American Journal of Food and Nutrition, 2024, Vol. 12, No. 3, 94-99
Available online at http://pubs.sciepub.com/ajfn/12/3/3
Published by Science and Education Publishing
DOI:10.12691/ajfn-12-3-3

Proximal Composition and Chemical Properties of the Seeds and Seed Oils of Two Peanut Varieties Grown in the Republic of Congo

Anicet Frédéric Binaki[1,2,*], Eliane Thérèse Biassala[1,3], Celestine Kiminou Ngounga[1,2], Jude Cédric Moumboko Kimbamba[1], Gouollaly Tsiba[4], Rosalie Kama Niamayoua[1]

[1]Multidisciplinary Food and Nutrition Research Team: Regional Center of Excellence in Food and Nutrition, Faculty of Science and Technology, Marien Ngouabi University. BP. 69
[2]Process Engineering Laboratory, UNESCO-ENSP Chair, Marien Ngouabi University. B P. 69, Brazzaville, Congo
[3]National Institute for Research in Exact and Natural Sciences (IRSEN), Brazzaville, Congo
[4]Institut National de Recherche en Sciences de la Santé (IRSSA). Département de la Pharmacopée et Médecine Traditionnelle Laboratoire de Chimie des Biomolécules Organiques et de Pharmacodynamique, Cité Scientifique (Ex-ORSTOM), Brazzaville, Congo
*Corresponding author: binaki2014@gmail.com

Received June 01, 2024; Revised July 02, 2024; Accepted July 09, 2024

Abstract The objective of this study is to evaluate and compare the chemical properties of oils and seed cakes of the two peanuts varieties sold on the Brazzaville markets with a view to identify their appropriate uses in nutrition and food technology. The extraction and chemical characterization of the seed oils and cakes were carried out according to standard analysis methods. The proximal composition of the seeds of the two varieties has approximately identical moisture contents (g/100gDM) (4.77±0.011 for the Var-R peanut and 4.15±0.007 for the Var-B peanut). The protein content (g/100gDM) of Var-B peanut cakes (37.76±0.003) is slightly higher than that of Var-R peanut cakes (35.71±0.001). The ash content (g/100gDM) is 5.16±0.006 for Var-B peanut cakes and 4.93±0.033 for Var-R peanut cakes. The carbohydrate content (g/100gDM) is 10.72±0.001 for Var-R peanut cakes and 3.67±0.001 for Var-B peanut cakes. The energy value (Kcal/100g) of Var-B peanut (609.06 ± 0.023) is higher than that of Var-R peanut cake (580.55± 0.041). The profile of the mineral elements analyzed is: P> Ca > Mg > Fe with contents (mg/100gDM) of the most abundant 14.30±0.93 for Var-B peanut cakes and 13.75 ± 1.5 for Var-R peanut cakes and the least abundant 0.095±0.003 for Var-B peanut cakes and 0.11±0.13 for Var-R peanut cakes. The Ca/P ratios in the seed cakes of the two peanut varieties are close. The oil yields (g/100gDM) of Var-B peanut seeds (49.26 ± 0.002) are significantly higher than those of Var-R peanut seeds (43.87 ± 0.01). The peroxide index (meq of O_2.kg^{-1}) of Var-B peanut oil (5.9) is twice as high as that of Var-R peanut oil (2. 67). The saponification indices (mg KOH/g of oil) of the oils of the two varieties are almost identical (189.177 for Var-B peanut oil and 187.303 for Var-R peanut oil). The same goes for the ester index (mg KOH/g of oil) (188.255 for Var-B peanut oil and 186.381 for Var-R peanut oil). On the other hand, the acid indices (mg KOH/g of oil) of the oils of the two varieties are identical (0.922). The oils of the two peanut varieties contain (in %) the three classes of fatty acids: saturated (22.4 for Var-B and 18.60 for Var-R), monounsaturated (40.53 for Var-B and 48.02 for Var-R) and polyunsaturated (36.12 for Var-B and 33.10 for Var-R). Among the polyunsaturated fatty acids we have, in varying proportions, ω-3 and ω-6. Oleic and linoleic acids constitute on average 79.876% for Var-B and 80.20% for Var-R, of total fatty acids.

