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Côte d'Ivoire *Blighia Sapida* Aril Oil Composition and Efficacy on Rat's compared with Palm Oil and Olive Oil

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Abstract

The purpose of this study was to determine and analyze the composition of *Blighia sapida* aril oil from Côte d'Ivoire and to compare its effects in diet to that of refined palm oil and olive oil.

A quantity of dried *Blighia sapida* arils was ground to fine powder. Oil extracted from the powder was filtered and characterized. After that, three experimental diets differed by the type of oil which were mixed with the food (*Blighia sapida* aril oil or refined palm oil or olive oil) were prepared. Three groups of young rats (six per group) were fed *ad libitum* with the different diets during 28 days. At the end of the experimentation, food intake, body weight and alimentary efficacy coefficient were measured and compared.

Chemicals analyze of the oil showed that it is oleic/palmitic/stearic oil. It contains low polyunsaturated fatty acids. The ratio of n-6/n-3 is 9.50 and the ratio unsaturated fatty acid/saturated fatty acid is 1.6. Food intake of the different group of rats was not significantly different ($p>0.05$) whatever the kind of oil in the diet. Body weight and alimentary efficacy coefficient obtained on rats fed with diet containing *Blighia sapida* aril oil were not significantly different ($p>0.05$) to that of rat's which consumed diet containing palm oil. However, body weight and alimentary efficacy coefficient in case of olive oil consumption were high ($p<0.05$) than those obtained with consumption of *Blighia sapida* aril oil or palm oil.

Blighia sapida aril oil and refined palm oil have practically the same nutritional value in alimentation while olive oil has more nutritional value. Refined *Blighia sapida* aril oil can enhance it nutritional value.

Keywords: *Blighia sapida* aril oil, characterization, oleic/palmitic/stearic oil, food intake, body weight, alimentary efficacy coefficient.

1. Introduction

In West Africa, *Blighia sapida* (ackee) arils consumption are introduced in the eating patterns of people in some regions. This is the case of its consumption freshly, raw, after made into sauce, or after being fried in oil in the North of Côte d'Ivoire (Arbonnier, 2002). The tree is originated from west and Centre tropical Africa (Hill, 1952; Bressler, Corridor, & Brendel, 1969). Because arils are nutritiously rich, the plant has been introduced in some countries such as Jamaïca and Haïti. Nowadays, *Blighia sapida* becomes the national plant of Jamaïca. In fact, for this country, it generates over 13 million Dollars USA every year (Orane, Blake, Maurice, Bennick, & Jose, 2006).

Some scientific studies are been carried out, in Côte d'Ivoire, in order to know the nutrition composition of the arils (Ouattara, Bobele, Dally, & Kati-coulibaly, 2010), the impact of arils powder level in diet on the growth, on the well-being (Ouattara, Meité, Kouamé, & Kati-Coulibaly, 2016) and on bone formation (Ouattara, Meité, Soro, & Kati-Coulibaly, 2016), the physicochemical properties of the oils extracted from *Blighia sapida* (ackee) arils and the biological tolerance of this oil in comparison with olive oil and palm oil (Ouattara, Amonkan, Mêté,

& Kati-coulibaly, 2014).

The result of nutrition study showed that *Blighia sapida* aril content high quantity of oil (45.32 %) and carbohydrate (24.43± 2.24) indicated that it could serve as food. But, the protein content is lower than that recommended by the Food and Agriculture Organisation [FAO], 2003. The determination of iodine value (56.26±2.55) of this oil indicated that, it contains low unsaturated fatty acid. The acid value obtain is lower than the minimum safe limit (15%) mean for consumption, then it has a low deteriorating rate and can therefore be store for a relatively long time (Ekpa, & Ekpa, 1996). The biological tolerance establishes that *Blighia sapida* arils oil are tolerated in rats following oral administration compare to result obtained with palm oil and olive oil (Ouattara et al, 2014). All these studies published on *Blighia sapida* aril oil give good reason for it used in human diet. However, it beneficial effects can be more apprehended with additional studies. In this work, we are shown the results of molecular characterization of *Blighia sapida* aril oil from Côte d'Ivoire and the effect of its incorporation in experimental diet of rats according to the international norm (Reeves, Nelsen, & Fahey, 1993) in comparison with refined palm oil and olive oil consumption by some efficacy parameters calculation.

