*Original Research Article*

# Endogenous Knowledge of Edible Insects in North Sudanian Localities of Burkina Faso


**ABSTRACT**

Background: The global interest in edible insects is increasing all the more so as there is a diversity of edible insects in the world. They are nutritionally useful because of their content of animal proteins, lipids, minerals and vitamins. In Burkina Faso, more than 10 species of edible insects have been identified. To gain a better understanding of the local knowledge of edible insects in certain localities of the country where there is little information, this study aimed to assess the endogenous knowledge of edible insects encountered in these localities.

Methods: The survey was carried out among 183 informants in three villages located in the North Sudanian zone of Burkina Faso. The questionnaire focused the number of known edible insects, modes of preparation, information on commercialization and the availability of bans, as well as edible and medicinal properties. Chi-square analysis was used to determine whether there were statistically significant differences among villages, ethnic group, and religious in knowledge and preference for edible insects

Results: Five species namely *Carbula marginella* (Hemiptera), *Macrotermes subhyalinus* (Blattodea), *Kraussaria angulifera* (Orthoptera), Gryllus campestris (Orthoptera) and *Sternocera interrupta* (Coleoptera) were identified as edible insects. Interestingly, C. marginella was the most frequently cited edible species (91.26%). *Sternocera interrupta* (Coleoptera) with 21.85% was mentioned for the first time in these localities. Women were the main actors in the commercialization of the insect and *C. marginella* was sold between 5,000 and 15,000 FCFA per kilogram.

Conclusion: Edible insects represent a potential source of income. The use of insects is part of the cultural habits of the local populations.



*Keywords: Carbula marginella, edible insects, local knowledge, commercialization, cultural uses.*

## 1. INTRODUCTION

There are almost a billion chronically undernourished people in the world (Bonneau, 2020). To meet today's food and nutrition challenges, we need to re-evaluate what we produce and consume, and find new ways of producing food. We urgently need to find alternatives to conventional sources of animal protein in our diet. Human consumption of insects therefore contributes positively to the preservation of the environment and livelihoods (Van Huis, 2013).

Insects are well represented in terrestrial ecosystems, especially tropical ones. They account for around 73% of the total fauna described, with more than one million species identified (Leandro, 2018). They present an immense diversity of forms and behaviors. Essential to the survival of ecosystems and biodiversity, their interactions with human beings are crucial in many areas. Insects are capable of causing serious problems such as crop losses, disease transmission to plants (Pradhan, 1983), to humans and animals (by mosquitoes for example) (Darriet, 1998), and damage to houses (destruction of wood by termites) (Fouquet, 2000). However, these pests only represent less than 1% of the insect species (Lathuillière, 2022). Most insects are extremely useful to humans, providing numerous ecological services such as pollinating plants, biologically degrading waste, and controlling parasites (Van Huis et *al.*, 2014). Insects and their products are used to treat certain diseases (Feng et al., 2009, Ouango et al., 2022). They can be a direct food resource for humans and animals and form an integral part of the nutritional balance of certain peoples (Van Huis et *al.*, 2014). More than 2,000 edible insect species have been identified (Van Itterbeeck & Pelozuelo, 2022). In Africa, around 524 edible insect species have been identified (Ramos-Elorduy et *al*., 1997), 549 in Mexico, 170 in China, 160 in the Lao People's Democratic Republic, 164 in Thailand and Viet Nam and 428 in Amazonia (Galęcki & Sokól 2019). The insects consumed worldwide are mainly Coleoptera (around 31%), consisting of ladybirds, beetles and chafer beetles, followed by Lepidoptera (18%) (caterpillars), Hymenoptera (14%) (bees, wasps and ants), Orthoptera (13%) (grasshoppers, locusts and crickets,) and Hemiptera 10%) (cicadas, leafhoppers, mealybugs and bugs,) (FAO, 2014). In West Africa, 91 species of edible insects belonging to five orders (Isoptera, Orthoptera, Coleoptera, Hemiptera, and Lepidoptera) have been identified Kelemu et *al*., 2015).

Edible insects supplement the diets of around two billion people worldwide (FAO, 2014). In Africa, many people consume large quantities of insects, particularly in West and Central Africa. More than 15,000,000 people eat insects in West Africa (Tchibozo et *al*., 2016). Insect consumption is thought to be due to the fact that they are a good source of animal protein, lipids, and minerals and vitamins (Ramos-Elorduy et *al*., 1997, Séré et *al.*, 2021, 2022). They can also be a source of additional income when collected for sale on the market. In Burkina Faso, five (05) insect species are commonly consumed, namely *Cirina butyrospermi, Brachytrupes membranaceus*, *Macrotermes subhyalinus*, *Carbula marginella* and *Acanthacris ruficornis* (Séré et *al*., 2018).