Keywords: *oil extraction, cakes, characterization, proximal composition, fatty acids, Arachis hypogaea L*

Cite This Article: Anicet Frédéric Binaki, Eliane Thérèse Biassala, Celestine Kiminou Ngounga, Jude Cédric Moumboko Kimbamba, Gouollaly Tsiba, and Rosalie Kama Niamayoua, "Proximal Composition and Chemical Properties of the Seeds and Seed Oils of two Peanut Varieties Grown in the Republic of Congo." *American Journal of Food and Nutrition*, vol. 12, no. 3 (2024): 94-99. doi: 10.12691/ajfn-12-3-3.

1. Introduction

The peanut (*Arachis hypogaea* L.) is a tropical plant native to South America [1,2] and is divided into two subspecies and three varieties corresponding to the Virginia, Spanish and Valencia types [3] which are to in turn divided into different varietal subgroups according to the climatic and edaphic conditions specific to their development and cultivation [4]. It is cultivated on all continents, in approximately 120 countries, over a total area of 24.6 million hectares for a production of 38.8 million tonnes [5]. It is of great importance in the food and medicinal industries. It represents 10% of global oilseed production [6]. Peanut production on the African continent has experienced significant growth since the beginning of the 1990s. With its 10 million tonnes, the African

continent occupies second place ahead of the American continent [7]. Peanuts are grown for their seeds which are used in many types of foods. It is consumed either as seeds (after shelling the pods), or in the form of oil (after industrial or artisanal crushing of the seeds), or in more or less elaborate forms (butter, paste, flour, confectionery, etc.). Protein-rich meals are used as human or animal food [8]. Peanuts, like most grain leguminous plants, are a good source of lipids, proteins and mineral salts. The seeds contain approximately (45-50)% lipids, (25-30)% proteins, (5-12)% carbohydrates and 3% fiber. The nutritional values of peanuts have recently been taken advantage of in the composition of foods with high nutritional value used for the treatment of severe malnutrition and the reduction of the risks of cardiovascular diseases [9]. In Congo, 16 varietal subgroups of peanuts are cultivated, namely: Manga; Mani-pintar; Mbéngui; Loudima red; Nguesson; Lady's heel; Lekana/Djambala; Kubelavé; Kindamba; JL-24; Blanche de Loudima; E-119; Israel; Otendé; Red beauty; Mâ-bouésso [10].

Among these different varietal sub-groups, we were interested in the Blanche de Loudima varieties, cultivated in the southern part of the country, more precisely in the Bouenza department, and the Lekana/Djambala variety, cultivated in the northern part of the country, more precisely in the plateau department. Nowadays, no study on the physicochemical characterization of oils and cakes of these two varieties has been carried out. This study therefore consists of carrying out a comparative study of the chemical and biochemical characteristics of these two varieties of peanuts in order to identify their possible uses in agri-food and cosmetics and thus add value to this product which is little valued locally.

2. Material and Methods

2.1. Study Framework

This study was carried out in various laboratories: the Pôle d'Excellence Régional en Alimentation et Nutrition of the Faculty of Science and Technology at Marien Ngouabi University, the analytical chemistry laboratory of the IRSEN research zone in Pointe-Noire, and at the Centre de Coopération Internationale en Recherche, Agronomique pour le Développement (CIRAD) in France.

2.2. Plant Material

The agricultural products used in this study consist of the seeds of two varieties of *Arachis hypogaea* L (the Blanche de Loudima variety noted Var-B and the Lékana/Djambala variety noted Var-R). Var-B comes from Loudima (13°3'30" East and 4°6'45" South) in the Bouenza department and Var-R comes from Lékana (2° 19' 49" South, 14° 36′ 0″ East) in the Plateaux department. These seeds were transported to the laboratory where they were cleaned and dried in an oven at 35°C until a constant mass was obtained before being ground using a manual grinder to give a fine powder. This powder was introduced into a glass bottle, sealed hermetically and stored at 4°C away from light.