2. Material and Methods

2.1 Plant Material

In Côte d'Ivoire, *Blighia sapida* is planted in Katiola region located in the North of Côte d'Ivoire. The arils are consumed in this region by people. The arils used for the experimentation was brought from Katiola in the period of March, April and May when it is more available. It was spread on polythene paper and exposed to sunlight to get dry for two weeks six hours a day. In the night, it was kept on the plastic and put in a house at room temperature (25 ℃- 30 ℃). After the drying process of the fresh arils, the dried arils were kept in plastic bags and sent to Abidjan the economical capital of Côte d'Ivoire located in South of this country. In Abidjan, the dried arils where utilized for several kinds of experimentation.

2.2 Blighia Sapida Aril Oil Extraction

A part of the dried *Blighia sapida* arils brought in Abidjan were ground to powder using a grinder (magimix, automatic 41000 multicuve). From the powder, oil was extracted at room temperature (25 ℃- 30 ℃) physically by tightening with a mechanical press. Oil obtained was filtered five times using a cotton-wool.

2.3 Analysis of Blighia sapida aril oil extracted

After *Blighia sapida* aril oil has been extracted, total fat acid and sterol composition were determined by molecular characterization.

The characterization of total fatty acid was made in two stages. Firstly, compounds were separated using a High Performance Liquid Chromatography (Thermofisher, France) and secondly the molecules separate were analyzed using also High Performance Liquid Chromatography (Thermofisher, France) as peace of apparatus.

Sterol compounds were determinated in three stages. Compounds which cannot be saponified were, in the first time, extracted. In the second time, they were isolated using thin coat silica gel chromatography method. At last, they were measured out using gaseous phase chromatography (chromatograph, GC8000).

2.4 Animals

18 young *albino Wistar* rats weighing between 49 and 65 g were used. They were bred in the animal house of Training Unitity of Biosciences of the University Félix HOUPHOUËT-BOIGNY of Abidjan (Côte d'Ivoire). During the breeding, rats were fed with an ailment made by a society in Côte d'Ivoire call IVOGRAIN which is specialized in mass production of livestock ailment. This ailment is making up by crud protein matter (15 %), crud fat matter (3.5 %), cellulose matter (12 %), mineral matter (9 %), calcium (1 %), phosphorus (0.9 %), sodium (0.3 %), vitamin A (15000 ui/kg), vitamin D3 (3000 ui/kg), and vitamin E (10 mg/kg).

2.5 Experimental Diets Preparation

Three experimental diets were prepared. These three diets were differed by the type of oil which was mixed with the food, *Blighia sapida* aril oil or refined palm oil or olive oil. Diets were prepared according to the nutritional composition preconized by the American Institute of Nutrition for rapid growth describes by Reeves, Nelsen, & Fahey (1993). The compositions of these diets are shown in Table 1.

Table 1. Composition of experimental diets (AIN-93G)

Diets composition	
Ingredients	**g/kg of food**
Proteins	
Casein	200
L-cystine	3
Sugar	
Saccharose	100
Corn starch	550
Fiber	
Agar-agar	32
Fatty matter	
oils : Bs oil or palme oil or olive oil	70
Vitamin	
AIN 93 vitamin mix	10
Mineral	
AIN 93 mineral mix	35

