

Research Application Summary

***Imbrassia oyemensis* and *Apis mellifera* larvae as a potential source of dietary proteins to alleviate food insecurity in Kabare, Eastern D. R. Congo**

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Abstract

With the rising global population growth, the demand for protein-rich foods is expected to increase. In this study, a nutritional and sensory analysis was conducted on two edible insects (*Imbrassia oyemensis* and *Apis mellifera* larvae) collected in Kabare Territory in Eastern D.R. Congo. These edible insects constitute a potentially valuable nutritional source with 48-56% protein, a high energy reserve (453-463 Kcal), a significant carbohydrate and fat content, and high overall sensory acceptability based on their taste. This and other similar studied edible insects could contribute to alleviate the problem of protein-energy malnutrition due to their high protein and energy content.

Keywords: *Apis mellifera* larvae, edible insects, *Imbrassia oyemensis*, nutritional potential, sensory attributes

Résumé

Etant donné la croissance démographique mondiale croissante, la demande d'aliments riches en protéines devrait augmenter. Dans cette étude, une analyse nutritionnelle et sensorielle a été menée sur deux insectes comestibles (*Imbrassia oyemensis* et larves d'*Apis mellifera*) collectés dans le territoire de Kabare dans l'est de la R.D. Congo. Ces insectes comestibles constituent une source nutritionnelle potentiellement intéressante avec 48-56% de protéines, une réserve énergétique élevée (453-463 Kcal), une teneur importante en glucides et en lipides, et une acceptabilité sensorielle globale élevée en fonction de leur goût. Cet insecte comestible et d'autres similaires étudiés pourraient contribuer à atténuer le problème de la malnutrition protéino-énergétique en raison de leur teneur élevée en protéines et en énergie.

Mots-clés: Larves d'*Apis mellifera*, insectes comestibles, *Imbrassia oyemensis*, potentiel nutritionnel, attributs sensoriels

Introduction

Edible insects can play a significant role in tackling the protein demand need (Halloran *et al.*, 2015), due to their high content of protein and other nutrients (Sánchez-Muros *et al.*, 2014), thus they are consumed for their nutritional value and for their taste (Mishyna and Chen, 2020). In addition, protein-energy malnutrition is one of the problems of food insecurity in most countries, such as the Democratic Republic of Congo (D.R.C) in general, and the Kabare Territory in particular, resulting in the inability to develop adequately, a situation exacerbated by poverty forcing people to desperately depend on forest products, including edible insects, as they are among the most abundant forest resources (Vliet *et al.*, 2019).

For regular consumption, a food must be sensory accepted, although its nutritional value should also play an important role in motivating consumers (Wendin *et al.*, 2017). Caterpillars and honeybees are among the most consumed edible insects in the world (Jongema, 2017), even though their taste and nutritional value vary from species to species, depending on the processing method. Despite the extensive published information on the nutritional and sensory aspects of *Imbrassia oyemensis* and *Apis mellifera* larvae as potential sources of dietary protein, there is lack of information on this in Kabare Territory, as results from other research cannot be extrapolated to consumers in the study area because of differences in ecology, culture and dietary habits. It is therefore imperative that a study be conducted in the area on this subject.

Material and methods

Sample collection and preparation. *Imbrassia oyemensis* and *Apis mellifera* larvae (Figure 1a, b) were collected from Kabare Territory, Eastern of D. R. Congo (Figure 1c). Each sample was kept in a separate 1kg Ziplock bag and transported frozen alive at - 20°C in cooler boxes lined with ice packs to the Natural Sciences Research Centre (NSRC), Lwiro for laboratory analysis. Using a domestic blender, the raw samples were blended prior to various analyses.

Nutritional composition. Proximate components were determined in accordance with Official Methods (AOAC, 2000). Crude protein was determined by the micro-Kjeldahl approach and its content was obtained by multiplying the corresponding total nitrogen content by a factor of 6.25. Moisture and ash were determined by the hot-air circulating oven (105°C) and through incineration in a muffle furnace (600°C), respectively. Available carbohydrate was determined by difference whereas energy was calculated using the Atwater's calorie conversion factors: 4 kcal/g for crude protein. 9 kcal/g for crude fat and 4 kcal/g for available carbohydrate.