2.3. Proximal Composition

2.3.1. Residual Water Content

The moisture content was determined by drying the product at a temperature of 103°C, in an isothermal oven and at atmospheric pressure to a constant mass.

The residual water content (TEr) was determined according to the formula (1):

$$\text{TEr} = \frac{M_0 - M_1}{M_0} \text{x}100 \quad (1)$$

With: M_0: mass of the product before drying; M_1: mass of the product after drying.

2.3.2. Oil Extraction and Obtaining Cakes

Oil extraction was carried out using the Soxhlet method following the standard protocol [11]. A mass M_0 of peanut seed powder is placed in an extraction cartridge which is introduced into a Soxhlet extractor fixed on a round bottom flask filled 2/3 with hexane. After 8 hours of extraction at a temperature of 70°C, we obtain cakes and a mixture of oil and hexane. The oil and hexane were separated using a Büchi type rotary evaporator system and traces of hexane in the cakes were eliminated in the open air.

The oil extraction yield (Oil %) was calculated using the formula (2):

$$\text{Oil } \% = \frac{M_H}{M_0} \text{x}100 \quad (2)$$

with: M_H = mass of the extracted oil; M_0 = mass of the seed powder used to make the extraction.

The oil was collected in a smoked glass bottle, labeled and placed in the refrigerator (4°C) and the cakes, freed from traces of solvent in the open air, were wrapped in aluminum foil before any analyses.

2.3.3. Protein Content

The Kjeldahl method [12] was used to measure all the nitrogen; for this it was necessary to destroy the organic compounds in order to obtain all the nitrogen in the same mineral form. To do this, mineralization was carried out. The nitrogen was then dosed following an acid-base reaction.

The calculation of the percentage of nitrogen and protein was carried out by the following formulas [13]:

$$\% \text{ N} = \frac{(A-B)xNx14,01x100}{M} \quad (3)$$

$$\% \text{ Protein} = \% \text{ N x } 6.25 \quad (4)$$

With: A: Volume (ml) of HCl titrating the sample; B: Volume (ml) of HCl titrating the blank; 6.25: Kjaldahl factor; 100: Percentage factor.; N: Normality of hydrochloric acid solution used for titration; 14.01: Relative atomic mass of nitrogen; M = sample mass.

2.3.4. Ash Content

Raw ash is the residue obtained after incineration of an organic product. The ash content was determined according to the method [14]. The principle is based on

the incineration of a mass (M_0) of a sample at 550±15°C in an electrically heated muffle furnace until the mass becomes practically constant. Weighing (M_1) after cooling the ash obtained in a desiccator made it possible to determine the ash content according to the formula (5):

$$\text{Ash}\% = \frac{M_0 - M_1}{M_0} \text{ x } 100 \quad (5)$$

2.3.5. Total Carbohydrate Content

The total carbohydrate content was determined by the difference between the dry extract and the sum of proteins, lipids and Ash.

2.3.6. Determination of Energy Value (EV)

The energy value was calculated by applying the coefficients from [15], adopted by [16], namely: 4 for total proteins and carbohydrates and 9 for lipids.

$$\text{EV (calories)} = (4 \text{ x } \% \text{ protein}) + (4 \text{ x } \% \text{ total carbohydrates}) + (9 \text{ x } \% \text{ fat}) \quad (6)$$

2.3.7. Dosage of Mineral Elements

The mineral elements (P, Ca, Mg and Fe) were measured by flame atomic absorption spectrophotometry after mineralization of the sample. The mineralization of the cakes was carried out by the wet method (acid attack). The Varian Vista brand spectrophotometer, equipped with the CCD (Coupled Charge Device) detector, was used for this analysis. The determination of the mineral element contents was carried out using a pre-established calibration curve.

2.4. Chemical Characterization of Oils

The saponification indices (IS), acid (IA), peroxide (IP) were determined following the protocol described by standard NF T 60-206 [11]. The ester index (EI) was calculated by taking the difference between the saponification index and the acid index.

