

Full Length Research Paper

Impact of *Blighia sapida* (k. Koenig) aril powder level in diet on the growth and the well-being of albino Wistar rats

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The aim of the present investigation was to evaluate the impact of *Blighia sapida* aril level in diet on the growth of albino Wistar rats and their welfare. A quantity of *B. sapida* arils was cooked and lyophilized. Thirty six young albinos Wistar rats teams up in six with six homogeneous groups were used for a four weeks research. Young rats group were fed *ad libitum* with six different diets which can be distinguished by the level of *B. sapida* arils powder. There were control diet (0% *B. sapida* arils powder), diet Bs₁ (6.25% *B. sapida* arils powder), diet Bs₂ (12.5% *B. sapida* arils powder), diet Bs₃ (25% *B. sapida* arils powder), diet Bs₄ (50% *B. sapida* arils powder) and diet Bs₅ (75% *B. sapida* arils powder). Body weight was measured weekly and the animals were observed for signs of abnormalities throughout the study. At the end of the experimentation, blood sample was collected and analyzed. Results show that the growth of rats fed with diets Bs₁, Bs₂ and Bs₃ were normal as compared to the growth of rats fed with the control diet. On the other hand, growth retardation was noticed on rats fed with diets Bs₄ and Bs₅. However, rats coat fed with diets Bs₄ and Bs₅ were also normal. Again, for rats fed with diets Bs₄ and Bs₅, a level (p<0.05) of total cholesterol and LDL-cholesterol was noticed as compared to values obtained in rats of the other groups. In the case of natural disaster, the consumption of *B. sapida* aril could be used as nutritional base at a degree neighboring 50% of the nutritional need of the organism. Outside this value, growth retardation and a level of total cholesterol and LDL-cholesterol can be noticed.

Key words: *Blighia sapida* aril, diet, rats, growth, welfare.

INTRODUCTION

The tree called fisanier in French is scientifically known as *Blighia sapida* L. (sapindaceae). It originates from west and Central tropical Africa (Hill, 1952; Bressler et al., 1969). It has been spread by cultivation in the tropical region (Arbonnier, 2002). It is available in West Africa,

Central Africa and also in Caribbean and Jamaica. *B. sapida* is grown because it has several uses. In fact, the tree is grown in towns for its shade. His wood, because it is termite hardy, is used as building material and for cooking (Arbonnier, 2002). The leaves are used as herbal

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medicine to treat amygdalitis, conjunctivitis, wound, icterus, vertigo and epilepsy (Arbonnier, 2002; Orwa et al., 2009). When the unripe fruits are crushed, they produce moss which is used as soap and also as fishing poison (Arbonnier, 2002).

The main reason why *B. sapida* is cultivated is for its arils, the freshly cream which colours the pulp of the fruit. These arils can be consumed freshly or when they are made into sauce or fried in oil (Arbonnier, 2002; Ekué et al., 2010). The consumption of *B. sapida* arils is worldwide. In fact, in Jamaica, they are industrially transformed and put into cans and are sold in America and Great Britain (Orane et al., 2005). Several research results on the beneficial uses of *B. sapida* arils show that it is an essential element that should not to be neglected in diet in many regions due to its lipids (45%), proteins (11%), ash (4%) and vitamin C (65 mg/kg) content (Morton, 1987; Akintayo et al., 2002; Ouattara et al., 2010). Nevertheless, some molecules such as hypoglycine A, saponin, saccharides and fructoligosaccharides (Jimoh et al., 2007; Benkeblia and Lopez, 2015) have negative effects on the organism function (Moyal, 1985, 1986; Chase et al., 1990; CDC, 1992; Bouree et al., 2002; OPS, 2002; Katibi et al., 2015). These negative effects can end up with death caused by hypoglycemia or hemolytic syndrome (Moyal, 1985, 1986; CDC, 1992; Bouree et al., 2002; OPS, 2002; Katibi et al., 2015). Despite everything, potentialities of *B. sapida* arils have been exploited in Côte d'Ivoire and in Jamaica when there were natural disasters in these countries. In Côte d'Ivoire, in the year 1984, a drought caused a diminution of cereals production. Then, consumption of *B. sapida* arils prevented a big famine. Also, the consumption of *B. sapida* aril prevented a big famine in Jamaica. This famine was due to flood which caused lack of cereals. According to an epidemiological study, mortality was caused either by the action of the toxic molecule called hypoglycin A and the high consumption of arils which do not satisfied the nutritional need of the organism (OPS, 2002). For a better understanding of this situation, some questions may be answered. Can *B. sapida* aril be a palliative to the lack of food? If not, to what extent can it be safely consumed?