*Cirina butyrospermi* has high levels of iron (31.27 ± 0.002 mg/100g), magnesium (150.09 ± 0.00 mg/100g) and potassium (1277.75 ± 0.01 mg/100g), protein (40.81%), and lipids (19.86%), with an energy value of 480.20 Kcal/100g (Séré et al., 2021). *Macrotermes subhyalinus* with a high zinc content (13.18 ± 0.09 mg/100g), has an energy value of 637.81 Kcal/100g, and is rich in lipids 50.12% and proteins 45.75% (Séré et al., 2021). *Brachytrupes membranaceus* has a high calcium content (193.45 ± 0.02 mg/100g), proteins content of 26.44%, lipids 49.56%, with an energy value of 632.82 Kcal/100g (Séré et al., 2021).

As for *C. marginella*, it's a bug species appreciated by some Burkinabés and is one of the most widely consumed species. It is consumed in roasted form by the Mossi, Bissa and Fulani ethnic groups and is available during the dry season (October-January) (Séré et al., 2018; Sary & Goungounga, 2021). It is rich in protein (41.49%), lipids (51.92%), and mineral salts (362.06 mg/100g potassium, 33.92 mg/100g calcium, 10.10 mg/100g iron and zinc, 74.55 mg/100g Magnesium, 185.84 mg/100g Sodium). *Carbula marginella* has a relatively balanced fatty acid composition, with 38.04% saturated fatty acids, 30.79% monounsaturated fatty acids and 31.13% polyunsaturated fatty acids (Séré et al., 2021). The iron content obtained with *C. marginella*, *C. butyrospermi* and *M. subhyalinus* covered the recommended iron requirement for adults. The zinc content of M. subhyalinus covers the recommended zinc requirements for adults (Séré et al., 2021).

Despite their nutritional qualities, little is known about these insects in this part of the country, particularly their ecology and economic importance. Hence the interest of our study, which aims to investigate endogenous knowledge of edible insects in the localities of Pagou, Vinnogo and Boudtenga in Burkina Faso.

## 2. METHODS

### 2.1 Study area

The study was conducted from January to May 2023 in three villages across the North Sudanian zone of Burkina Faso. They are Pagou (Garango) located in the province of Boulgou, Vinnogo (Meguet) in the province of Ganzourgou and

Boudtenga (Saaba) in the province of Kadiogo (Fig. 1). The climate is tropical with two seasons in both study zones: the dry season from October to April and the rainy season from May to September. Mean annual rainfall ranged from 600 to 900 mm and the average annual temperatures ranged from 20 to 28°C during the rainy season and from 35 - 40°C during the dry season (Ilboudo et *al.*, 2020). The vegetation of the North Sudanian zone is dominated by savanna with annual growing grass, trees, and shrubs (Barthelemy et *al*., 2017).