2.5. Fatty Acid Composition

The fatty acids were analyzed by gas chromatography coupled with a flame ionization detector (GC/FID) according to standard NF T 60-233 [11].

The device used was the FOCUS GC 800 chromatograph equipped with a CP-Sil 88 column with helium as carrier gas at 17 Psi and a temperature gradient from 140°C to 200°C, in a total of 40 min. the injection port was maintained at 250°C, with a split ratio of 1:100 and the detector set at 270°C. The fatty acids were identified by comparison to the standard.

2.6. Statistical Analysis

The data collected at the end of this study were subjected to statistical analyses. For each parameter measured, three tests were carried out and the result is expressed as mean ± standard deviation. A multivariate analysis of variance was carried out to assess the existence of differences between the samples studied. For these statistical treatments, the XLSTAT software version 2016.02.28451 which is an EXCEL macro command was used.

3. Results

3.1. Proximal Composition

Chemical characterization of seeds shows that these two varieties have virtually identical moisture contents, with 4.77±0.01g/100gMS for Var-R and 4.15±0.01g/100gMS for var-B. On the other hand, the protein content of Var-B oilcake (37.760±0.003g/ 100gMS) is slightly higher than that of Var-R (35.710±0.001g/100gMS). Likewise for the ash content, these values correspond respectively to 5.16±0.01 g/100gMS for Var-B and 4.93±0.03 g/100gMS for Var-R. On the other hand, the carbohydrate contents for the two varieties are significantly different ($P<0.05$), i.e. 10.720 ± 0.001g/100gMS and 3.670±0.001g/100gMS respectively for Var-R and Var-B cakes. The energy values whose value is 609.06±0.02 Kcal/100g for Var-B, a value higher than that of Var-R (580.55± 0.04 Kcal/100g) (Table 1). The fat yields of Var-B seeds (49.260 ± 0.002 g/100gMS) are significantly higher than those of Var-R seeds (43.87± 0.01 g/100gMS).

Table 1. Biochemical composition of seeds

	Samples	
Biochemical composition	**Var-B**	**Var-R**
Humidity (g/100gMS)	4,15±0,01	4,77±0,01
Protein (g/100gMS)	37,760±0,003	35,710±0,001
Fats (g/100gMS)	49,26 ± 0,002	43,87± 0,01
Ashes (g/100gMS)	5,16±0,01	4,93±0,03
Carbohydrates (g/100gMS)	3,670±0,001	10,720±0,001
EV (Kcal/100g)	609,06±0,02	580,55± 0,04

EV: Energetic value

3.2. Mineral Element Composition of Cakes

The mineral element contents of the seed cakes of the two peanut varieties are presented in Table 2.

Table 2. Composition (mg/100gMS) of mineral elements in the seed cakes of the two peanut varieties

	Samples	
Mineral elements	**Var-B**	**Var-R**
Ca	**7,5**±0,07	**7,5**±0,07
Mg	**0,12**±0,10	**0,95**±0,17
Fe	**0,095**±0,003	**0,11**±0,13
P	**14,30**±0,93	**13,75**±1,5
Ca/P	**0,52**±0,04	**0,43**±0,05

Among these elements, two are present in significant quantities and which the human body needs and called "macroelements". These are Calcium, the content of which is higher in Var-B cakes (7.5±0.07 mg/100gMS) than in Var-R cakes (5.90±0.07mg/100gMS) and phosphorus whose contents for the two varieties are almost identical (around 14 mg/100gMs). The other two which are in tiny quantities called “trace elements” are represented by magnesium, the content of which is lower

in Var-B cakes (0.12±0.10 mg/100gMS) than in Var-R cakes. (0.95±0.17mg/100gMS) and iron, the contents of which for the two varieties are close (around 0.10 mg/100gMS). The Ca/P ratios in the seed cakes of the two peanut varieties are close.