Then, the aim of this study was to evaluate the effect of *B. sapida* arils consumption in accordance with the level of arils in diet on Albino Wistar rats. In this work, the results of growth, visual observation and blood sample parameters such as lipids parameters, glucose, protein and urea are shown.

MATERIALS AND METHODS

Plant material

B. sapida is planted in the North and the Centre of Côte d'Ivoire. In these regions, the arils of the plant are very much consumed. Arils used for the experimentation were brought from Katiola, a town in the North Central of Côte d'Ivoire, in the months of March, April and

May. In these months, arils are more available.

At Katiola, arils were spread on polythene paper and exposed to sunlight for two weeks, six hours a day, to get dry. In the night, they were kept on the plastic and put in a house at room temperature (25 - 30°C). After the drying process of the fresh arils, the dried arils were kept in plastic bags and sent to Abidjan in the South of Côte d'Ivoire.

Animals

Thirty six young albino Wistar rats weighing between 49 and 75 g were used. They were bred in the animal house of UFR Biosciences of the University Félix HOUPHOUËT-BOIGNY of Abidjan (Côte d'Ivoire). During the breeding, rats were fed with food made by a society IVOGRAIN which is specialized in mass production of livestock food. This food is made up of crude protein matter (15%), crude 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).

Preparation of the arils

In Abidjan, the dry arils were crushed with a laboratory mortar. Each time, 500 g of *B. sapida* arils powder was cooked, using a gas stone, in one liter of water (500 g/l) for two hours. Approximately, 10 kg of *B. sapida* arils powder was cooked. Arils pasta obtained were lyophilized. The freeze-dry aril obtained was used to formulate five kinds of experimental diets. These experimental diets were named diets Bs₁, Bs₂, Bs₃, Bs₄ and Bs₅. Previously, a control diet was prepared. The composition of the control diet was similar to that recommended by scientists of the American Institute of Nutrition for rapid Growth (AIN-93G) on experiment with animals, particularly, rats (Reeves et al., 1993). Table 1 shows the nutritional composition of the control diet.

Difference between the experimental diets

In the experimental diets, a part of the control diet was substituted by the freeze-dry aril. The degree of substitution was 6.5% for diet Bs₁, 12.5% for diet Bs₂, 25% for diet Bs₃, 50% for diet Bs₄ and 75% for diet Bs₅.

Experimentation

At the beginning of the experimentation, the animals were grouped into six different homogeneous young groups of rats. They were put individually in metabolic cages and maintained under standard laboratory conditions (temperature 25±2°C) with dark and light cycle (12/12 h). In the metabolic cages, rats were acclimatized to this condition and fed with the control diet five days before the beginning of the experiment. After that, the animals were fed *ad libitum* with the different diets (control diet, diets Bs₁, Bs₂, Bs₃, Bs₄ and Bs₅) during 28 days according to the different group they belong to.

Treatment of animals during the experimentation

Body weight of each rat was measured weekly and the animals were observed for signs of abnormalities throughout the study. At the end of the experimentation, blood samples were collected at the vena cava level of all the animals and put in individual vacuum valve. The blood samples were taken in the morning after giving ether anesthesia to the albino rats. Samples were collected with a

Table 1. Nutritional composition of the control diet.

Diet composition	g/kg of food
Component	
Protein	
Casein	200
Sugar	
Saccharose	100
Starch of maize	550
Fiber	
Agar-agar	32
Fats	
Palm oil	70
Mixture of vitamins	10
Mixture of mineral	35
L-cystine	3

The control diet composition used in the experimentation is approximately equal to that recommended by the American Institute of Nutrition for rapid Growth (AIN-93G) proposed by Reeves et al. (1993).

sterile disposable syringe. Also, at the end of the experimentation, the urine (24 h urine) of each animal was taken, measured and analyzed.