Bs: Blighia sapida

2.6 Experimentation

At the beginning of the experimentation, the animals were grouped to form three homogeneous young groups of rats. They were put individually in metabolic cages and maintained under standard laboratory conditions (temperature 25±2 ℃) with dark and light cycle (12h/12h). In the metabolic cages, rats were acclimatized to this condition and fed with a diet which differs to the experimental diet by incorporation of corn oil. This diet was used to feed the three homogenous young groups of rats during five days before the commencement of the real experiment. After that, rats of the different experimental group were fed *ad libitum* with a diet containing *Blighia sapida* aril oil symbolized HBs, or a diet containing palm oil symbolized HP and, or a diet containing olive oil symbolized HO. So, rats of the first group received diet containing *Blighia sapida* aril oil when rats of the second group received diet containing palm oil and rats of the third group received diet containing olive oil. Body weight of each rat was taken at the beginning of the experimentation and every four days. The time of the experiment was 28 days.

2.7 Methodology Used During the Experimentation

Every day, during the experimentation, when it was time to feed the rats, each kind of food, HBs or HP and, or HO, was made in paste by add in it a quantity of water clearly determined in order to minimize the waste. After that, a quantity of each mashed food made, was weighted and was given to each animal according to the group. Few mashed of the different food (HBs or HP and, or HO) was every day weighted after being dry during 4 hours in an oven (MMM Medcenter Gmbh (D-82152, Munich, Germany) at 105 ℃ and the weight obtained was written in a notebook. Then, with this sample the dry matter in each food give to animals can be calculated. The following day, before distributing the diets, the rests of food give the day before were separately collected and were weighted after being dried during 4 hours in an oven at 105 ℃. The different weights obtained were also written in a notebook. This methodology permitted us to determine the total dry matter consumed every day by each animal which is the difference between the dry matter food give the day before and the rest collected and dry the following day. Then, the total dry matter of food consumed by each group during the time of the experiment (28 days) is obtained by the summation of the dry matter consumed per day by each rat of the group during the 28 days. The mean Dry Matter Ingested every day (DMI/d) by each animal is obtained by the difference between Total Dry Matter of food consumed divided by 28.

2.8 Calculation of the Mean Weight Gain

The mean weight gain of each rat of each group during the time of the experimentation was calculated. The weight gain of each rat is obtained by the difference between the final body weight of a rat and the initial body weight of the same rat. Because there are six rats in a group and because the time of the experimentation is 28 days, the Mean Body Weight per group (MBW) is the summation of the difference between Final body weight and Initial body weight of the six rats of the group divided by 6 and by 28. Then, the Mean Body Weight (MBW) of each animal per group was obtained using the next formula:

$$MBW = \frac{\sum \quad FBW - IBW}{6 \times 28}$$

MBW: mean body weight;

FBW: final body weight;

IBW: initial body weight.

2.9 Calculation of the Mean Alimentary Efficacy Coefficient

The Alimentary Efficacy Coefficient (AEC) expresses the efficiency with which the diet has being ingested. This value was obtained by dividing the body weight gain per day of each rat of the group during the time of the experimentation by the Dry Matter Ingested (DMI) every day by each rat. Seeing that there are six rats per group, the Mean Alimentary Efficacy Coefficient (MEAC) per group was obtained by summation the AEC of each rat in the group which value obtained was divided by the number of rats in the group (6).

2.10 Statistical Analysis

The experimental results were expressed as the mean ±S.E.M. Data were assessed by the method of analysis of ANOVA followed by Dunnett test (Ostle, 1966; Woolson, 1987). p. value of < 0.05 was considered as statistically significant.