3.3. Chemical Characteristics of Oils

The peroxide index of Var-B peanut oil (5.9±0.5 meq of $O_2.kg^{-1}$) is twice as high as that of Var-R peanut oil (2.67±0.13 meq of $O_2.kg^{-1}$). The saponification indices of the oils of the two varieties are almost identical (189.18±3.62 mg KOH/g of oil for Var-B peanut oil and 187.303±2.50 mg KOH/g of oil for that of peanut Var-R). Likewise for the ester index (188.26±3.63 mg KOH/g of oil for Var-B peanut oil and 186.38±2.51 mg KOH/g of oil for that of peanut Var-R). On the other hand, the acid indices of the oils of the two varieties are identical (0.92±0.01 mg KOH/g of oil) (Table 3).

Table 3. Peroxide, saponification and acidity indices of oils

Indices	Var-B	Var-R
IP (meq of $O_2.kg^{-1}$)	5,9±0,5	2,67±0,13
IS (mg KOH/g of oil	189,18±3,62	187,30±2,50
IA ((mg KOH/g of oil)	0,92±0,01	0,92±0,01
IE (mg KOH/g of oil)	188,26±3,63	186,38±2,51

3.4. Fatty Acid Composition of Oils

The fatty acid (FA) content of the sheaths of the two peanut varieties grown in Congo is shown in Table 4.

This analysis revealed three classes of fatty acids in varying proportions in the oils of the two peanut varieties: saturated (22.4% for Var-B and 18.60% for Var-R), monounsaturated (40.53% for Var-B and 48.02% for Var-R) and polyunsaturated (36.12% for Var-B and 33.10% for Var-R). Among the polyunsaturated fatty acids there is the presence of ω-3 and ω-6, two essential fatty acids.

Table 4. Fatty acid composition of sheath oils of the two peanut varieties grown in Congo

Fatty acids	Denomination	Results (%)	
		Var-B	Var-R
C16: 0	Palmitic acid	12,48	10,56
C17: 0	Heptadecanoic acid	0,063	Tr
C18: 0	Stearic acid	3,92	2,33
C20: 0	Stearic acid	1,73	1,22
C22: 0	Behenic acid	3,41	2,97
C23: 0	Tricosanoic acid	0,06	0,06
C24: 0	Lignoceric acid	1,28	1,46
C18: 1 (n-9)	Oleic acid	40,53	48,02
C 18: 2 (n-6)	Linoleic acid	35,23	31,84
C 18: 3 (n-3)	Alpha-linoleic acid	0,84	1,21
C20: 3 (n-9)	Eicosatrienoic acid	0,05	0,05
Saturated fatty acids		22,94	18,60
Monounsaturated fatty acids		40,53	48,02
Polyunsaturated fatty acids		36,12	33,10
of which (n-3)		2,33	3,66
of which (n-6)		97,54	96,20
of which (n-9)		0,14	0,15

Tr: trace < 0,05%

4. Discussion

4.1. Proximal Seed Composition

The seeds of the two varieties of Congo peanut have a fat content (49.26 g/100g MS for Var-B and 43.87 g/100g MS for Var-R) which is much higher than that of the seeds of peanut from Daloa (Ivory Coast) (28.26 g/100g MS) studied by [17] and much lower than that of *Irvingia gabonensis* (60 to 80 g/100g MS) [18]. The humidity level has a lot of influence on the conservation of seeds. A lower content allows storage for long periods at room temperature because it delays the growth of micro-organisms. The moisture levels of the seeds of the two peanut varieties studied comply with the standard [19] (less than 9%) which shows that they can be stored for a long time with little risk of microbial contamination. The protein contents obtained are lower than those of peanut seeds reported by [17] and [20], which are 47.0 g/100gMS and 49.8 g/100gMS respectively.

Carbohydrate levels in the sheaths of the two peanut varieties studied are significantly higher than those found in the sheaths of *Sesanum indicum* L. (2.05 g/100gMS) [21]. They are lower than those found by [17] in peanut seeds from Daloa (Ivory Coast) (15.48 g/100gMS). The oilcakes of these two peanut varieties can contribute to the fight against protein-energy diseases and can be used in livestock feed due to their high protein content.

