | 0.85±0.42[a] | 0.82±0.03[a] | 0.257 | 0.781 | 0.88±0.22 |
| | K (%DM) | 5.42±0.24[a] | 4.85±0.05[a] | 4.52±1.57[a] | 0.743 | 0.515 | 4.93±0.84 |
| | Ca (%DM) | 0.71±0.26[a] | 0.42±0.05[a] | 0.32±0.04[a] | 5.085 | 0.051 | 0.48±0.20 |
| | Mg (%DM) | 0.57±0.07[a] | 0.52±0.08[a] | 0.46±0.03[a] | 2.411 | 0.172 | 0.52±0.06 |
| | Na (PPM) | 7.41±0.33[a] | 6.35±2.14[a] | 5.70±0.84[a] | 1.240 | 0.354 | 6.49±1.30 |
| | Fe (PPM) | 4.81±0.39[a] | 3.54±0.54[b] | 1.42±0.05[c] | 58.759 | **<0.001** | |
| | Mn (PPM) | 2.33±0.23[a] | 2.21±0.19[a] | 2.06±0.04[a] | 1.754 | 0.251 | 2.20±0.20 |
| | Zn (PPM) | 0.32±0.16[a] | 0.28±0.17[a] | 0.22±0.02[a] | 0.410 | 0.681 | 0.27±0.12 |
| | Cu (PPM) | 0.02±0.01[a] | 0.02±0.01[a] | 0.01±0.01[a] | 0.600 | 0.579 | 0.02±0.01 |
| Antinutrients (mg/100g) | Phytates | 22.44±0.96[a] | 21.40±0.53[a] | 20.91±0.17[a] | 4.488 | 0.064 | 21.58±0.8 |
| | Oxalates | 38.83±2.69[a] | 32.52±1.02[b] | 28.69±0.35[c] | 28.096 | **0.001** | |

***Per raw, values with various lower scripts are different at 5% significance. P-value, statistical probability value; F-value, statistical Ficher value; Vit C, vitamin C; P, phosphorous; K, potassium; Ca, calcium; Mg, magnesium; Na, sodium; Fe, iron; Mn, manganese; Zn, zinc; Cu, copper.***

Indeed, fibers have the capacity to complex with carcinogenic molecules, thus preventing their contact with the colon and facilitating their excretion [25, 26]. They play a protective role against constipation and also against colorectal cancer. Consumption of aubergine may therefore increase gastric volume and constitute a post-ingestive state to reach a state of satiety more quickly [26, 27].

The total phenols content (55.94-66.34 mg/100g) is interesting. They are credited with many health benefits, such as reduction of risks of cardiovascular, inflammatory or neurodegenerative diseases, cancer prevention, antiplatelet effects, blood pressure regulation, etc [28].

Aubergine also contains 6.25-6.74 mg/100 mg vitamin C. Its consumption in a diversified diet added with other vegetables is highly beneficial. Indeed, vitamin C contributes in the health of bones, cartilage, teeth, and gums. It also protects against infections, accelerates healing and promotes the absorption of iron.

The study showed that Solanum aethiopicum anguivi contains numerous minerals. Generally, the markets investigated display similar mineral values. Thus, the usual availability of Solanum aethiopicum anguivi along seasons on markets in rural areas is favorable for its consumption in various diets for populations. In fact, a diet richer in calcium and phosphorus is a beneficial in the prevention of osteoporosis and also the reduction in the risks of hypertension and prostate [29]. The mineral potassium increases the cardiovascular well-being, while the magnesium is recommended for the prevention of many concerns involving myocardial infarction [30].

## V. CONCLUSION

From the study, the aubergine Solanum aethiopicum anguivi could be accounted as a vegetable which consumption is very beneficial for the population in Northern Côte d'Ivoire since it's widely produced by local farmers. It is a low calory food and can be promoted in balanced diets. It also regulates the appetite thanks to the significant fiber density. S. aethiopicum anguivi contains minerals and antioxidants namely vitamin C and polyphenols, and its consumption has important roles in the prevention of cancer and other cardiovascular diseases.

## REFERENCES


[1] Lester RN & Seck A (2004). *Solanum aethiopicum* L. In: Grubben G.J.H. and Denton O.A. Editions. Ressources végétales de l'Afrique tropicale 2. Legumes. Fondation PROTA, Backhuys Publishers, Wageningen, Pays-Bas: pp 530-536.

[2] Djedji AH & Fondio L (2013). Bien cultiver l'aubergine en Côte D'Ivoire. Centre National de Recherche Agronomique, Abidjan, Côte d'Ivoire,4p. https://www.agrici.net/pdf/ftec_aubergine.Pdf

[3] Ludy MJ & Mattes RD (2011). The effcts of hedonically acceptable red paper doses on, thermogenesis and appetite. *Physiol Behav*., 102(3-4): 251-258.

[4] Zimmer AR, Leonardi B, Miron D, Schapoval E, Oliveira JR & Gosmann G (2012). Antioxidant and anti-inflammatory properties of Capsicum baccatum: From traditional use to scientific approach. *J. Ethnopharmacol*., 139(1): 228-233.

[5] AOAC (1990). Official methods of analysis of the AOAC, 15th Edition, Methods 932.06, 925.09, 985.29, 923.03. Association of official analytical chemists. Arlington, VA, USA.