3. Result

3.1 Blighia Sapida Aril Oil Composition

The proximate compositions of the dry aril oil studied are shown in Table 2. From the data, the highest component of the dried aril oil is oleic fatty acid (55.50%) followed respectively by palmitic acid (26.50%), stearic acid (14.80%), linoleic acid (1.90%), arachidic acid (0.80%), vaccenic acid (0.40%) and linolenic acid (0.20%). Traces of lauric acid and myristic acid have been found in the dry aril oil. When we assemble the fats in to class according to their saturation, we found that monounsaturated fatty acids were the highest (55.90%) followed respectively by the saturated fatty acids (42.10%) and the polyunsaturated fatty acids (2.10%) which were in low quantity in the dry aril oil. The ratio of n-6/n-3 was 9.50 and the ratio unsaturated fatty acid/saturated fatty acid was 1.6. These results are shown in Table 2.

Table 2. Fatty acid composition found in *Blighia sapida* aril oil from Côte d'Ivoire

Simple formula	Common appellation	Proportions (%)
C12 :0	Lauric acid	-------
C14 :0	Myristic acid	-------
C16 :0	Palmitic acid	26.50
C18 :0	Stéaric acid	14.80
C18 :1(n-9)	Oleic acid	55.50
C18 :1(n-7)	vaccenic acid	0.40
C18 :2(n-6)	Linoleic acid	1.90
C18 :3(n-3)	Linolenic acid	0.20
C20 :0	Arachidic acid	0.80
Elements analyze	**Value**	
Total saturated fatty acid	42.10 %	
Total monounsaturated fatty acid	55.90 %	
Total polyunsaturated fatty acid	2.10 %	
n-6 /n-3	9.50	
Unaturated fatty acid/saturated fatty acid	1.38	

-------traces

3.2 Rats Growth Comparison According to the Oil Used in Diet, Blighia Sapida Aril Oil or Refined Palm Oil or Olive Oil

Rats growth of the different group were relatively rapid whatever the kind of oil in the diet (*Blighia sapida* aril oil or refined palm oil or olive oil). However, growth curved of rats fed with diet containing olive oil was lightly above the growth curved of rats fed with diet containing refined palm oil and also lightly above to that of rats fed with diet containing *Blighia sapida* aril oil. The growth curved of rats fed with diet containing *Blighia sapida* aril oil and the growth curved of rats fed with diet containing refined palm oil were practically the same. These

curved are shown on Figure 1.

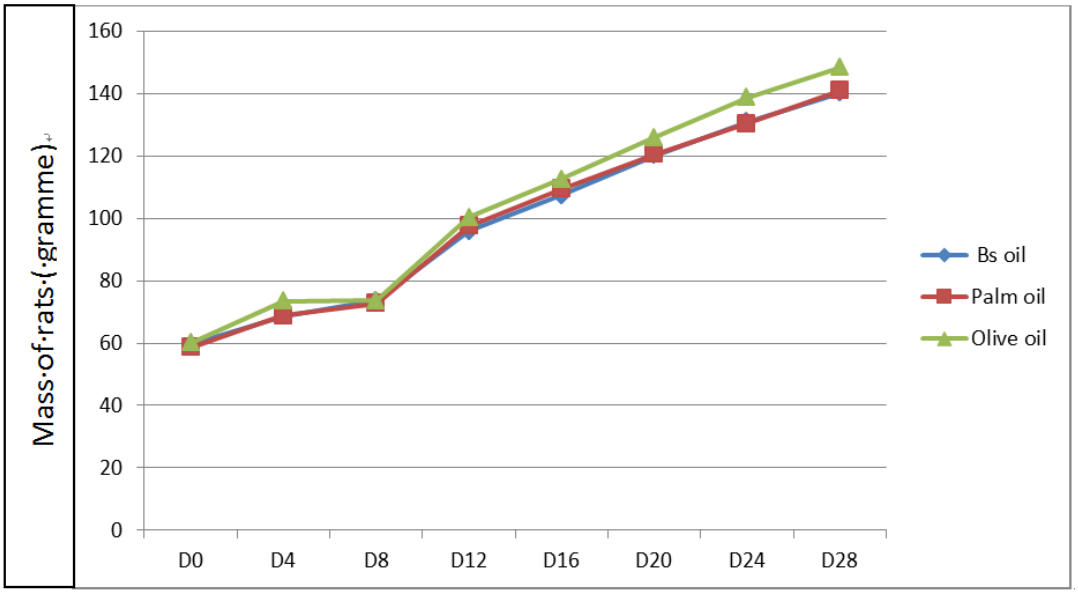

Figure 1. Comparative growth of rats fed with *Blighia sapida* aril oil, refined palm oil and olive oil