The ash levels are of the order of 5 g/100gMS, a value higher than that found by [17] in peanut seeds from Daloa (Ivory Coast) (3.57 g/100gMS) thus indicating that these seeds are important sources of minerals for the populations who consume them.

4.2. The Composition of Mineral Elements

For all the mineral elements analyzed, the most abundant in the seeds of the two peanut varieties is phosphorus while the least abundant is iron, with the following decreasing profile: P> Ca > Mg > Fe. The seeds of the two varieties of peanut are richer in phosphorus and poor in calcium than the kernels of *Irvingia gabonensis* [22]. Calcium and phosphorus are necessary for bone growth.

Calcium deficiency causes growth retardation, rickets in children, spasmophilia in adults and osteoporosis in the elderly. The Ca/P ratio between 0.5 and 0.8 promotes intestinal absorption of calcium. The presence of magnesium in the seeds of both varieties of peanuts is an advantage because magnesium is vital for bones, muscles and the nervous system. To improve the biological availability of iron, it is necessary to supplement a food ration based on peanut meals with other sources of iron.

4.3. Chemical Characteristics of the Oils

The peroxide values of the oils of the two peanut varieties are lower than those found by [17] for peanut oil from Daloa (Ivory Coast) (7.87 meq $O_2.kg^{-1}$). Moreover, these peroxide values are lower than those found by [23] for Olive oil (11 to 19 meq $O_2.kg^{-1}$). These peroxide values are lower than the 10 meq $O_2.kg^{-1}$ found in most

conventional oils [24]. In fact, peroxide values below 10 meq $O_2.kg^{-1}$ are generally considered to reflect an acceptable level of oxidation [25]. The saponification indices of the oils of two peanut varieties studied are higher than that found by [17] on peanut oil from Daloa (Ivory Coast) (173.98 mgKOH/100g) and lower than that obtained by [26] on the oil of *Irvingia gabonensis* (195.02 mg KOH/100g). Which shows the cosmetic interest of these oils [27]. The acid value of the oils studied complies with standards [19] (less than 4 mg KOH/g oil). This value is lower than that of some common oils such as soybean (max = 6) and sunflower (max = 4) [24]. These low acid number values characterize the purity and stability of Congo peanut oils at room temperature, and their resistance to rancidity according to [28]. The ester index values for the two peanut varieties are slightly lower than that of *Citrullus colocynthis* seeds (192.32 mg KOH/g of oil) [13]. The ester index makes it possible to determine the molar mass (therefore the structure) of the triglycerides in an oil. For the seed oil of the two varieties of Congo peanuts, the value of the calculated molar mass of triglycerides is equal to 898.40 g/mol.

4.4. Fatty Acid Composition

Peanut oil is particularly rich in oleic and linoleic acids, which make up an average of 79.876% for Var-B and 80.20% for Var-R, of total fatty acids. This allows it to be classified as an oleic/linoleic oil like olive oil. It can be compared with baobab seed oil, which also has the same fatty acid profile [29]. Its oleic acid content makes this oil particularly useful for cholesterol regulation.

Taking into account the total contents of unsaturated fatty acids (76.65% for Var-B and 81.12% for Var-R) and saturated fatty acids (22.94% for Var-B and 18.6% for Var-R), peanut oil is close to *Sesanum indicum* L. oil [30]. This oil could be very interesting for food and fight against cardiovascular diseases and other diseases linked to the central nervous system. Thanks to its high linoleic acid content, peanut oil has revitalizing properties. The work of [31] confirms the work of [32] and [33] which shows that the deficiency in polyunsaturated fatty acids leads to neurochemical abnormalities explained by increased behavioral reactivity and learning difficulties.

5. Conclusion

This study made it possible to evaluate and compare the chemical properties of the oils seed and seeds of the two peanuts varieties sold on the Brazzaville markets. The oil yield of Var-B peanut (49.26 ± 0.002 g/100gMS) is higher than that of Var-R peanut (43.87± 0.01 g/100gMS). The peroxide value and acid value of the oils of both varieties comply with Codex Alimentarius standards. The saponification indices of the oils of the two varieties are almost identical. The same goes for the ester index. The proximal composition shows that these two varieties have approximately identical moisture contents.