Biochemical parameters

The blood samples were centrifuged at 8000 r.p.m for 15 min to harvest the plasma which was used for the various analyses. Glucose was assayed by glucose oxidase-peroxidase method using a kit (Sigma Diagnostics, Sigma kit #315). Total cholesterol and triglycerides were measured as described by Richmond (1973) and Trinder (1969b), respectively. Urea was estimated by the diacetyl method of Wybenga et al. (1971). Total protein was estimated using assay kits (Sigma Diagnostics, St. Louis, MO, USA). Biochemical analysis of serum samples was performed using an automatic chemistry analyzer (Hitachi model 902, Roche).

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.

RESULTS

Observation and growth

All the rats used in this work had, after the

experimentation, generally, either normal coat or normal appearance. At the growth level, some differences were noticed. There were no significant difference ($p > 0.05$) of growth between the control group and group of rats fed with diets Bs₁, Bs₂ and Bs₃. But, growth of rats fed with diets Bs₄ and Bs₅ was relatively low ($p < 0.05$) as compared to that of the control group. The growth of rats fed with diets Bs₄ and Bs₅ was also low ($p < 0.05$) when compared with that of rats fed with the diets Bs₁, Bs₂ and Bs₃. Lower growth was observed in the animals fed with diet Bs₅ than those which consumed diet Bs₄. The percentage of the difference of growth between animals of the control group and those which consumed diet Bs₄ was 28.75% ($p < 0.05$) while this difference between the control group and those which consumed diet Bs₅ was 61.53% ($p < 0.001$). Table 2 shows the curve of rats' growth according to *B. sapida* aril powder level in diet.

Effect on the urinary volume

The urinary volumes obtained from rats fed with diets Bs₁, Bs₂ and Bs₃ were not significantly different ($p > 0.05$) from that obtained from rats fed with the control diet. But, in rats fed with diets Bs₄ and Bs₅, urinary volumes were respectively high ($p < 0.05$) and very high ($p < 0.001$) when compared with urinary volume obtained from rats fed with the control diet.

Urinary volumes obtained was 6.78±1.04 ml/24 h for rats fed with the control diet, 6.57±2.25 ml/24 h for rats fed with diet Bs₁, 6.55±1.10 ml/24 h for rats fed with diet Bs₂, 6.60±1.34 ml/24 h for rats fed with diet Bs₃, 3.11±0.73 ml/24 h for rats fed with diet Bs₄ and 1.90±1.11 ml/24 h for rats fed with diet Bs₅. These results are shown on Figure 1.

Effect of *B. sapida* aril powder level in diet on plasmatic triglycerides

Triglycerides level observed were 1.60±0.24 g/l for rats fed with diet Bs₁, 1.86±0.17 g/l for rats fed with diet Bs₂, 1.42±0.30 g/l for rats fed with diet Bs₃, 1.47±0.20 g/l for rats fed with diet Bs₄ and 1.37±0.19 g/l for rats fed with diet Bs₅. These values were not significantly ($p > 0.05$) different from that obtained in rats fed with the control diet (1.66±0.11 g/l). These results are shown in Figure 2.

Effect of *B. sapida* aril powder level in diet on plasmatic total-cholesterol, LDL-cholesterol and HDL-cholesterol

Total-cholesterol and LDL-cholesterol values obtained in rats fed with diet Bs₅ were 0.98±0.07 g/l and 0.51±0.07 g/l, respectively. These values were significantly high ($p < 0.05$) as compared to that obtained in rats of the control group. The total-cholesterol and LDL-cholesterol found in

Table 2. Rat growth according to *B. sapida* aril powder level in diet.

	Body weight (g)					
	Control diet	Diet Bs ₁	Diet Bs ₂	Diet Bs ₃	Diet Bs ₄	Diet Bs ₅
Week 0	57.9± 5.41 ^a	54.67±5.51 ^a	54.65±5.45 ^a	57.73±5.30 ^a	54.33±5.48 ^a	54.62±5.02 ^a
Week 1	76.55±5.47 ^a	75.04±5.25 ^a	73.54±5.57 ^a	76.92±5.27 ^a	58.23±5.41 ^b	59.23±4.97 ^b
Week 2	108.26±5.32 ^a	105.05±5.67 ^a	107.82±5.49 ^a	110.56±5.37 ^a	85.44±5.53 ^b	50.96±5.10 ^c
Week 3	120.03±5.01 ^a	127.41±5.54 ^a	128.96±5.51 ^a	135.96±5.32 ^a	97.32±5.56 ^b	52.25±4.98 ^c
Week 4	131.4±5.49 ^a	143.32±5.60 ^a	150.42±5.58 ^a	154.97±5.29 ^a	93.72±5.54 ^b	60.55±4.89 ^c

