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NUTRITIONAL PARAMETERS OF RATS FED BY THE DRIED CATERPILLARS IMBRASIA OYEMENSIS'S FLOUR

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Objective: The aim of this study was to evaluate the nutritional quality of the meal Imbrasia oyemensis dried caterpillars and consumed in the Central West of Cote d'Ivoire. Three groups of young Wistar rats growing fed during 21 days with 3iso-caloric diets (4200 Kca) and differented only by the quality of their animal protein. Two diets isoprotein consist of caterpillars and fish and each containing protein while the third deprives protein have been used. The 5 last days of the experimental period were used to make the nitrogen balance. The nutritional parameters that are: ponderal growth, total protein ingested, the coefficient of efficiency and proteic CEP or food CEF or weight gain WG were determined. Ingesting these foods induces growing about 2 protein diets: 0. 39±0.06 g/j for the caterpillar's diet and 0.32±0.09 g/j for the fish one and decreased weight for the diet without protein of 0.32±0.09 g/j. The others parameters were respectively for fish and caterpillars: 5.44±0.26 g/day and 5.45±0.32g/day concerning the MSI; 0.544±0.026 g/day and 0.545±0.032 g/day for PTI; 0.059±0.017 and 0.0732±0.122 (CEF); 0.59±0.175 and 0.73±0.12 for the CEP. The two diets digestibilities were 85% for the caterpillars and 88% for the fish one. The biological value of caterpillar was 92%. There isn't any significant difference ($p \leq 0.05$) between all those values.

Keywords: Nutritional quality, Animal protein, Growing

INTRODUCTION

Protein-energy malnutrition stands at the forefront of eating disorders and is a serious challenge for the food security of African states (Desjardins-Requir, 1989; and Bobby, 2002). Indeed, the high costs of regular food protein (meat and fish) are an obstacle for nutrition and thus the development of these countries (FAO, 1998). Ivory Coast, developing country located in West Africa, suffers from this scourge. This finding requires the search for other sources of lower cost proteins and accessible to all (FAO, 2003 and 1998). The caterpillar Imbrasia oyemensis by its high protein, minerals, fat can locally be a credible alternative to fight effectively against this food insecurity (Latham, 2001; Malaisse *et al.*, 2003; FAO, 2008; and Amon *et al.*, 2009). In view of extension of the consumption of these animals, animal testing is conducted to assess the nutritional qualities attributed to them. Thus, nutritional assessment of flour Imbrasia oyemensis dried through animal testing in young Wistar rats was conducted in growth.

MATERIALS AND METHODS

Animal Material

The animals are male Wistar rats strain growing. They come from the Nutrition and Pharmacology Laboratory pet's of

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University Felix Houphouet-Boigny. The rats are housed in individual cages metabolism screened funds that enable the selection of feces upstream and downstream collecting urine flowing into jars by a fixed funnel. The cages are equipped with racks and bottles for feeding rats.

Ingredients

The ingredients used in this study are: corn starch "Mazeina" and corn oil are used to make the diets prepared for nutritional equal energetic tests. Mineral standard mixtures (U.A.R. 205) and vitamins (U.A.R. 200) are added to the systems; Sugar is used to make various attractive schemes; of agar has also been used as ballast. All these products are from trade. The tracks used and commonly called "zégré" come from the city of Zuénoula in the Central West of Côte d'Ivoire. They were harvested, dried in an oven at 70 °C for 24 hours. Then they were ground in a Moulinex blender for flour dried caterpillars. Fish meal was produced in the same manner as flour caterpillars, from fish (herring) expense, purchased commercially (Table 1).