Dn: day of rats weighing

3.3 Comparison of Dry Matter Ingested of Each Rat per Group Every Day

For rats fed with diet containing *Blighia sapida* aril oil, the dry Matter Ingested (DMI/d) every day by each rat was 8.60±0.07 g/d. That of rats fed with diet containing refined oil was 8.75±0.04 g/d and that of rats fed with diet containing olive oil was 8.57±0.06 g/d. The Dry Matter Ingested by each group of rats was not significantly different ($p>0.05$) with that ingested by the other group. These results are shown on Figure 2.

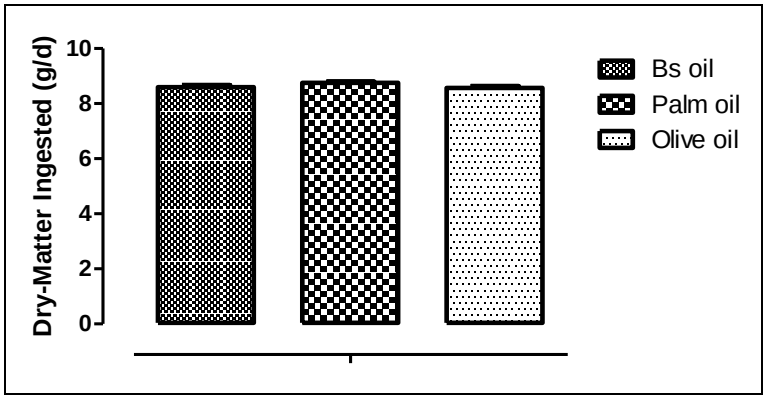

Figure 2. Dry Matter Ingested by rats according the type of oil consumed

3.4 Comparison of Mean Body Weight of Each Rat Per Group

Mean body weight of rat fed with diet containing *Blighia sapida* aril oil was 2.69±0.39 g/d.

That of rats fed with diet containing refined oil was 2.94±0.39 g/d and that of rats fed with diet containing olive oil was 3.15±0.43 g/d. Mean body weight increased of rats fed with diet containing olive oil was 14.60% times higher ($p<0.05$) than that of rats fed with diet containing *Blighia sapida* aril oil. The increase of the mean body weight of rats fed with diet containing refined oil was 8.5% times higher ($p>0.05$) than that of rats fed with diet containing *Blighia sapida* aril oil. The histograms on Figure 3 are shown the Gain weight of rats according to the type of oil consumed.