Means with same letter are not significantly different; a, b and b, c indicate mean which are significantly different ($p < 0.05$); a, c are mean which are very significantly different ($p < 0.001$). Growth evolution of animals fed with the diets Bs₁, Bs₂ and Bs₃ were respectively similar to those of the control group ($p > 0.05$) while growth of rats fed with the diets Bs₄ and Bs₅ was relatively low as compare to that of the control group.

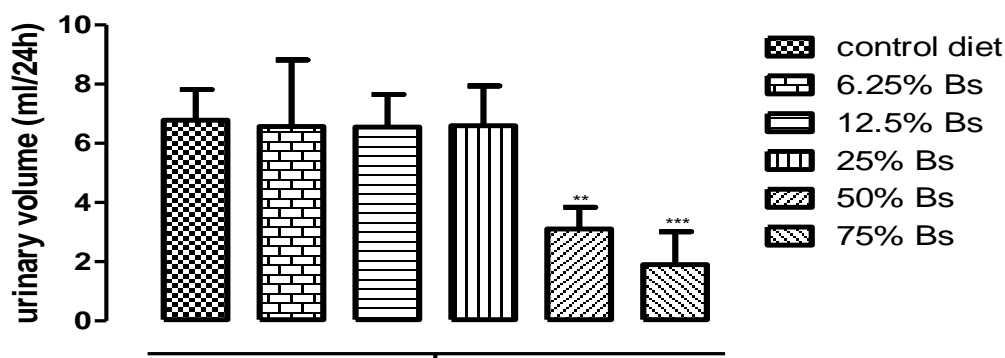


Figure 1. Urine volume in relation to the diet consumption. The urine volumes obtained from rats fed with diet Bs₁, Bs₂ and Bs₃ were not significantly different ($p > 0.05$) from that obtained from rats fed with control diet. But in rats fed with Bs₄ and Bs₅ urine volumes were respectively high ($p < 0.05$) and very high ($p < 0.001$) when compared with that obtained from rats fed with the control diet. (**): high variation; (***): very high variation.

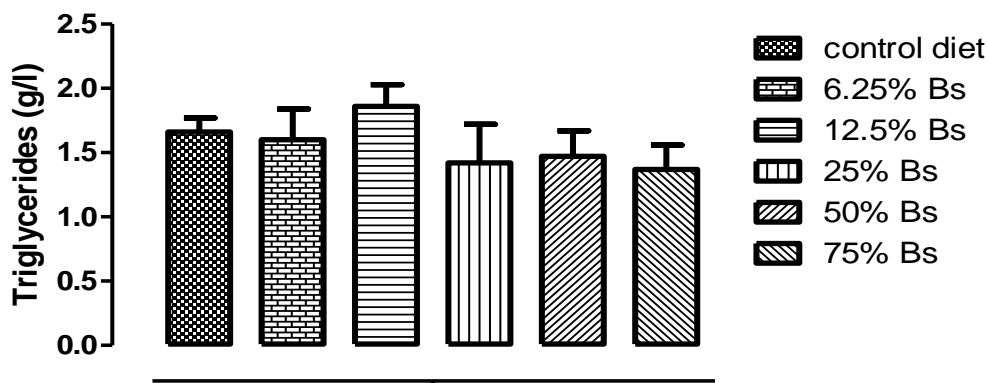


Figure 2. Effect of *B. sapida* aril powder level on plasmatic triglycerides. Plasmatic triglycerides values were not significantly ($p > 0.05$) different from that obtained in rats fed with the control diet.

rats of the control group were 0.88 ± 0.07 and 0.40 ± 0.00 g/l, respectively.