Table 1: Overall Composition of Fish and *Imbrasia oyemensis* Flour

Parameters	Fish Flour	Caterpillar Flour
Moisture (g/100 g de MF)	11.00 ±0.90	7.09±0.02
Ash (g/100 g de MS)	9.47 ±1.05	2.36±0.03
Fat (g/100 g de MS)	11.01± 0.94	23.10±0.65
Proteins (g/100 g de MS)	61.20 ±2.18	55.49±0.175
Carbohydrates (g/100 g de MS)	6.30 ±0.64	11±0.1
energy values (Kcal/100 g de MS)	524±2.17	476.96±3.47

Methods

Formulation of Food Diets

This work was a quality of a food protein studies. Thus in different diets(with protein), the protein content is 10% with an energy level equal to 4.200 kcal/kg of dry matter. The proportions of carbohydrate and lipid diets are obtained by calculation. And that, in order to meet the caloric level required plans, taking into account energy carbohydrate intake (4 kcal/1 g), fat (9 kcal/1 g) and protein (4 kcal/1 g). All three diets were equal-caloric (4200 kcal) and only those fish and caterpillars contained equal protein (10%) (Adrian *et al.*, 1991).

Table 2: Composition of Different Experimental Diets

Components	Protein-Free	Fish Flour (Control)	Caterpillars Flour
Proteins (g)	0	163.158	180.212
salt mixture (g)	40	40	40
Vitamin mixture (g)	10	10	10
Shop sugar (g)	350	350	350
Agar(g)	5	5	5
Corn oil (ml)	50	50	50
Corn starch (g)	580	416.84	399.79
Protein content (%)	0	10	10
Total DM (g)	1000	1000	1000
Energy in kcal	4200	4200	4200

Batch Creation of Animals and Animal Testing

The experiment was conducted according to the method of Adrian *et al*. (1991). It comprises two distinct phases: a growth phase of 21 days and another check carried out on the last 5 days of the first. The experimental room had a temperature of 26 °C with humidity between 70 and 80% and illuminated continuously for 12 h. Each diet corresponded a lot of 7 in growing rats.

Driving Experience and Steps to Perform

Diets are distributed once a day at 8 AM in puree form to avoid waste. Water is served and renewed at three-day intervals. At the start of the experiment, the animals are first weighed, and then they were all three days. Growth was determined by the difference between the final and initial weight. The difference between the amounts of food served and the remains (including losses) on the dry material was used to determine the amount consumed. During the experiment nitrogen balances, urine and feces are collected daily, weighed and stored at -10 °C for analysis. During this period, consumption and growth measures and the collection of feces and urine are performed individually on animals. Animal feces of the same diet are weighed, dried in an oven at 70 °C for 24 hours, crushed and mixed to the determination of total nitrogen. The urine of rats the same diet were collected, weighed and then a few drops of hydrochloric acid 0.1 N and stored in the freezer for the determination of total nitrogen.

Nutritional Evaluation

Growing (G): Expressed in g /day, Growing represents the difference between the final weight and the initial weight of the animals divided by the duration of the experiment in days.

G (g/d) = (Final weight – Initial weight)/Number of days.

Total Dry Matter Intake (TDMI): The amount of TDMI (g) represents the total amount of food ingested in the form of solids by the animal during the duration of the experiment. It expression in g/day is obtained by dividing the amount of TDMI (g) by the duration of the experiment.

TDMI (g/day): Sum of the amounts of dry matter (of food) eaten during the period of experimentation/number of days.

Total Protein Intake (TPI): TPI represents the amount of dietary protein intake during the duration of the experiment. TPI (g/day) are obtained by dividing the TPI (g) by the duration of the experiment

TPI (g/day) = TDMI x Percentage of protein in the diet/ Number of days.

Feed Efficiency Coefficient (F.E.C): FEC is calculated by dividing growing (g) and the amount of TDMI (g). It reflects the efficiency with which the food is assimilated. FEC is obtained by the ratio of the growing (g/d) and PTI (g/d).

$$F.E.C = \frac{\text{G}}{\text{T.D.M.I}}$$

Protein Efficiency Ratio (PER): It reflects the efficiency of the use of the protein diet.

$$P.E.R = \frac{\text{G}}{\text{TPI}}$$

Digestibility: Protein digestibility is calculated from the coefficients of apparent (CUDA) and real (CUDr) digestibility.