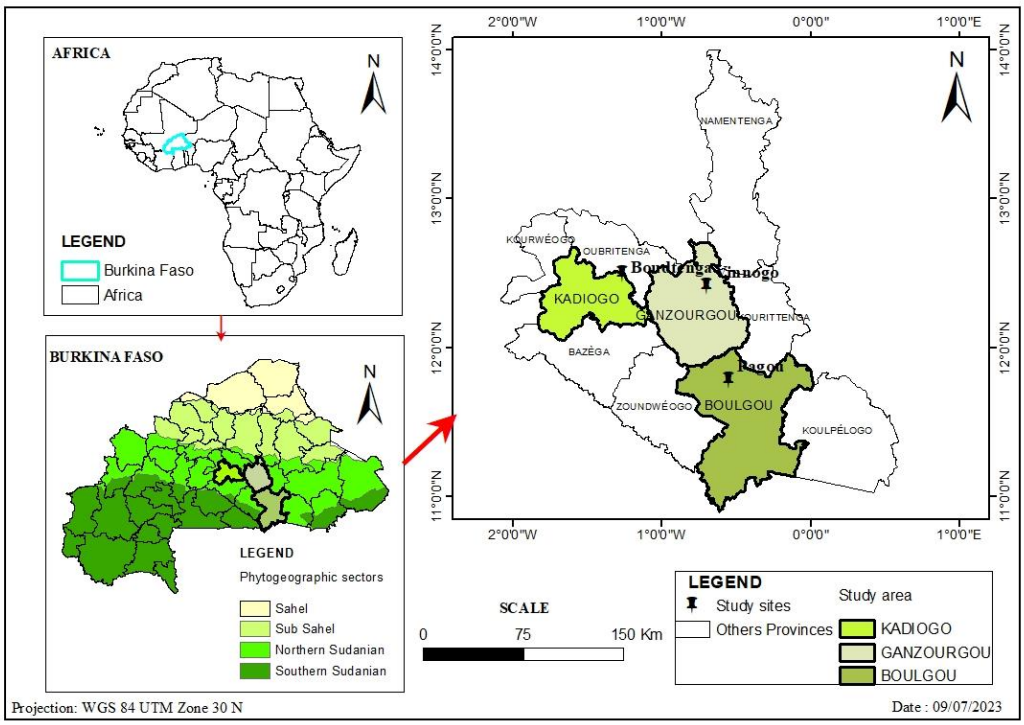


Fig.1: Map of the study area in Burkina Faso

## 2.2 Data collection

In each village, 61 informants were interviewed through individual semi-structured interviews. Members of the three ethnic groups that make up the villages were interviewed. There were bissa, mossi and peuhl without regarding their religious affiliation and their ages. The informants were between 12 and 83 years old. The respondents were included in the questionnaire regardless of their education and occupation. A total of 110 men and 73 women were interviewed. The questionnaire included the number of known edible insects, seasonal availability, stages of insects consumed, modes of preparation, storage techniques, information on commercialization and the availability of bans, as well as edible and medicinal properties. During interviews or at a given period, insect specimens were collected and kept in bottles containing alcohol for identification according to Scholtz, (2016) classification.

## 2.3 Data collection

Data processing and analysis were performed with the R 4.3.0 software. Chi-square analysis was used to determine whether there were statistically significant differences among villages, ethnic group, and religious in knowledge and preference for edible insects. Statistical significance was tested at the 5% level.

# 3. RESULTS

## 3.1 Local knowledge extent on edible insects

### 3.1.1 Edible insects in the three localities and frequency of citations

Five edible insect species belonging to four orders were cited as consumed by population (Fig. 2). They were consumed at the same stage of development: *C. Marginella* (Hemiptera), *Macrotermes subhyalinus* (Blattodea), *Gryllus campestris* (Orthoptera), *Kraussaria angulifera* (Orthoptera), and *Sternocera interrupta* (Coleoptera) were eaten at the adult stage.

*Carbula marginella* was the most frequently cited species with 91.26%, followed by *M. subhyalinus* (74.86%) and *K. angulifera* (55.19%). *Sternocera interrupta* and G. campestris were rarely cited by the populations surveyed, with frequencies of 21.85% and 6.01%, respectively (Fig. 3).