Sensory assessment. The sensory attributes of the ready to eat *Imbrassia oyemensis* and *Apis mellifera* larvae were assessed by using a 7-point hedonic scale with the participation of 40 panelist members from Université Evangélique en Afrique (UEA). The *Imbrassia oyemensis* was roasted and spiced with vegetable oil, onions, tomatoes and magic cubes while the *Apis mellifera* larvae was boiled and spiced with little oil, onions and magic cubes. Each formulation was randomly coded with a 3-digit number. Samples were placed in small plastic bowls and sensory evaluation in relation to color, aroma, taste, texture and overall score were carried out using a questionnaire based on its intensity scaled on a 7-point hedonic scale (1 = disliked extremely, 2 = disliked moderately, 3 = disliked slightly, 4 = neither liked or disliked, 5 = liked slightly, 6 = liked moderately and 7 = liked extremely) according to Bauserman *et al.* (2015).

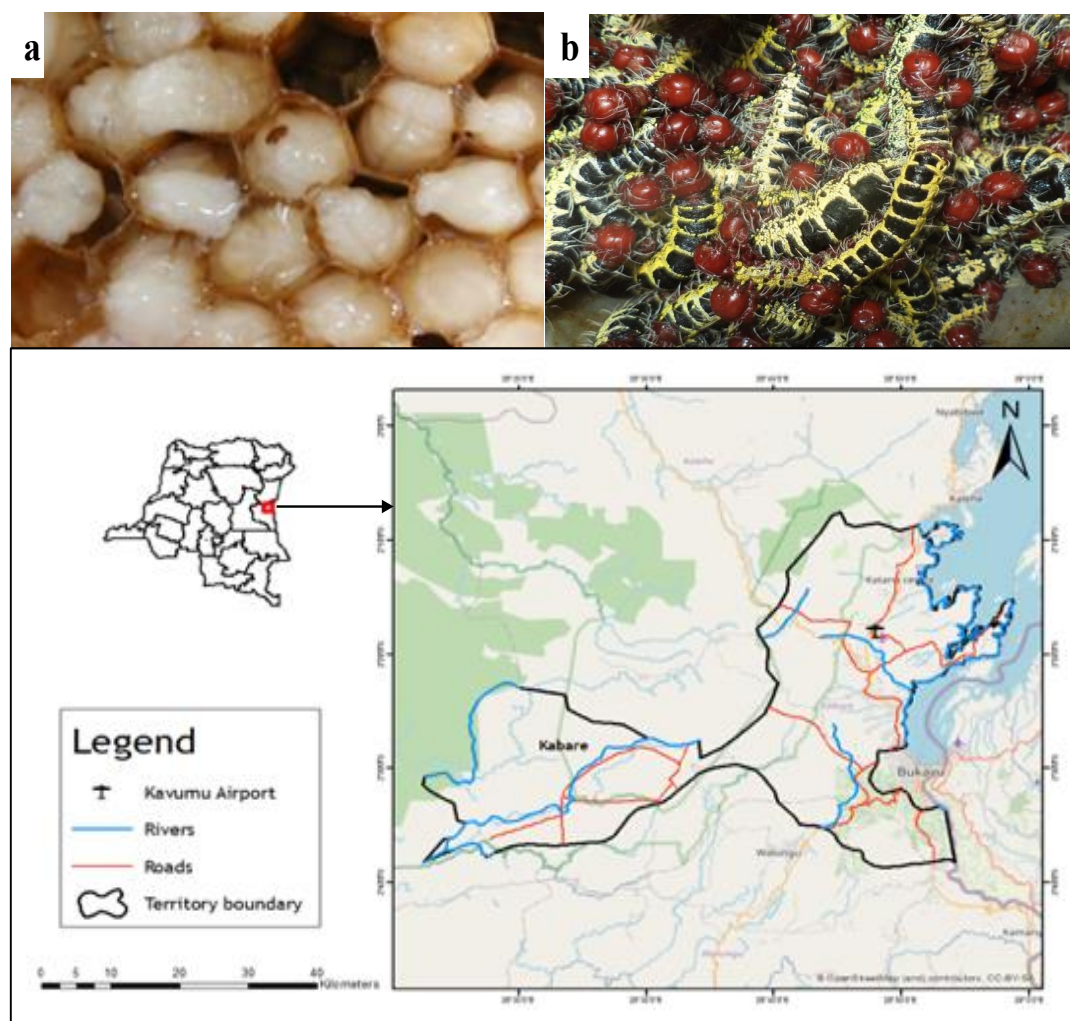


Figure 1. a. *Apis mellifera* larvae (Honey bee); b. *Imbrassia oyemensis* (Caterpillar), c. Map showing Kabare Territory, Eastern of D. R. Congo

Data analysis. All samples were statistically analyzed in triplicates and data presented as mean $\pm$ standard error. The means were subjected to an ANOVA for significance test ($p < .05$) and least significant difference (LSD) using R.