CUDA is the difference between the amounts of fecal protein and dietary protein reported food protein multiplied by 100

$$CuDa = \frac{\text{I - F}}{\text{I}} \times 100$$

The CUDr meets the same expression but considers fecal protein from animals consuming diets without protein. These proteins are deducted from the total fecal proteins.

$$CuDr = \frac{\text{I} - (\text{F} - \text{Fsp})}{\text{I}} \times 100$$

Protein Net Utilized (PNU): It represents the proportion of food proteins that are retained by the body.

$$PNU = \frac{\text{I - (F - Fsp) - (U - Usp)}}{\text{I}}$$

Biological Value (BV): It corresponds to the proportion of absorbed protein that is retained by the body.

$$\text{BV} = \frac{\text{I - (F - Fsp) - (U - Usp)}}{\text{I - (F - Fsp)}} \times 100$$

F = Proteins excreted in the feces of a subject other than that submitted to protein-free diet.

FSP = Proteins excreted through the feces of a subject being protein-free diet.

U = Proteins excreted in the urine of a subject other than that submitted to protein-free diet.

Usp = Proteins excreted in the urine of a subject being protein-free diet.

Statistical Analysis

Analysis of data was done using STATISTICA 6.0 software. Comparing the average was due to test Newman Keuls with a significance level set at 5%.

RESULTS

Total Dry Matter Intake (TDMI)

The TDMI amounted to 5.44±0.26 g/d for fish diet; and showed no significant difference ($p \geq 0.05$) with that obtained for the regime caterpillars 5.45±0.32 g/day (Table 3).

Total Protein Ingested (TPI)

The intake level obtained with the system tracks is 0.545±0.032 g/d and that of the fish diet is 0.544±0.026 g/d. Statistical analysis indicated that there was no significant difference between these two values ($p \geq 0.05$) (Table 3).

Table 3: TDMI and TPI of Different Diets

Parameters	Fish Diet	Caterpillar Diet
TDMI (g/d)	5.44±0.26[a]	5.45±0.32 [a]
TPI (g/d)	0.544±0.026[a]	0.545±0.032[a]

Each value is the mean ± standard deviation of seven rats; there is no significant difference ($p \geq 0.005$) between two values lying on the same line.

Weight Evolutions and Growing (G)

The growths rats are regular during the experimental period (Figure 1).

All animals except those fed diet without protein have magnified. Growings are similar with 0.32±0.09 g/day for fish diet and 0.39±0.06 g/day for the caterpillars (Figure 2). Statistical analysis indicated that there was no significant difference between these two values ($p \geq 0.05$).

Figure 1: Body Growth Curves of Rats Fed the Different Diets

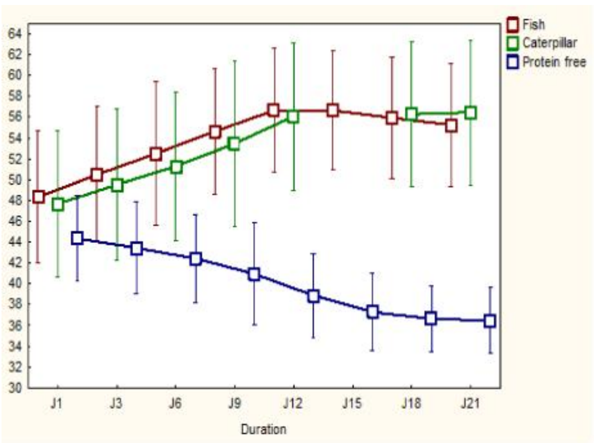
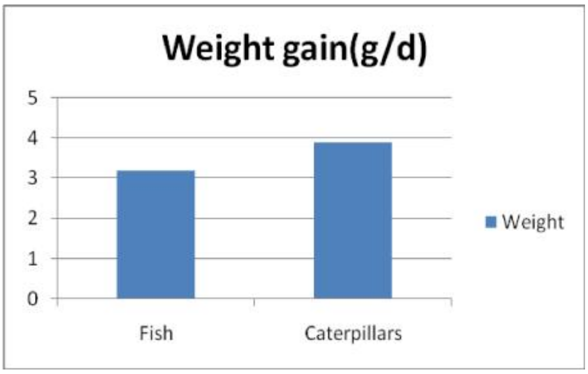