*Carbula marginella (Thunberg)*

*Sternocera interrupta (Olivier, 1790)*

*Macrotermes subhyalinus (Rambur)*

*Kraussaria angulifera (Krauss, 1877)*

*Gryllus campestris (Linnaeus, 1758)*

Fig.2: Edible insects across the three localities

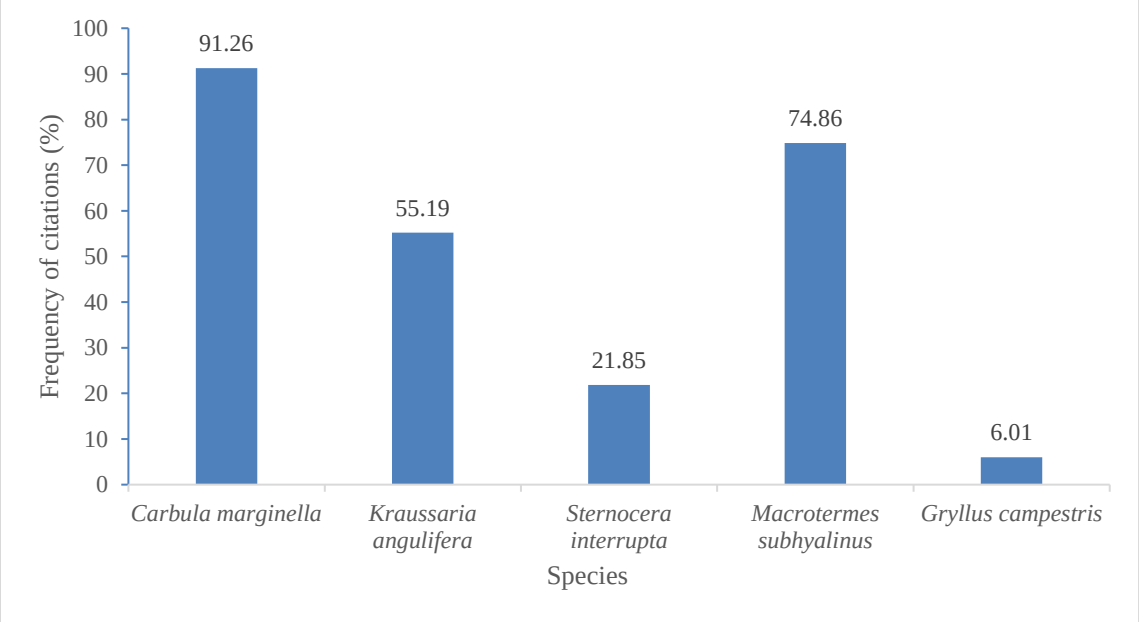


Fig. 3: Frequency of citations of edible insect species

**3.1.2 Distribution of cited edible insects according to localities**

*Carbula marginella, M. subhyalinus* and *K. angulifera* were cited in all three localities, but *S. interrupta* was cited only in Pagou and Vinnogo, whereas G. campestris was only cited in Vinnogo (Fig. 4). Thus, in addition to *C. marginella*, three species were cited in the locality of Pagou, four species in the locality of Vinnogo, and two species in the locality of Boudtenga.

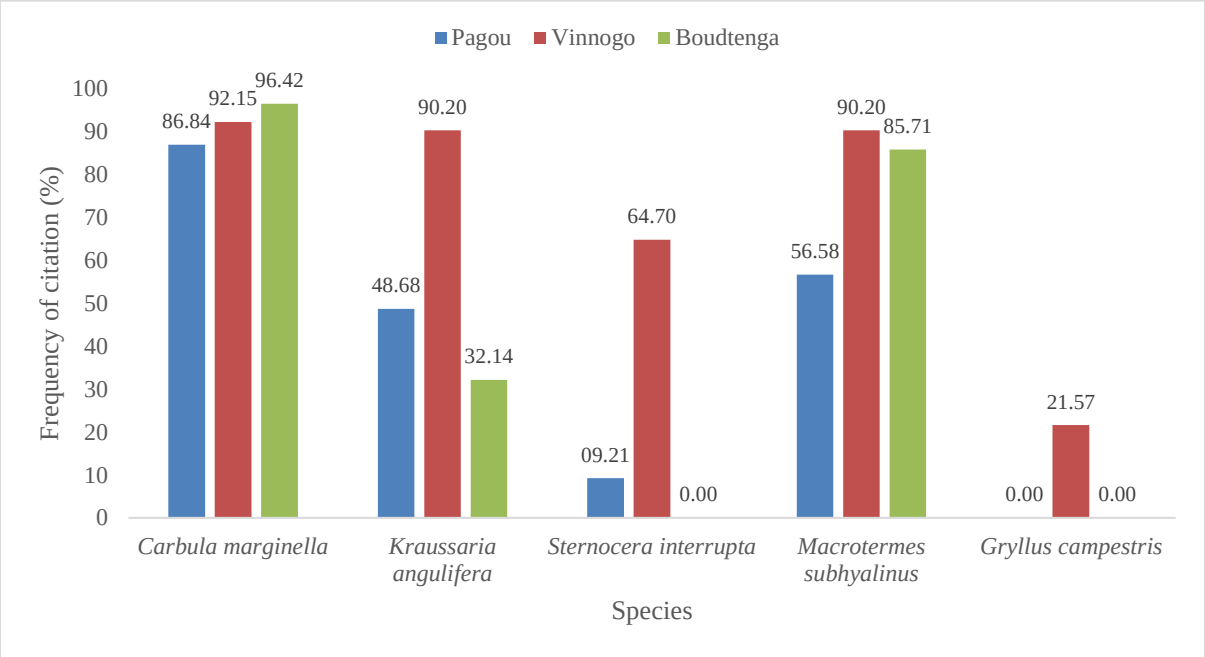


Fig.4: Frequency of citations of edible insect species according to locality

### 3.1.3 Knowledge of edible insects among ethnic groups

There was no significant difference in the consumption of *C. marginella* and *K. angulifera* ($P$ = 0.7) between these three ethnic groups. However, *S. interrupta* was less cited frequently by the Bissa (10.45%) than by the Mossi (29.25%); *Gryllus campestris* was cited only by the Mossi group (Fig. 5). *C. marginella* was less cited frequently by the Peuhl group, as well the other species.

