PROFILE IN AMINO AND FATTY ACIDS OF *BUNAEOPSIS AURANTIACA* CATERPILLARS EATEN IN SOUTH KIVU PROVINCE, EASTERN OF THE DEMOCRATIC REPUBLIC OF CONGO

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Abstract

A survey on the particular importance of aminoacids and fatty acids component caterpillars' Bunaeopsis aurantiaca, nowadays much more eaten by the South Kivu province people was assessed during the investigation. Samples of caterpillars formed by 150 specimens last stage were harvested in their ecological environment, brought to the laboratory and dried at 65°C for 72 hours and then incinerated in an oven at 550°C. Dry matter of the larvae obtained were analyzed by methods for protein and Kjeldal Folch for lipids. This study shows that Bunaeopsis aurantiaca caterpillars are excellent nutritional potential. These excavators are composed of 49.47% protein and content in its profile 5 major essential amino acids: aromatic amino acids (phenylalanine + tyrosine) 5.23g/16N, lysine 2.40g, 2.33g leucine and threonine 2.17 g/16N. 24.19% fats contain saturated and unsaturated acids amounting to 50.05% and 47.78% respectively of the total fatty acids, and 2.16% of other unidentified acids. Rich in polyunsaturated fatty acids: oleic acid C18: 1 ω9 40.28% and linoleic acid C18: 2 ω6 6.58%. Saturated fatty acids are represented by 38.53% of stearic acid; most abundant monitoring palmitic acid 10.05%. The overall results show that caterpillars Bunaeopsis aurantiaca are an important source of nutrients that can contribute to the harmonious development of human organism. The nutritional value is similar to that of meat and fish that are more costly for the poorest. Development of complementary foods made from flour caterpillars to overcome cultural constraints, should better offer to children and adults, for their significant nutritional value. Thus, in communities that are not accustomed to eating whole insects, pasta recipes and pellets could be better accepted.

Keywords: caterpillars, amino acids, fatty acids, nutritional value

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1. INTRODUCTION

Malnutrition remains one of the main concerns of global forums. The United Nations has also made a priority (objective 1 of the 8 Millennium Development Goals) (United Nations, 2011; FAO, 2004; Lavalette, 2013). Today, it is estimated that more than 800 million human beings suffer by undernourished (FAO, 2010). This affects some countries more than others: some areas in South America (Bolivia, Paraguay, Peru), Asia (Mongolia, Pakistan), but mainly in Africa (WFP, 2011). It is in Central Africa (Ethiopia, Mozambique, DR Congo, Chad...) that remain the highest rates of malnutrition and undernutrition in the world.