The values of total-cholesterol found in rats fed with diets Bs₁, Bs₂, Bs₃, Bs₄ and Bs₅ were 0.82 ± 0.11 , 0.84 ± 0.05 , 0.80 ± 0.03 , 0.78 ± 0.05 and 0.98 ± 0.07 g/l,

respectively. These values were not significantly different ($p > 0.05$) when compared with that of the control group. The variation of LDL-cholesterol in the experimental group was not significantly different ($p > 0.05$) from those obtained in the control group. These values were

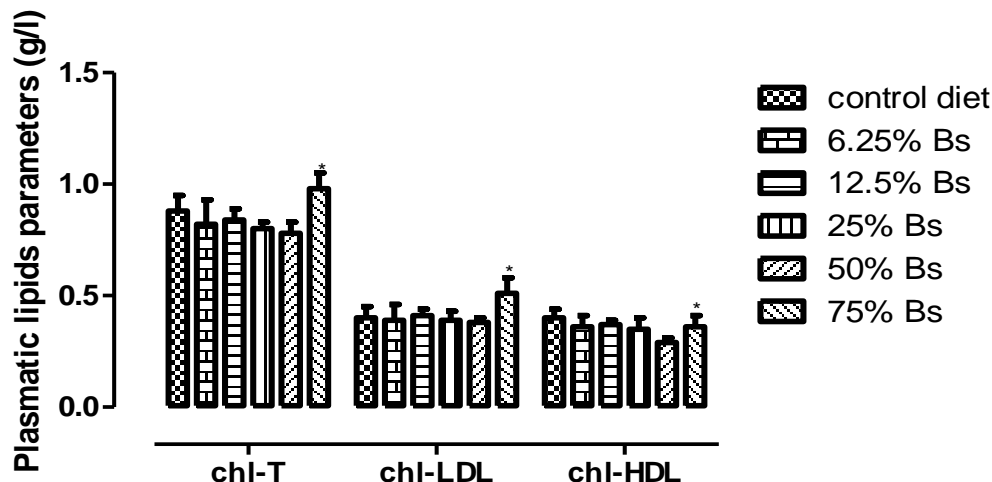


Figure 3. Effect of *B. sapida* aril powder level on plasmatic total-cholesterol, LDL-cholesterol and HDL-cholesterol. Significant augmentation ($p < 0.05$) of total-cholesterol, LDL-cholesterol and HDL-cholesterol in rats fed with diet Bs₅ as compared to that obtained in rats of the control group was observed. (*): Significant augmentation.

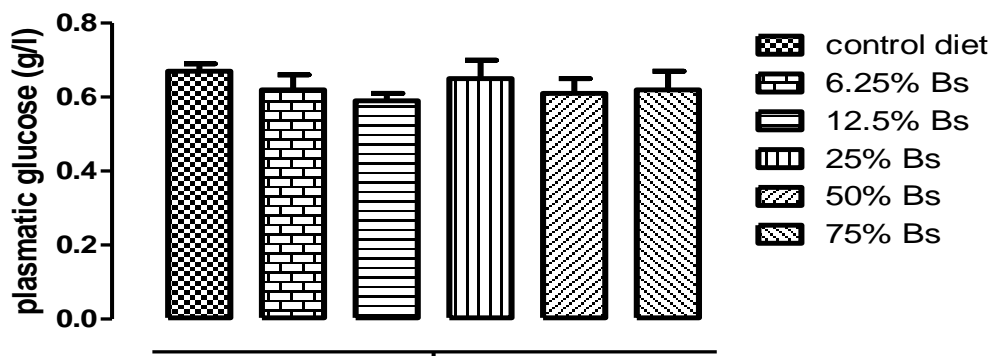


Figure 4. Effect of *B. sapida* aril powder level on plasmatic glucose. Plasmatic glucose values were not significantly ($p > 0.05$) different from that obtained in rats fed with the control diet.

0.39±0.07 g/l for diet Bs₁, 0.41±0.03 g/l for diet Bs₂, 0.39±0.04 g/l for diet Bs₃, 0.38±0.02 g/l for diet Bs₄ and 0.51±0.07 g/l for diet Bs₅.

The values of HDL-cholesterol found in rats fed with diets Bs₁, Bs₂, Bs₃, Bs₄ and Bs₅ were 0.36±0.05, 0.37±0.02, 0.35±0.05, 0.29±0.02 and 0.36±0.05 g/l, respectively. These values were not significantly different ($p > 0.05$) when compared with that of the control group. The effect of *B. sapida* aril powder level on plasmatic total-cholesterol, LDL-cholesterol and HDL-cholesterol is shown on Figure 3.