On the other hand, the protein content of Var-B peanuts is slightly higher than that of Var-R peanuts. The same applies to ash content. Carbohydrate content and energy values are very different for the two varieties. The oilcakes of these two peanut varieties can contribute to the control of protein-energy diseases and can be used in livestock feed due to their high protein content. For the mineral elements analyzed, phosphorus and calcium are the predominant elements in both varieties. Oleic and linoleic acids, which make up an average 79.876% of total fatty acids for Var-B and 80.20% for Var-R, classify these oils as oleic/linoleic.

ACKNOWLEDGEMENTS

The authors would like to warmly thank Professor David Mampouya and Doctor Bob Wilfrid Loumouamou for their multifaceted assistance which enabled this work to be carried out.

References

[1] Jarvis, A., M.E. Ferguson, D.E. Williams, L. Guarino, P.G. Jones, H.T. STalker, J.F.M.Valls, R.N. Pittman, C.E. Simpson, and P. Bramel, *Biogeography of Wild Arrachis:* 1108, 2003.

[2] Ferguson, M.E., A. Jarvis, H.T. Stalker, D.E. Williams, L. Guarino, J.F. Valls, R.N.Pittman, C.E. Simpson, and P.J. Bramel,. Biogeography of wild Arachis (Leguminosae): distribution and environmental characterisation. Biodiversity and Conservation 14: 1777-1798, 2005.

[3] Schilling R., Peanuts in tropical Africa. Maisonneuve et Larousse. 171p. 1996, p15-30 and 142-146.

[4] Youssi S., Analysis of the peanut sector in the South-West Malagasy region: tool to support the strategic thinking of a regional peasant organization; *End of study dissertation*; IRC Montpellier Sup Agro; 2008, 88 p.

[5] FAO STAT, Food and Agriculture Organization of the United Nations Statistics Division (FAOSTAT), 2012, Website: http:// faostat.fao.org.

[6] Fletcher, S., and D. Nadolnyak, Strategic Behavior and Trade in Agricultural Commodities B–Competition in World Peanut Markets. In 2006 *Annual Meeting, August* 12-18, Queensland, Australia, 2006.

[7] FAO STAT, Food and Agriculture Organization of the United Nations Statistics Division (FAOSTAT), 2008, Website: http:// faostat.fao.org.

[8] Alexis Malou, Variability of the chemical composition and nutritional value of raw materials and foods used and potentially usable in poultry farming in the Niayes zone in Senegal RI. Engineering dissertation; ENSA Thiès 67 p., 1989.

[9] Holbrook, C., and H.T. Stalker, Peanut Breeding and Genetic Resources. Plant breeding reviews 22: 297-356, 2003.

[10] Bembé Albert Pierre, Miyouna Thomas Claude, Samba Joseph Leon, Second report on the state of phylogenetic resources for food and agriculture in the Congo. Ministry of Scientific Research and Technical Innovation. Republic of Congo, 2007, 49p.

[11] AFNOR (French Standardization Association), Fats, oilseeds and derived products. Collection of French standards. Paris, France 2nd Ed, 1981, 438p.

[12] Helrich, *K.*, Method 988.05. Official Methods of Analysis, 15th Edition, 1990.

[13] Meriem Bireche, Boulanouar bakchiche, Mohamed Maatallah, and Abdelaziz Gherib, Physicochemical properties of lipid and quantification of seed proteins of Citrullus Colocynthis fruits. International Journal of Innovation and Applied Studies. 9: 1944-1948, 2014.

[14] AOAC, Official methods of Analysis of AOAC International, 16th Ed. AOAC International Arlington, VA., 1995.

[15] Merril A., Watt BX. Energy value of foods. Basic and derivation. USDA Agric. Hanbook n ° 74, 1955.

[16] FAO, Food composition tables for use in Africa. Doc. Nutr. No. 3, FAO, Rome, Italy, 1970, 218 pp.