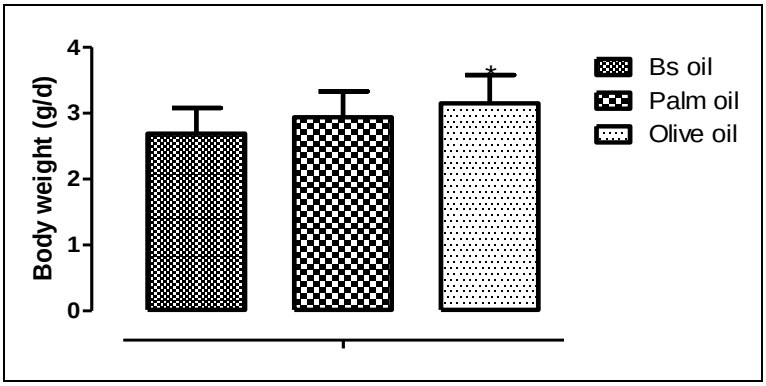

Figure 3. Gain weight of rats according to the type of oil consumed

(*): $p<0.05$; significant variation

3.5 Comparison of Mean Alimentary Efficacy Coefficient of Each Rat per Group

The Mean Alimentary Coefficient obtained on rat fed with diet containing *Blighia sapida* aril oil was 0.31±0.04. That of rats fed with diet containing refined oil was 0.37±0.04 and that of rats fed with diet containing olive oil was 0.37±0.06. Mean Alimentary Efficacy Coefficients obtained on rats fed with diet containing refined palm oil was not significantly different ($p>0.05$) to that obtained on rats fed with diet containing *Blighia sapida* aril oil. However, that of rats fed with diet containing olive oil was significantly high ($p<0.05$) than that obtained on rats fed with diet containing *Blighia sapida* aril oil. These results are shown on Figure 4.

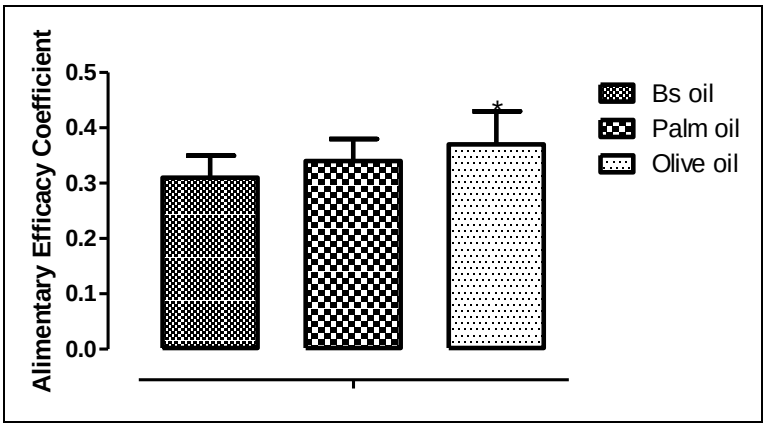

Figure 4. Alimentary Efficacy Coefficient obtain on rats according to the diets consumed

(*) : $p<0.05$; significant variation

4. Discussion

Essentials component of lipids found in plants oil, according to the number of unsaturation in their structure, are saturated fatty acids, monounsaturated fatty acids (MUFAC) and polyunsaturated fatty acids (PUFAC). Relative proportion of each class of fatty acids found in fats content of a plant is the best way to apprehend the functional properties and the stability of this oil. Analysis of *Blighia sapida* aril oil from Côte d'Ivoire showed that it is oleic/palmitic/stearic oil. These results of analysis are in the same way with that done by Omobuwayo, Sanni, & Olajide (2002), concerning *Blighia sapida* seed oil, which showed that the majority components are oleic acid followed respectively by palmitic acid and stearic acid. The proportions of PUFAC found in *Blighia sapida* aril oil from Côte d'Ivoire are lower than that of vegetable oils [palm oil (10% polyunsaturated fatty acids), soybean oil (60% polyunsaturated fatty acids), colza oil (31% polyunsaturated fatty acids), sunflower oil (67% polyunsaturated fatty acids), olive oil (11.4% polyunsaturated fatty acids) and argan oil (34.40% polyunsaturated fatty acids)] commonly used in human nutrition (Adlouni, 2007). Lower content of PUFAC and high content of oleic acid and saturated acids of *Blighia sapida* aril oil from Côte d'Ivoire give to that oil high stability than the