Effect of *B. sapida* aril powder level diet on plasmatic glucose

Plasmatic glucoses level obtained were 0.62±0.04 g/l for

rats fed with diet Bs₁, 0.59±0.02 for rats fed with diet Bs₂ g/l, 0.65 ± 0.05 g/l for rats fed with diet Bs₃, 0.60±0.04 g/l for rats fed with Bs₄ and 0.62±0.05 g/l for rats fed with diet Bs₅. These values were not significantly different ($p > 0.05$) from that obtained in rats of the control group which was 0.67±0.02 g/l (Figure 4).

Effect of *B. sapida* aril powder level in diet on plasmatic protein

Plasmatic protein obtained in rats fed with diets Bs₁, Bs₂, Bs₃, Bs₄ and Bs₅ were not significantly different ($p > 0.05$) from that obtained in rats fed with the control diet. These values were 68.50±2.74 g/l for rats fed with control diet, 77.00±5.40 g/l for rats fed with diet Bs₁, 72.17±4.26 g/l for rats fed with diet Bs₂, 71.00±1.79 g/l for rats fed with diet

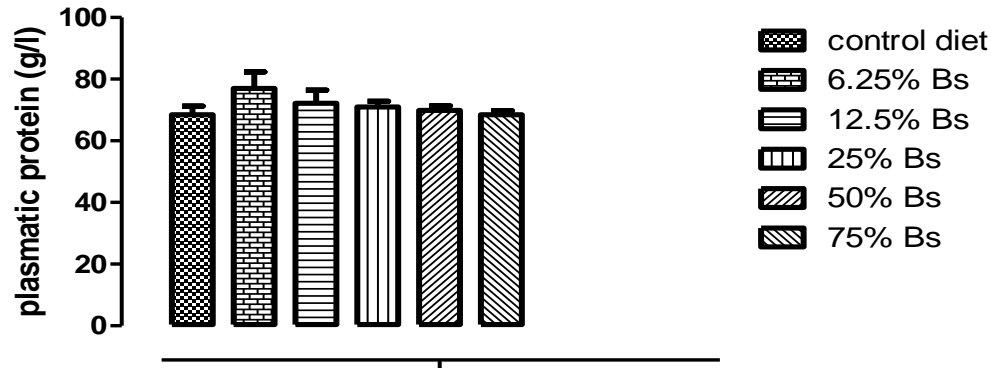


Figure 5. Effect of *B. sapida* aril powder level on plasmatic protein. Plasmatic protein values were not significantly ($p > 0.05$) different from that obtained in rats fed with control diet.

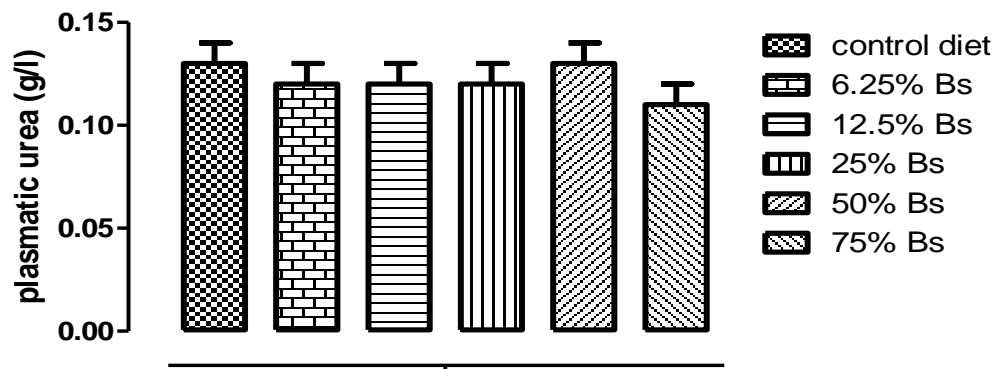


Figure 6. Effect of *B. sapida* aril powder level on plasmatic urea. Plasmatic urea values were not significantly ($p > 0.05$) different from that obtained in rats fed with the control diet.

Bs₃, 69.83±1.47 g/l for rats fed with diet Bs₄ and 68.50±1.89 g/l for rats fed with diet Bs₅ (Figure 5).