Currently, in many parts of Africa, undernourished are particularly deficient in animal protein while the daily protein intake for a man of 70 kg should be minimum of 22 g (Nkouka 1987; Desjardin-Requir, 1989; Kinkela and Bézard, 1993; WHO, 2004). In the Democratic Republic of Congo, malnutrition deficiency in protein and energy continues to remain an important public health problem, as witnessed by the results of EDS 2007 survey (MAG 13%), MICS4 2010 (MAG 11%) and all provinces are hit with prevalence protruding the action level (MAG>10%) (Pronanut, RDC, 2012). In order to improve protein and energy intake in developing countries, the solution will not come from conventional breeding too expensive water in place and strong producer of emissions. We must therefore turn to alternative solutions: the harvest, consumption and rearing of insects are one of these solutions (Van Hui, 2013; Lavalette, 2013). Many studies have shown that the nutritional value of entomophagy (Bodenheimer, 1951) is not just the wealth of insect protein, but also in their lipid quality, rich in minerals (Fe, Zn, Ca and P), as well as strong vitamin content (Adedire and Aiyesamni 1999; Malaisse and Parent, 1980; Mbata and Chidumayo, 2003). Similarly, the individual caterpillars are likely to offer to man the nutrients (amino acids, fatty acids, vitamins, minerals and sugars) necessary for its nutritional balance as evidenced by several authors for Africa: Mabossy- Mobouna *et al.*, 2017; Paiko *et al.*, 2014; Anvo *et al.*, 2016; Agbidye and Nongo, 2009, 2012; Akinnawo and Ketiku, 2000; Akinnawo *et al.*, 2002; Ande, 2003; Ande and Fasoranti, 1998; Badanaro *et al.*, 2004; Igbabul *et al.*, 2015; Malaisse, 1997; Muvundja *et al.*, 2013; Odebiyi *et al.*, 2003; Odeyemi and Fasoranti, 2000; Omotoso, 2006; Osasona and Olaofe, 2010; Ombeni and Munyuli, 2016; Dooshima *et al.*, 2014. Among the species of caterpillars most eaten by the riparian population of the Congo Basin in general and South Kivu in particular, the species *Bunaeopsis aurantiaca* (family saturnidés), known locally as of "Milanga" is more dominant in the diet of lega (a dominant Kivu forest tribe). Recently consumption frequency was reported in South Kivu by Ombeni and Munyuli (2016); Ombeni, (2015), consumption and evaluation of its overall nutritional value lined for the first time in South Kivu by Muvundja *et al.* (2013) in his study on the value of edible caterpillar *Bunaeopsis aurantiaca* in forests community management of South Kivu in DR Congo. He describes the harvest areas, biological material (taxonomy) and the host plant of this caterpillar species. These results exhibit the overall chemical composition of caterpillar B. *aurantiaca*, being rich in proteins (49%), containing 24.2% fat, 4.5% sugars and 3.2% total mineral matter in weight dry. The energy value of 100 g of dry matter of the food was evaluated according to him to 433 kcals. His study is limited to the overall chemical composition (i.e. protein, fat, carbohydrates, total ash, moisture and energy intake) caterpillars *Bunaeopsis aurantiaca* integral to this investigation. View the increase in consumption of this caterpillar species in the population, the part it plays in human diet and for future project development of complementary food for children based on its flour (Ombeni, 2015), Mapping detailed establishment of the physico-chemical and nutritional composition of the caterpillars' *Bunaeopsis aurantiaca* would be possible.

Thus, in this work the content and composition of amino acidic proteins and fatty acids lipids of caterpillars' *Bunaeopsis aurantiaca* will be evaluated to contribute a little more to their valuation as part of nutritional rehabilitation our vulnerable populations. Finally it will be a lasting solution to the issue of malnutrition remains a brake on development (WHO, 2003, 2004; Stevenson *et al.*, 2007).

2. MATERIALS AND METHODS

Field equipment

Jars of 5 liters, covered with 2 mm mesh were used to store caterpillars from their ecology areas.

Biological material

The biological material consists of one hundred and fifty (150) specimens of caterpillars *Bunaeopsis aurantiaca* last stage (photo 1a, b) harvested in the field (ecological environment) in the forest part of Mwenga territory not far from the capital (Kamituga) South Kivu province, dated January 22, 2015, transported within 48 hours to the laboratory for pretreatment chemical analyzes. This insect species lives at the expense of "False Mangrove" (« Faux Palétuvier » in French), whose scientific name is *Uapaca guineensis* Müll. Arg. (Balagizi, 2012; Burkill, 2004).

Photo 1: Edible caterpillar last stage *Bunaeopsis aurantiaca* "Milanga" harvested Kamituga: (a) dorsal view of the insect (b) ventral view of the insect (Muvundja *et al.*, 2013).

Photo 2: Adult butterfly *Bunaeopsis aurantiaca* (Mike Newport, 2010 taken byhttp://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxid=94555 and Muvundja *et al.*, 2013)

Method and study area

The collected caterpillars were analyzed at General and Organic Chemistry Laboratory of Food Science and Technology Department, Jomo Kenyatta University of Agriculture and Technology (JKUAT), Nairobi, Kenya.

Determination of amino acid composition and chemical index

Specimens collected were dried an oven at 65°C for 72 hours to constant weight after two consecutive weightings, then crushed using a porcelain mortar for caterpillar flour.