[6] Agbo NG, Uebersax M & Hosfield G (1986). An efficient extraction technique of sugars from dry edible beans (Phaseolus vulgaris) and estimation in HPLC, Université Nationale de Côte d'Ivoire. Annals serie C (sciences) Tome XXI: 169-184.

[7] Dubois M, Gilles KA, Hamilton JK, Rebers PA & Smith F (1956). Colorimetric method for determination of sugar and related substances. *Anal. Chem*. 28: 350-356.

[8] Bernfeld P (1955). Amylase beta and alpha (Assay Method), in methods in enzymology, Ed. Academic press, New-York, USA, pp 149-154.

[9] AFNOR (1986). Recueil de normes françaises. Contrôle de la qualité des produits laitiers. AFNOR, Paris – la- défense.

[10] Wolff JP (1968). Manuel d'analyse des corps gras; Azoulay Edition, Paris (France), 519 p.

[11] FAO (2002). Report of the International Rice commission. Vingtième session, 23-26 Juillet 2002, Bangkok, Thaïlande.

[12] AOAC (1984). Official methods of analysis of the Association of Official Analytical Chemists (14th Edition). Washington. DC.

[13] Mohammed AI, Ponhamperuma AJP & Youssef SH (1986). New chromophore for phytic Acid Determination. *Cereal Chem*. 63(6): 475-478.

[14] Singleton VL, Orthofer R & Lamuala-RRM (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. *Methods Enzymol*. 299: 152-178.

[15] Bainbridge Z, Tomlins K, Willings K & Westby A (1996). Methods for assessing quality characteristics of non-grain starch-staple. Part 4 Advanced methods. National ressources institute, University of Greenwish, UK ISBN 0-85954- 400-, 43-79.

[16] Meda A, Lamien CE, Romito M, Millogo J & Nacoulma OG (2005). Determination of the total phenolic, flavonoid and proline contents in Burkina fasan honey, as well as their radical scavenging activity. *Food Chemistry*. 91: 571-577.

[17] IITA (1981). Analyse des prélèvements pédologiques et végétaux. Manuel N°1, Oyo- Road, Nigeria, 66 p.

[18] Dossou JI, Soule & Montcho M (2007). Evaluation des caractéristiques physico-chimiques et sensorielles de la purée de tomate locale produite à petite échelle au Benin. *Tropicultura*, 25(2): 119-125.

[19] Touré S & Kibangou-NS (2000). Comparative study of natural solar drying of cassava, banana and mango. *Renewable En*. 29: 975-990.

[20] Ali A, Alhadji, Tchiegang C & Saïdou C (2010). Physico- chemical properties of Palmyra palm (*Borassus aethiopum* Mart.) fruits from Northern Cameroon. *Afri. J. Foods Sci*. 4, 115-119.

[21] Amani NG, Tetchi FA & Coulibaly A (2004). Propriétés physico-chimiques de l'amidon de gingembre (Zingiber officinale roscoae) de Côte d'Ivoire. *Tropicultura*, 22, 77-83.

[22] Ciqual (2013). Table de composition nutritionnelle des aliments. http//ciqual. Anses.fr. consulté le 26/08/2018 à 13H.

[23] FAO (1982). Etude FAO, Alimentation nutrition 47/2. Utilisation des plantes tropicales: tubercules et racines. 135 p.

[24] Niamke AM, Saki SJ, Koffi KM, Sea TB, Bidie ADP, Djaman AJ & Biego GH (2013). Studies on physicochemical properties of fresh paste of the young growths of *Borassus aethiopum*. *International Journal of Plant, Animal and Environmental Sciences*, 3(4): 197-202.

[25] Jansen MC, Buenode MHB, Buzina R, Fidenza F, Menotti A, Blackburn H, Nissinen AM, Kok FJ & Kromhout D (1999). Dietary fiber and plant foods in relation to colectoral cancer mortality: the seven countries study. *Int. J. cancer*. 81: 174-179.

[26] Chene C (2003). Journal de l'ADRIANOR Agro-jonction n°33. Septembre-octobre 2003. Les fibres alimentaires pp.1-8

[27] Al Dobaib N (2009). Effect of diets on growth, digestibility, carcass and meat quality characteristics of four rabbits breeds. *Sandi J. Biol. Sci*. 17: 83-93.

[28] Achat S (2013). Polyphénols de l'alimentation : Extraction, pouvoir antioxydant et interaction avec des ions metalliques. Thèse. Université A. Mira. Bepala. Faculté des Sciences de la Nature et de la Vie. Département des Sciences Alimentaires (Algérie). Université d'Avignon et des pays de Vaucluse. Ecole Doctorale 536-Avignon (France). 211 pages.

[29] Bonithon-KC, Kronborg O, Giacosa A, Rath U & Faivre J (2000). Calcium and fiber supplementation in prevention of colorectal adenoma reccurence: a randomized intervention trial. *The lancet*. 356: 1300-1306.

[30] Kannel WB (1997). Hazards risks and threat of heart disease from the early stages to symptomatic coronary heart disease and cardiac failure. *Cardiovasc. Drugs and their*. 11: 199-212.