Effect of *B. sapida* aril powder level in diet on plasmatic urea

Plasmatic urea obtained in rats fed with diets Bs₁, Bs₂, Bs₃, Bs₄ and Bs₅ were not significantly different ($p > 0.05$) from that obtained in rats fed with the control diet. These values were 0.13±0.01 g/l for rats fed with control diet, 0.12±0.01 g/l for rats fed with diet Bs₁, 0.12±0.01 g/l for rats fed with diet Bs₂, 0.11±0.01 g/l for rats fed with diet Bs₃, 0.13±0.01 g/l for rats fed with Bs₄ and 0.11±0.01 g/l for rats fed with Bs₅ (Figure 6).

DISCUSSION

The absence of growth difference in rats fed with experimental diets (diets Bs₁, Bs₂, Bs₃, Bs₄ and Bs₅) in comparison with growth of rats fed with the control diet could be explained by the fact that these diets are also

nutritiously rich. In fact, the different diets may contain satisfactory nutriment elements such as carbohydrate, lipid, vitamin and mineral which are favorable for good growth (Basiotis et al., 2002; American Dietetic Association, 2007; Cindy et al., 2013).

As for rats fed with diets Bs₄ and Bs₅, growth retardation was noticed when compared with the growth of rats fed with the control diet. This growth retardation was higher among rats fed with diet Bs₅ than those fed with diet Bs₄. However, the coat of all rats was natural. Growth retardation in rats fed with diets Bs₄ and Bs₅ may be the result of an inadequate alimentation due to a deficiency of some nutritional elements (IRD, 1996; Katona and Mokhda, 1998; Lefere, 2000). It may be a deficiency of protein (FAO/WHO, 2007). In fact, according to an analysis of the nutritional composition of dry *B. sapida* aril made by Ouattara et al. (2010) the protein content was 11.99±1.12 g/100 g. This protein content is lower than the one recommended by the Food Agriculture Organization (FAO, 2003) which must be between 12 and 15% in diet. The mixtures of control diet with freeze-dry aril correspond to a diminution of protein in diet. So, when the substitution of the control diet by the

freeze-dry aril is important, the diminution of protein content in the diet obtained is higher. This clearly explains the best growth of rats which consumed the diet Bs₄ than those which consumed the diet Bs₅. Protein restriction in diets Bs₄ and Bs₅ was very important than protein content of the other diets (control diet, diets Bs₁, Bs₂ and Bs₃) so that it has caused malnutrition due to the deficiency of protein or some amino acids (Drewnowski, 2005). The deficiency of protein or some amino acids justify the growth retardation observed in rats fed with these diets (diets Bs₄ and Bs₅) than the growth of rats which consumed the other diets (control diet, diets Bs₁, Bs₂ and Bs₃). But, no death was observed in the groups of rats fed with diets Bs₄ and Bs₅: this suggests that *B. sapida* aril powder contain adequate quantity of protein and nutritional elements easy to use by the rats fed with these diets (diets Bs₄ and Bs₅) even if they do not particularly have sufficient protein.

The absence of lipids level in rats fed with diets Bs₁, Bs₂, Bs₃ and Bs₄ as compared to that obtained in rats fed with the control diet suggested that lipids have been used as source of energy in order to satisfy the energy need of the animal instead of the decrease of carbohydrate in diets. Nevertheless, lipids level obtained in rats fed with diet Bs₅ is higher when compare with that obtained in rats of the control diet. This situation is due to the lipids abundance in the diet Bs₅ and to the fact that they have not been all utilized as source of energy: they may be accumulated in the rats fed with this diet and then they increased the level of total-cholesterol and LDL-cholesterol. Since no death was noticed, the freeze-dry aril can be used as a palliative to prevent untimely death in the case of lack of food.

Conclusion

Consumption of *B. sapida* aril powder does not affect the growth of rats until the degree was approximately 50%. At a degree near the value of 50% and above, body weight and growth are affected. At these values of consumption, a rate of total-cholesterol and LDL-cholesterol is noticed. This rate is due to the high content of the diet on fat based on aril. So, *B. sapida* aril should be consumed with moderation to improve body wellbeing. Therefore, it cannot absolutely be utilized as a palliative to the lack of food but it can contribute to avoing untimely death in the case of lack of food.

Conflict of interest

The authors did not declare any conflict of interest.

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