Crude protein was determined by Kjeldahl nitrogen method. Content of crude protein (CP) or total brute protein (PTB) was determined by multiplying 6.25 by the nitrogen content obtained using a Kjeltec autoanalyzer (method 981.10, AOAC, 1990). The amino acids obtained after hydrolysis were determined by the method of Moore *et al.* (1958) on one type of device Biochrom 20 Alpha Plus. Non-sulfur amino acids were quantified after acid hydrolysis for 24 hours at 110°C under nitrogen in 6N HCl containing 0.1% phenol.

For against, because of their instability in hydrochloric acid medium, the sulfur-containing amino acids (cysteine and methionine) were measured after oxidation with performic acid (Lewis, 1966) (conversion to cysteic acid and methionine sulfone respectively) and acid hydrolysis for 24 hours at 110 ° C in the presence of 6N HCl containing 0.1% phenol. Tryptophan was determined separately after 15 hours of hydrolysis at 110°C under nitrogen in a solution of $Ba(OH)_2.8H_2O$ with 8.4 G/16ml according Leterme and Monmart, (1990) . The chemical indices were calculated committee of the data based on FAO/UNU/WHO (2007). This calculation gives, according Ngudi *et al.* (2003) a correct prediction of the amount of protein needed to cover the needs of essential amino acids in growing period. The amino acid that has the lowest index is the limiting amino acid of the interest protein.

Lipid extraction, determination of fatty acid and calculating index Iodine

After grinding caterpillars dried, lipids were extracted with chloroform/methanol (2:1 v/v) according to the method of Folch *et al.* (1957) and then concentrated by evaporation at 35°C under reduced pressure using a Buchi type evaporator and weighed. The methyl esters of fatty acids (FAME) were prepared by transesterification catalyzed by boron trifluoride (10mg of sample were placed in Sovirel tubes, diluted in 200Nl of n-hexane and then reacted with 0,5 mL of a 8:55:25 p.m. mixture of n-hexane, dry methanol and methanol to 14% of BF 3 for 90 min. at 70°C. After reaction, 200 Nl of sulfuric acid at 10% w/v and 500 Nl of a saturated solution of sodium chloride were added. The resulting solutions containing the FAME were finally

diluted with 8 ml of n-hexane and analyzed by gas chromatography on an Agilent 6890 chromatograph equipped with an injector cold on-column and an FID detector maintained at 260°C according to the following temperature program: from 55°C to 150°C (30°C/min) then to 150°C to 250°C (5°C/min). Helium was used as gazvector at a flow rate of 1.7 ml/min. The FAMEs were separated on a Varian column CP9205 VF-Wax ms (30m length x 0.25mm internal diameter, df = 0.25 Nm) and identified by comparison of retention times with those of a reference solution containing 37 FAME (CRM47885 Supelco 37 Component FAME Mix). The results are expressed in area% with a 1 response factor for each molecule. The iodine index values were calculated according to the formula AOCS, (1998). This index to determine the degree of total unsaturation of a food fat. It corresponds to the amount in grams of iodine fixed by 100 grams of fat.
All these methods have been applied to aliquots taken on the same animal powder.

Statistical processing and analysis

Collected data processing, seizure and production of crude paintings were made with software Epi info.6.04, XLSTAT and Excel 2007. Quantitative variables are expressed as mean (x) ± standard deviation (s) all indicating extreme values (minimum and maximum). Categorical variables are expressed as numbers and percentages. Comparing calculated percentage and percentage read on the Student table is made with the Student's statistical test (k-1) degree of freedom, with a significance level of 5%.

3. RESULTS AND DISCUSSION

Caterpillars B*unaeopsis aurantiaca* are an important source of animal proteins both qualitatively and quantitatively (49.47%). This rate is similar to that obtained by Muvundja *et al.* (2013) on the same caterpillars. Comparing the results of this investigation with those obtained by Osasona and Olaofe (2010) on the caterpillar *Cirina forda* (Saturnidae), it turns out that the B. *aurantiaca* is more protein than *Cirina forda*, with 49% against 20% but lower than the caterpillars I. *truncata* (70.63%) obtained by Mabossy-Mobouna *et al.* (2017). By juxtaposing this rate with that of other conventional foods, caterpillars *Bunaeopsis aurantiaca* exhibit a higher protein content than beef (18.2%) and fresh fish (18.3%) or dried and salt(47.3%). Similarly, larvae protein contents of *Rhynchophorus phoenicis* (Curculionidae) (21.21%) and *Oryctes rhinoceros* (Scarabeidae) (42.66%) obtained by Lenga *et al.* (2012) are lower than that of caterpillars B. *aurantiaca.* This protein content is consistent with that of FAO (2004) noted that a high protein in the caterpillars favoring their incorporation in poor flour protein to fight against child malnutrition. It is therefore clear from our study that caterpillars *Bunaeopsis aurantiaca* are among the most protein foods but underneath eggs whose proteins are complete in 94% (FAO, 1998; Vantome, 2010). The essential function of a protein food is to satisfy the needs of nitrogen in the body and essential amino acids (WHO, 1985).