[17] Diomande Massé, Kouame Kan Benjamin, Koko Anauma Casimir, Comparison of the chemical properties of peanut and cashew nut

oil and cake sold on the markets of Daloa, Ivory Coast. *International Journal of Engineering and Applied Sciences* (IJEAS). 4:28-32, 2017.

[18] Loumouamou B. W., Contribution to the valorization of oilseeds from the Congo basin, Chemical composition and technological potential of almonds of the *irvingia genus*. Unique doctoral thesis, Marien Ngouabi University, 2012, 160p.

[19] Codex Alimentarius, International Food Standards for Named Vegetable Oils CODEX STAN 210-1999. Adopted in 1999. Amendment: 2005, 2011, 2013, 2015. Revision: 2001, 2003, 2009. Codex Alimentarius, 2009.

[20] Larbier M., Leclercq B, Nutrition and feeding of poultry. INRA, Paris, 1992, 355p.

[21] Kouame N'dri Marie-Thérèse, Soro Kafana, Mangara Ali, Diarrassouba Nafan, Koulibaly Annick Victoire and Boraud N'Takpé Kama Maxime, Physico-chemical study of seven (7) spontaneous food plants from the center-west of the Ivory Coast. Journal of Applied Biosciences 90: 8450 – 8463, 2015.

[22] Th. Silou, S. Biyoko, S. Heron, A. Tchapla, M.G. Maloumbi, Physico-chemical characteristics and technological potential of Irvingia gabonensis almonds. La rivista italiana delle sostanze grasse. 131: 49-58, 2004.

[23] S. Boulfane, N. Maata, A. Anouar and S. Hilali, Physicochemical characterization of olive oils produced in traditional oil mills in the Chaouia-Morocco region. Journal of Applied Biosciences 87: 8022–8029, 2015.

[24] FAO (Food and Agricultural Organization), Codex Alimentarius Commission. Vegetable fats and oils, division 11, FAO/WHO abbreviated version. Codex Stan, 1981, 20-23.

[25] Rossell, B., Measuring resistance to oxidative rancidity Food. Sci Technol. 4, 220–225, 1993.

[26] Nijimbere A., Variability of the chemical composition and nutritional value of raw materials and feed used and potentially usable in poultry farming in the Niayes zone in Senegal RI. Engineering dissertation; ENSA Thiès, 2003, 67 p.

[27] Eka O.U., Proximate composition of bush mango tree and some properties of dikafat. Nigerian Journal of Nutritional Science, 1(1), 33-36, 1980.

[28] Tchiegang C., Aboubakar D., Kapseu C. & Parmentier M., Optimization of oil extraction by pressing Ricinodendron heudelotii almonds Pierre ex Pax. *Journal of Food Engineering*, 68 (1): 79-87, 2005.

[29] Magdi A. Osman, Chemical and nutrient analysis of baobab (Adansonia digita) fruit and seed protein solubility. Plant Food for Human Nutrition 59: 20-33, 2004.

[30] Y.Okandza, JP. Ossoko, J. Enzonga Yoca, M.G. Dzondo, M. Mvoula Tsieri, A. Yesly, B.Toubate, Study of some physicochemical properties of sesanum indicum L. oil, originating from the Republic of Congo. *Journal of Biotechnology and Biochemistry*. 3: 11-16, 2017.

[31] Chalon S., Proceedings of the Chevreul days “fat bodies, nutrition and health, current issues” (Bordeaux Pessac). And Inserm U316, medical and pharmaceutical biophysics laboratory, faculty of pharmacy, 31 av Monge 37200 Tours, France. Oilseeds, fatty substances, lipids. Volume 7, No. 1 p.68-73, 2000.

[32] Wainwright P., Do essential faty acids play a role in brain and behavioral development? Neurosci Behav Rev, 16:193-205, 1992.

[33] Frances H., Monier C., and Bourre JM., Effects of dietary alpha-linolenic acid deficiency on neuromuscular and cognitive function in mice. Life Sci, 57: 1935-47, 1995.