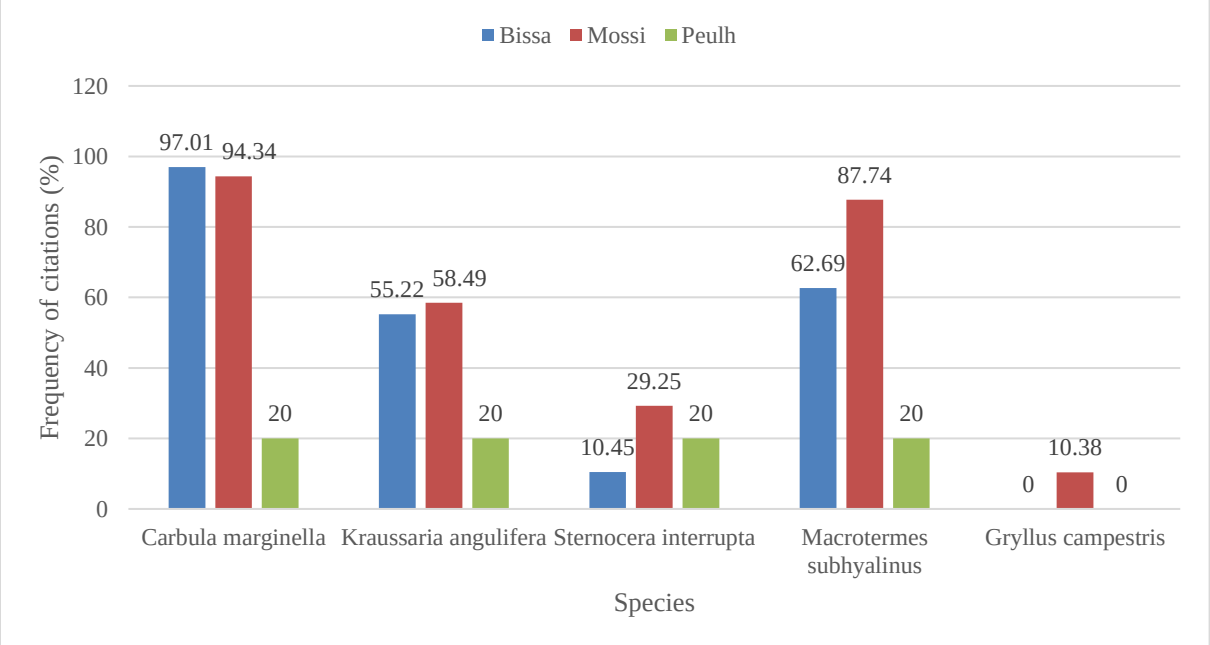


Fig. 5 : Frequency of citations of edible insect species by ethnic group

### 3.1.4 Knowledge of edible insects according to religious group

Insect consumption in the three localities was independent of religion ($P$ = 0.1). For each species, the frequency of citations was almost the same between the two religious groups (Muslims and Christians) (Fig. 6). *Carbula marginella* remains the most cited species, followed by *M. subhyalinus* and *K. angulifera. S. interrupta* and *G.campestris* were rarely cited.