Amino acid composition samples caterpillars' *Bunaeopsis aurantiaca* and the ratio between the sum of the essential amino acids and the sum of the total amino acids

The contents of amino acids caterpillars' *Bunaeopsis aurantiaca* reveal the presence of all essential amino acids that contain appreciable amounts of protein's caterpillar B. *aurantiaca.* Amino acid profile result indicates an amount of essential amino acids 15.67g/16N from a total of 36.84g. Aromatic amino acids (phenylalanine + tyrosine), lysine, leucine and threonine are the major amino acids. Sulfur amino acids (methionine + cysteine) and tryptophan are most poorly represented. Leucine is the primary limiting factor with a chemical index 39.49; sulfur-containing amino acids constitute the second limiting factor. The majority of these amino acids have superior chemical indices at 50%. Tyrosine and phenylalanine (aromatic amino acids), lysine; ensure proper absorption of calcium and helps maintain a good balance of nitrogen in adults body, leucine; responsible for increasing the production of growth hormone and threonine;

preventing the accumulation of fat in the liver. Moreover, these proteins contain amino acids whose chemical indexes above 100%. These are the aromatic amino acids and tryptophan. The ratio between the sum of essential amino acids and sum of total amino acids of proteins analyzed shows a value greater than 33% (**Table 1**).

These results are close those of De Foliard (1991) noted that poverty insects sulfur amino acids. It suggests that the proteins insects tend to be low in particular amino acids and contain per against other types, lysine and threonine. They are also consistent with those of Kodondi *et al.* (1987); Mabossy-Mobouna *et al.* (2013; 2017) on *Imbrasia truncata* caterpillars who noted low concentrations of sulfur amino acids and tryptophan. Lysine being deficient in cereal proteins, caterpillars analyzed in this study can be incorporated into the maize gruel given to infants Congolese households for enriching lysine. These caterpillars have a high content of arginine which according Voet *et al.* (2006) would be essential for growing children because it promotes collagen formation and growth of osteoblasts, from which the actual bone mass can develop (Williams *et al.*, 2002). The profile of essential amino acids that we analyzed is different from that obtained by Akpossan *et al.* (2014) on *Imbrasia oyemensis* caterpillars where they noticed a high content of lysine followed by leucine and valine.

Protein caterpillars *Bunaeopsis aurantiaca* therefore reports leucine/isoleucine (1.37) and leucine/lysine (0.97) and nutritionally favorable correct according to FAO (1981) [0.5; 4.6]. These outcomes are similar to those obtained by Mabossy-Mobouna *et al.* (2017) on the caterpillars of *Imbrasia truncata* and Foua Bi *et al.* (2015) on the powder caterpillars *Imbrasia oyemensis*. The ratio sum of the essential amino acids with respect to the sum of the total amino acids of protein caterpillars *Bunaeopsis aurantiaca* is greater than 33%, reflecting a chemical equilibrium between these different amino acids (Blankership and Alford, 1983). However, compared to the composition of the reference protein (FAO/WHO/UNU, 2007), protein caterpillars *Bunaeopsis aurantiaca* analyzed contains many amino acids limiting because their chemical indices are below 100°C. This is the case of histidine (98.00) a conditionally essential Aa for children and necessary for the growth, production of red blood cells and leukocytes, threonine (94.35), isoleucine (56.26) required for the formation of hemoglobin, lysine (53.33), valine (50.00) essentially necessary for the metabolism of muscles, sulfur amino acids (43.78) and leucine (39.49). The latter amino acid is the primary limiting factor with a deficit of percentage of 60.51%; sulfur-containing amino acids constitute the second limiting factor.