Figure 2: Growing for Caterpillars and Fish Diets



Feed Efficiency Coefficient (FEC)

The FEC is 0.073±0.012 and 0.059±0.017 respectively for the caterpillars and the control diet. These two values are not significantly different ($p \geq 0.05$) (Table 4).

Table 4: FEC and PER Values

Parameters	Fish's Diet	Caterpillar's Diet
FEC	$0.059 \pm 0{,}017^{a}$	0.0732 ± 0.122^{a}
PER	0.59 ± 0.175^{a}	0.73 ± 0.12^{a}

Protein Efficiency Ratio (PER)

The PER for caterpillar's diet is 0.732±0.122 and the fish diet is 0.592±0.17. Statistical analysis indicated that there was no significant difference between the two values ($p \geq 0.05$) (Table 4).

Protein Digestibility

Apparent digestibility (CUDa) for the control diet (fish) amounted to 0.88±0.18 and the caterpillars's one is 0.85±0.167. It is the same for true digestibility (CUDr) whose values are respectively 0.194±0.93 and 0.91±0.19 for the control and caterpillars diet. As for the protein retention, its value amounted to 3.69±0.22 for the control diet and 2.91±0.198 for caterpillars. The practical use of nitrogen's value was 0.89±0.178 and 0.79±0.162 respectively for the control diet and the caterpillars. The biological value had a value of 95±0.198% for the control and 92±0.19% for the caterpillars.

Statistical analysis indicated that there was no significant difference between the values of the control schemes and caterpillars ($p \geq 0.05$) (Table 5).

Table 5: Nutritional Parameters of Nitrogen for Different Experimental Diets

Parameters	Fish's Diet	Caterpillar's Diet
CUDa	0.88 ± 0.18^{a}	0.85 ± 0.167^{a}
CUDr	0.93 ± 0.194^{a}	0.91 ± 0.19^{a}
Protein retention (Pr)	3.69 ± 0.22^{a}	2.91 ± 0.198^{a}
Protein net utilized (PNU)	0.89 ± 0.178^{a}	0.79 ± 0.162^{a}
Biological value (%)	95 ± 0.198^{a}	92 ± 0.19^{a}

Each value is the mean ± standard deviation of seven rats. The values in lines with the same superscript letter are not significantly different ($p \geq 0.05$).

DISCUSSION

The characterization tests performed in previous work indicates that caterpillars *Imbrasia oyemensis* are rich in protein and fat (Foua Bi *et al.*, 2015). The nutritional parameters such as total dry matter intake (TDMI), growing (G), the FEC and PER, the apparent (CUDA) and real (CUDr) digestibility, net protein used (PNU) and the biological value (BV) seem to reinforce this view. Nitrogen balances caterpillars are significantly identical ($p \geq 0.05$) than fish taken here as reference protein because of its high nutritional value. The Three (3) diets (control, caterpillars and protein-free) TDMI of these rats were not statistically different in pe"0.05 assuming thereby ingesting the same appetite for these plans. Food consumption depends on several factors including the physiological state of the body as well as factors related to the characteristics of foods such the aroma, flavor and chemical composition (Jacob, 1981). It could be that the sugar added to all plans, to enhance their flavor, in part, the absence of differences between the amounts of food consumed in these plans. However, by the results, this consumption created different effects on other nutritional parameters and would be linked to the nature of the plans. Indeed, it is of interest for the determination of endogenous nitrogen amounts excreted in feces and urine of the protein-free diet rats. Unlike rats fed caterpillars and the witness where it generates weight gain (GP) respectively of 0.39±0.06g/day and 0.32±0.09 g/day. This weight gain could well substantially protein origin.