above-mentioned oils. In fact, more saturated acids oils are more stable than more monounsaturated oils which are more stable than more polyunsaturated fatty oils (Rossignol-Castera, 2004). *Blighia sapida* aril oil from Côte d'Ivoire is not predominantly saturated because it's containing more MUFAC than saturated acids. Oils more saturated are admittedly more stable but had disastrous consequences for human nutrition due to cardiovascular risk potentiation (Anonymous, 1992). All these assertions suggested that *Blighia sapida* aril oil from Côte d'Ivoire is good for frying because it is stable and it is low for oxidation process (Rossignol-Castera, 2004). Although PUFAC content in this oil is low, the ratio n-6/n-3 is between 4 and 10, a value of ratio recommended by nutritionists (Rahmani, 2005). Then, the ratio n-6/n-3 of *Blighia sapida* aril oil from Côte d'Ivoire is better than that of palm oil (20) the first oil consumed in world (Fond Français pour l'Alimentation et la Santé, 2012). Also, the ratio, monounsaturated fatty acid/saturated fatty acid, of *Blighia sapida* aril oil from Côte d'Ivoire is lower than the value 1.5. Oils with ratio monounsaturated fatty acid/saturated fatty acid lower than 1.5 got benefic effects when utilized in human diet and are therefore recommended by nutritionists (Rahmani, 2005). This oil is poor in PUFAC and then it is good to make margarine (FAO, 1996). When we considered the saturated fatty acids composition, we noticed that the mayor component is palmitic acid followed by stearic acid. Lauric acid and myristic acid is found in trace. Stearic acid doesn't raise cholesterol (Grundy, 1995) and myristic acid raises this value (Grundy, 1997). Then, the fact that there are high presence of stearic acid and absence of myristic acid in *Blighia sapida* aril oil is another reason to it possible used in human nutrition.

The analysis of the results of molecular characterization suggested that although *Blighia sapida* aril oil from Côte d'Ivoire contains low quantity of PUFAC, it is getting nutritional properties which must be confirmed or invalidated in experimentation deal with laboratory animals. That is what, in experimentation with young rats deal during 28 days, we investigated the growth, food intake and body weight of young rats which consumed diets differ from each other by the type of oil (*Blighia sapida* aril oil or palm oil or olive oil).

The fact that there was no significant different ($p>0.05$) between Dry Matter Ingested by each group of rats imply that the different diets were ingested with the same appetite. So, *Blighia sapida* aril crude oil from Côte d'Ivoire may get equal organoleptic properties with refined palm oil and olive oil. The fact that Alimentary Efficacy Coefficient obtained with diet containing olive oil was higher ($p<0.05$) than that obtained with diet containing *Blighia sapida* aril oil suggested that the nutrition value of olive oil is more important than that of *Blighia sapida* aril oil. It will be the consequence of the low PUFAC content of *Blighia sapida* aril oil. This assertion is corroborated by a gain weight more low in the case of *Blighia sapida* aril oil consumption and a growth lightly lower than the growth of rats fed with olive oil. When the Alimentary Efficacy Coefficient and the growth of rats fed with *Blighia sapida* aril oil are compared with values obtained on rats fed with palm oil, there are no significant difference ($p>0.05$) suggesting that *Blighia sapida* aril oil and palm oil get equal qualities in human nutrition. Better again, the fact that *Blighia sapida* aril oil contains few MUFAC than palm oil, it may be interesting to prefer *Blighia sapida* aril oil than palm oil in alimentary industries when we want to make margarine. In fact, palm oil contains 10% of PUFAC (FAO, 1996) when *Blighia sapida* aril oil contains 2.1% of PUFAC.

5. Conclusion

According to our study, *Blighia sapida* aril oil from Côte d'Ivoire is oleic/palmitic/stearic oil. It contains low PUFAC. It has the value, 9.50, of ratio n-6/n-3 and the value, 1.6, of ratio unsaturated fatty acid/saturated fatty acid. When used in young rat's diet, the gain of weight and the alimentary efficacy are lower than the use of olive oil in young rat's diet. But, these parameters compared to that obtained on young rat's which consumed diet containing refined palm oil are practically the same suggesting that the both oils have the same performance in diet. Refined *Blighia sapida* aril oil could improve it value and then it can become better than refined palm oil in diet.

Conflict of interest

The authors declare no conflict of interest

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