Table 1: Profile in amino acids of caterpillars *Bunaeopsis aurantiaca* and ratio evaluating of the sum of essential amino acids and sum of total amino acids

Amino acids	***Bunaeopsis aurantiaca***
Protein (49.47%)	**g/16g N**
Leu	2.33 ± 0.06
Iso	1.69
Lys	2.40 ± 0.14
Trp	0.77
His	1.47 ± 0.03
Thr	2.17 ± 0.03
Asp	3.33 ± 0.01
Val	1.95 ± 0.07
Phe	2.19 *
Tyr	3.04 ± 0.02
Met + Cys	0.70 ± 0.014
Sum of essential amino acids	15.68
Ser	2.14 ± 0.07
Glu	4.43 ± 0.16
Pro	2.45 ± 0.08
Gly	1.88 ± 0.06
Ala	1.86 ± 0.04
Arg	2.05 ± 0.007
Sum of nonessential amino acids	21.16*
Sum of total amino acids	36.84 ± 0.89
Report = $\frac{\text{Sum of essential amino acids}}{\text{Sum of total amino acids}} \times 100$	42.56*

The chemical index of protein's caterpillars *Bunaeopsis aurantiaca* is of 39.49. It is lower than caterpillars *Imbrasia truncata* (Mabossy-Mobouna *et al.*, 2017) and *Hadraphe ethiopica* which varies between 69.9 to 87.2 (Malaisse *et al.*, 2003). From another point of view, these proteins contain three essential amino acids whose chemical indexes above 100. These aromatic amino acids (137.63); necessary in the metabolism of thyroid hormones and the neurotransmitters: dopamine, noradrenaline and adrenaline. These aromatic amines acids (phenylalanine + tyrosine) contained in caterpillars *Bunaeopsis aurantiaca* as involved in the regulation of appetite (Gardan, 2009). Tryptophan (131.33) being the source of melatonin synthesis, commonly known as "sleep hormone", and niacin, also known as vitamin B3. It is also essential to relieve depression and helps to lose weight (Growland, 1901).

Chemical index samples *Bunaeopsis aurantiaca* caterpillars

Chemical clues essential amino acids protein caterpillars *Bunaeopsis aurantiaca* exhibit a chemical index of protein caterpillars is 39.49.

According Ngudi *et al.* (2003), chemical index calculation of each essential amino acid helps to correct accurately the amount of protein needed to cover the needs for essential amino acids in growing period. So caterpillars' *Bunaeopsis aurantiaca* can be used to supplement foods low in tryptophan such as chicken, dried fish and shellfish (Adrian *et al.*, 1995), threonine and aromatic amino acids.

Table 2: Chemical index of *Bunaeopsis aurantiaca* caterpillars' samples

Caterpillars *Bunaeopsis aurantiaca*	
Essential amino acids (g/100g protein)	**Chemical Index**
Threonine	94.35
Valine	50.00
Methionine + Cysteine	43.78
Isoleucine	56.26
Leucine	39.49*
Tyrosine + Phenylalanine	137.63
Histidine	98.00
Lysine	53.33
Tryptophan	131.33

Lipid content and fatty acid composition of the samples caterpillars' *Bunaeopsis aurantiaca*

Caterpillars *Bunaeopsis aurantiaca* have significant levels of fatty acids α-oleic, stearic and palmitic quite important in oleic and linoleic acids. Results note the presence of α-linolenic acid and arachidonic in small quantities. From the viewpoint degree of saturation, these caterpillars contain more polyunsaturated fatty acids (7.41%) than saturated fatty acids (50.07%), with a higher content of essential unsaturated fatty acids (C18: 1n-9 and C18 : 2n-6). The lipids extracted from these samples caterpillars *Bunaeopsis aurantiaca* are thus characterized both by significant levels of oleic acid (40.28%) and linoleic acid (6.58%). The α-linolenic acid (0.82%) is very poorly represented.