First, it would be influenced by the large quantities of total dry matter and total protein intake for these 2 protein diets (Agbessi *et al.*, 1987; and FAO, 1998). Indeed, caterpillars and fish are rich in protein (with rates of 55.49 g/100 g DM and 61.20 g/100 g DM of protein). This correlation consumption proteins-weight-gain is clearly justified because proteins are essential nutrients for healthy growth of organs (Rahman *et al.*, 2005). These comments were made by Bouafou *et al*. (2007), Méité *et al*. (2008), Dally *et al*. (2010) and Ouattara *et al.* (2010) which confirmed the interest of the protein administered to rats. Then, physiologically, weight gains seen with caterpillar diet could indicate a steady development of cellular metabolism with efficient synthesis of rat's clean material (Kiki-M'Vouaka *et al.*, 1988; and Trèche *et al.*, 1994). The growth curves made from the obtained mean values are materializing more precise physiological states and the weight of growing rats and allow deducing the qualitative aspects of these caterpillars. Also, the caterpillar's coefficients of food and protein efficiency (FEC and PER) allow to enjoy the best performance of the use of ingested food. They have statistically identical values ($p \geq 0.05$) for the control diet and caterpillars (0.073±0.01 against 0.059±0.01 for FEC and 0.73±0.12 against 0.59±0.17 for PER). These observations lead to two essential points: first, the caterpillar diet is well accepted by these rats because growth allows better weight gain with values close to those observed in control rats. On the other hand, it is better tolerated because no indigestion or diarrhea was observed thus demonstrating its relative digestibility. Apparent digestibility (CUDA) has a higher value than those obtained on the maggots flour dried diet (86%) by Bouafou *et al.* (2008), but less than those obtained by Dally *et al.* (2010) (95%) on 3 Ivorians dishes. Indeed, baking would cause an improvement of organic matter involving improved digestibility cooked systems (Vidal-Valverde, 1994). But in reality, this low digestibility (CUDr) could be explained by the low organic content of these animals which facilitate and speed up their intestinal transit (Afass, 2002; and Carolle *et al.*, 2013). However the nutritional value in the strict sense of a protein is estimated by the percentage of nitrogen ingested used for protein synthesis (Beaufrere, 1993). This Protein net utilized takes account both of the digestive and metabolic utilization of dietary protein and measuring the proportion of protein ingested is used for tissue synthesis (Blaivacq, 2004). Net proteins used in these two regimes are both statistically equal, indicating that they are well assimilated by growing rats for their quantitative and qualitative needs. This may entail a good biological value for the caterpillars. The biological value (BV) measures the proportion of absorbed protein that is retained for various syntheses (Darmau, 1993). The caterpillars (92%) close to that of beef (94%) but remain lower than that of the egg (100%) (FAO, 1998) and tends to confirm the high nutritional value of these animals. In other words, equivalent to nitrogen supply, caterpillar's flour proteins are as bioavailable than the control and reflect a more efficient metabolic utilization of tracks for young rats. These observations confirm that the nutritional value of food protein depends on both their availability and balance of their essential amino acids (Tremolieres, 1977; Borys, 2001; and Apfelbaum, 2004). All these results are the same direction as those obtained by Bouafou (2007) with the fishmeal protein typically used in animal feed and those obtained with casein protein by Dally *et al*. (2010).

CONCLUSION

The company animal experiment was used to assess the nutritional quality of the tracks. These results, taken together, express and confirm the good nutritional value caterpillars studied. However, they do not take into account the state of the essential nutrition of regulatory bodies for the proper functioning of the body and little about the metabolism of these animals. In view of the above, an exploratory study of blood parameters and physiological regulatory bodies of the nutrition needed.

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