Results and discussion

Nutritional composition. The nutrient content varied significantly ($p < .05$) between insect species except for fat and energy content (Table 1). The caterpillar *Imbrassia oyemensis* had a high content of protein (56.10%), fat (20.56%), ash (3.11%) and moisture content (9.14%) compared to the *Apis mellifera* larvae which on the other hand had a higher content of carbohydrates (26.36%) and energy (463.41 Kcal).

The protein contents of *I. oyemensis* and *A. mellifera* larvae reported in this work are in the range reported in the literature. For *I. oyemensis*, its protein content is similar to that of *I. truncata* and *I. epimethea* (Mba *et al.*, 2019). As for *A. mellifera* larvae its protein content is slightly higher than

that reported by Ghosh *et al.* (2016). Although the fat and energy content reported in this work is similar to that reported by Ghosh *et al.* (2016), the ash, moisture, and carbohydrate content were significantly different probably due to the fact that they were determined based on fresh weight, which would have an impact on carbohydrate content since it resulted from the difference.

Sensory attributes. In contrast to color and texture, the overall score, aroma and taste varied significantly ($p < .05$) between insect species (Table 2). While *I. oyemensis* was generally appreciated for its aroma (5.38) and taste (5.55), *A. melifera* larvae was appreciated for its color (4.33) and texture (4.48).

Table 1. Nutritional composition of two insects species

Insects	Protein (%)	Fat (%)	Ash (%)	MC (%)	CHO (%)	Energy (Kcal)
<i>A. melifera</i> L.	48.02±1.03b	18.43±2.11a	1.82±0.16b	5.37±1.32b	26.36±1.33a	463.41±11.64a
<i>I. oyemensis</i>	56.10±0.66a	20.56±1.29a	3.11±0.43a	9.14±0.38a	11.09±1.09b	453.80±7.00a
P-value	0.0004***	0.2508ns	0.0075**	0.0058**	0.0014**	0.2770ns
CV	1.77	9.44	22.27	13.69	12.71	2.06

Mean values (n=3) ± SE on dry weight basis. Values in the same column with the same following letter do not significantly differ ($p < .05$) ; MC : Moisture content CHO: carbohydrates; CV : Coefficient of Variation.

Table 2. Nutritional composition of two insects species

Insects	Color	Texture	Taste	Aroma	Overall score
<i>I. oyemensis</i>	3.88±0.91a	4.40±1.15a	5.55±0.88a	5.38±0.90a	5.78±0.80a
<i>Apis melifera</i>	4.33±1.16a	4.48±1.04a	4.60±0.81b	4.45±0.78b	4.68±0.83b
P-value	0.0577ns	0.7602ns	0.0002***	0.0000***	0.0000***
CV	25.48	24.68	16.62	17.14	15.59

Mean values (n=3) ± SE. Values in the same column with the same following letter do not significantly differ ($p < .05$) ; CV : Coefficient of Variation

As for nutritional value, the sensory aspect is of great importance to the acceptability of a food. Availability (Van Huis, 2013), ethnicities/cultures (Riggi *et al.*, 2016), palatability (Chakravorty *et al.*, 2013), seasonality (Kinyuru *et al.*, 2013), and nutritional benefits (Ishara *et al.*, 2021) are the factors affecting the consumption of edible insects. Alongside *Ruspolia differens* and *A. melifera* larvae, *I. oyemensis* is among the most consumed and preferred insects in Kabara Territory and the most appreciated in Mwenga Territory (Ishara *et al.*, 2021). Consumption of caterpillar edible insects, including *I. oyemensis*, is a common practice in D. R. Congo (Bomolo *et al.*, 2017). This study confirms the findings of Bomolo *et al.* (2017) and Ishara *et al.* (2021) by highlighting that in South Kivu, most edible insects are valued for their taste, for example in the case of *R. differens*,

I. oyemensis, and *A. melifera* larvae, *Gryllotalpa africana*.

Conclusion and recommendations

The results of this work highlight the importance of *I. oyemensis* and *A. melifera* larvae as potential food sources to tackle the issue of protein-energy malnutrition in D. R. Congo in general and particularly in Kabare Territory, due to their high protein and energy content with a significant concentration of fat and carbohydrates. In addition, these insects are appreciated for their taste. The results of this study may reinforce the use of these edible insects as sources of proteins, but a thorough study of the protein quality in term of amino acid profiling is recommended.

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