Iodine value is very high (213.693), which explains the high rate of unsaturated fatty acids relative to the proportion of saturated fatty acids. Reports ω6/ω3 and ω3/ω6 their fats are respectively outside the range [0.2-5]. The fat content caterpillars *Bunaeopsis aurantiaca* analyzed in this study is 24.19% (Table 3).

These outcomes are the same as those obtained by Muvundja *et al.* (2013) on the same species of caterpillar. Comparing the results of this investigation with those obtained by Osasona and Olaofe (2010) on the caterpillar *Cirina forda* (Saturniidae) and Mabossy-Mobouna *et al.* (2017) on *Imbrasia truncata* caterpillars, it turns out that B *aurantiaca* is more lipid than *Cirina forda* and I. *truncata* (with 24.2% against 12.5% and 15.22% respectively) . This rate is also higher than most foods such as lean meat of sheep and avocado, chicken meat, mackerel, fresh eggs, the majority of dairy products (breast milk, whole cow's milk liquid) and beef lean meat (Adrian *et al, 1995).* It's very high compared to that of fresh or dried and salted fishes (Wu Leung *et al.*, 1970).

However, these caterpillars are lower in fat than the larvae *Oryctes rhinoceros* (28.85%) and *Rhynchophorus phoenicis* (28.85%) studied by Lenga *et al.* (2012). Nevertheless, amount of fat is equivalent to an energy value of 217.71kcal 136.68kcal and represents 50.40% of the total energy intake of this food, which although similar to *Plumpy'nut*: a therapeutic food ready for use (RUTF Ready to Use Therapeutic Food), especially dedicated to treating severe malnutrition at home (WHO, 1999), but higher than normal range of recommended value for fat is 30 to 35% (EFSA, 2004).

Because of their relatively high in fat, caterpillars B. *aurantiaca* constitute an important source of fat-soluble vitamins (vitamins A, D, E and K). The iodine value of fat measured at 213.693 is greater than that of caterpillars *Imbrasia truncate* (134.453), fat soybean *(Glycine max)* and sunflower *(Helianthus annuus)* but higher than those of fat rapeseed *(Brassica campestris)*, cotton *(Gossypium* sp.) and maize *(Zea mays)* indicated by Adrian *et al.* (1995). This index reflects a high rate of fat caterpillars *Bunaeopsis aurantiaca* in unsaturated fatty acids. B. *aurantiaca*'s fat is very rich in α-oleic acid (40.28%). It is rich in linoleic acid (6.58%) and low α-linolenic acid (0.82%), which is at the base of nonadherence ratio ω6/ω3 and ω3/ω6 in the meantime. Oleic acid exerts favorable actions on health by promoting increased "good" cholesterol and is relatively insensitive to oxidation (FAO/WHO, 1993), which is a guarantee of stability during frying and the box (Nzikou et al., 2010).

Table 3: Profile in fatty acids composition of the samples caterpillar B. *aurantiaca* (in% per mass of fat) and iodine numbers

Fatty acids Total fat (24.19%)	Mass molecular ions (FAME)	*Bunaeopsis aurantiaca*
Myristic acid C14: 0	242	1.99 ± 0.01
C15: 0	25	nd
C15: 1	254	0.48
Palmitic acid C16: 0	270	10.05 ± 0.71
C16: 1	268	0.52 ± 0.014
C17: 0	284	0.86 ± 0.0056
C17: 1	282	nd
Stearic acid C18: 0	298	38.53 ± 0.13
Oleic acid C18: 1 n-9	296	40.28 ± 0.23*
Linoleic acid C18: 2 n-6	294	6.58 ± 0.1
α-linolenic acid C18: 3 n-3	292	0.82 ± 0.33
C20: 0	326	0.09 ± 0.005
C20: 1	324	nd
C20: 4 n-6	318	0.51 ± 0.007
Saturated (SFA)		50.07 ± 0.2
Monounsaturated (MUFA)		40.37 ± 0.014
Polyunsaturated (PUFA)		7.41 ± 0.32*
Total		97.84 ± 0.031
Other (unidentified)		± 0.035
Ratio ω6/ω3		8.02
Ratio ω3/ω6		0.12
Iodine value (calculated)		213 693*

nd = not detected

Saturated fatty acids with 50.07g per 100g of fat are important components of cell membranes, but their excessive consumption increases bad cholesterol (FAO, 1998). Of these fatty acids analyzed in caterpillars B. *aurantiaca* stearic acid is the most abundant (38.53%) followed by palmitic acid (10.05%). The palmitic acid is recognized as atherogenic (Bioweight, 2005), its action could be mitigated by the simultaneous presence of stearic acid and oleic acid. Indeed, these two acids each contribute to the increase in HDL-cholesterol (FAO/WHO, 1993).

The profile of major fatty acids of caterpillars' *Bunaeopsis aurantiaca* studied is identical to that obtained by Foua Bi *et al.* (2015) on the powder caterpillars *Imbrasia oyemensis,* different from that obtained by Mabossy-Mobouna *et al.* (2017) in caterpillars *Imbrasia truncata*, and Lenga *et al.* (2012) in the larvae *Rhynchophorus phoenicis* and *Oryctes rhinoceros.* The PUFA ratio (7.41%) on SFA (50.07%) equal to 0.14 indicates a very high nutritional value of the lipid level caterpillars of *Imbrasia truncate* (Le Grand, 2010). These caterpillars have good nutritional value on lipid level as the larvae *Rhynchophorus phoenicis* and *Oryctes rhinoceros* (Lenga *et al.*, 2012), the meat *Cephalophus monticola* (Mananga *et al.*, 2015) and the rat-taupe silver meat *Helephobius argenteocinereus* (Ombeni and Munyuli, 2016). Their fat has almost the same nutritional value as the fat of pig meat (Mourot, 2001) and of fish fat (and Kinkela Bezard, 1993) whose report PUFA SFA is 1.

Ratio ω3/ω6 caterpillars that we analyzed is 0.12, similar to that obtained by Foua Bi *et al.* (2015) on the powder caterpillars *Imbrasia oyemensis* different to that obtained by Mabossy-Mobouna *et al.* (2017) on the caterpillars *Imbrasia truncata* is 4.92. Ratio ω6/ω3 which is 8.02 is outside the range [1; 4] recommended by EFSA, (2004). These excess raised can be adjusted in a moderate and controlled feed to avoid development of various diseases such as cardiovascular diseases, cancer and various inflammatory diseases and autoimmune diseases (Artemis, 2002). This is slightly higher than those found by Amon *et al.* (2009) 5.06% and Niaba *et al.* (2013) 1.25%.

Caterpillars *Bunaeopsis aurantiaca* can therefore provide the people who consume a sufficient amount of essential amino acids and polyunsaturated fatty acids. Hence, this animal is an important source of essential nutrients entering proper functioning of the human organism.

4. CONCLUSION

Bunaeopsis aurantiaca caterpillars have significant potential in amino acids and fatty acids nutrients that can cover daily needs of the human body. The presence of appreciable amount of all essential amino acids which contain proteins (49.47%) of caterpillars B. *aurantiaca* including tyrosine and phenylalanine (aromatic amino acids), lysine, leucine and threonine having substantially specific functions the human body. Lipids represented 24.19% are rich in polyunsaturated fatty acids (oleic acid C18: 1 ω9 and 40.28% linoleic acid C18: 2 ω6 6.58%). As the results, these caterpillars are a melting pot of essential nutrients of great nutritional interest both for baby food for a balanced diet of malnourished adults. Apart from a seemingly unattractive and low importance by the middle class people, these caterpillars can become a serious alternative to regular animal protein (meat, fish) and high cost of increasingly scarce.

This is why environmental education coupled with strict regulation of logging will protect forests and therefore caterpillars (Muvundja *et al., 2013;* Lisongo *et al.*, 2011).

However, animal testing will be considered in order to deepen the study on the confirmation of quality presumption obtained in the biochemical analysis of this animal. Thus, development of a domestication program of these caterpillars will well make it available at all times and at all times of these dishes also highly nutritious. This nutritious potential help nutritionists to its extension as part of the practice of eating habits of our people.

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