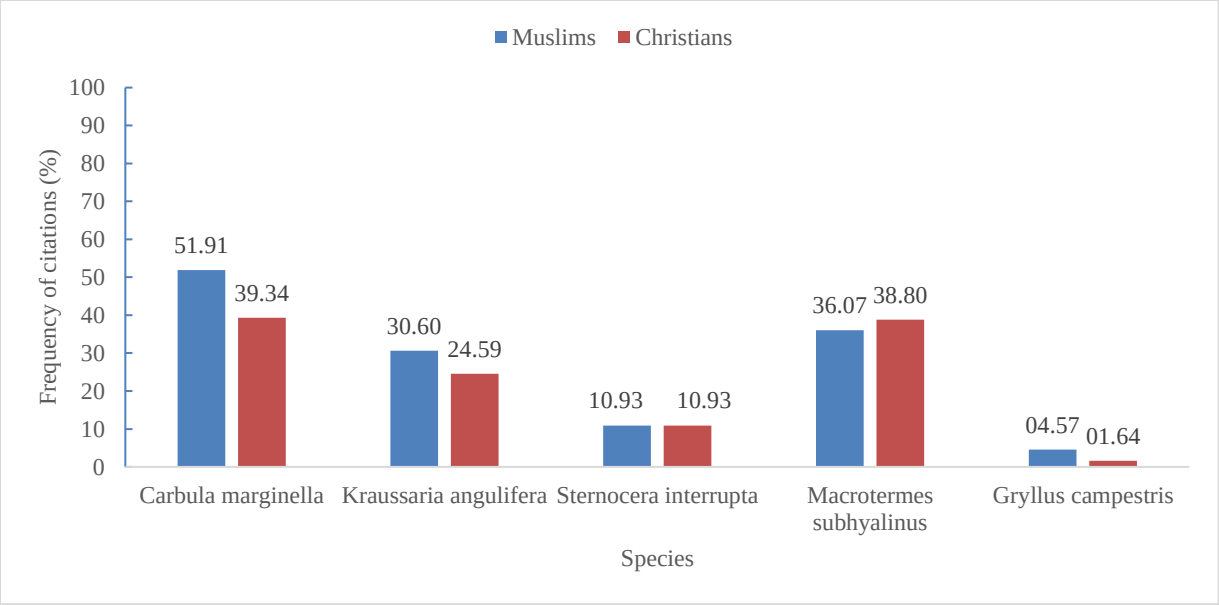


Fig. 6: Frequency of citations of edible insect species according religious group

## 3.2 Seasonal availability of insects, collection methods and consumption stages according to locality

### 3.2.1 Seasonal availability of C. marginella and other edible insects

*Carbula marginella* is observed at the end of the rainy season and throughout the dry season from November to May in the localities of Pagou and Vinnogo (Table 1). In Boudtenga, it is available from September to December. *Kraussaria angulifera* and *S. interrupta* were reported during the rainy season, from June to October. However, *K. angulifera* was observed at the start of the dry season, mainly in November. *Macrotermes subhyalinus* is available at the start of the rainy season between May and August. As soon as the rains begin, the winged reproductives of these species are attracted by light sources. They are abundant in the evenings, especially during morning rains.

| Species | Locality | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Carbula marginella* | Pagou | ■ | ■ | ■ | ■ | ■ | | | | | ■ | ■ | ■ |
| | Vinnogo | ■ | ■ | ■ | ■ | ■ | | | | | | ■ | ■ |
| | Boudtenga | | | | | | | | | ■ | ■ | ■ | ■ |
| *Kraussaria angulifera* | Pagou | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| | Vinnogo | | | | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | |
| | Boudtenga | | | | | ■ | ■ | ■ | ■ | ■ | ■ | | |
| *Macrotermes subhyalinus* | Pagou | | | | | ■ | ■ | ■ | ■ | | | | |
| | Vinnogo | | | | | | ■ | ■ | | | | | |
| | Boudtenga | | | | | | ■ | ■ | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Sternocera interrupta* | Pagou | | | | | | | | | | | |
| | Vinnogo | | | | | | | | | | | |
| *Gryllus campestris* | Vinnogo | | | | | | | | | | | |

Table 1: Seasonal occurrence of edible insects in different localities
Jan = January; Fev = February; Mar= March; Apr= April; Aug = August; Sept = September; Oct = October; Nov = November; Dec = December. The colored line indicated the period of insect availability.

### 3.2.2 Edible insect collection methods and the consumption stage

Edible insects were collected and consumed as adults in all three localities (Table 2). However, the methods of collection depended on the edible species. *Carbula marginella* and *M. subhyalinus* were particularly sought during their period of availability, while *K. angulifera, S. interrupta* and *G. campestris* were captured during travel and agricultural work. The local population collected C. marginella in caves while the other species were captured in fields or around concessions. They can be captured by hand or with sticks. M. Subhyalinus was captured using a container of water and nearby light. C. marginella was collected mainly by young girls and boys. In Vinnogo, women are actively involved, whereas in Pagou, married women do not take part in collecting.

Table 2 : Collection, and forms of consumption of edible insects in different localities

| Species | Order | Locality | Period of occurrence | Period of collection | Collection site | Collection method | Consumption stage |
|---|---|---|---|---|---|---|---|
| *Carbula marginella* | Hemiptera | Pagou | September-november | October – February | Hill (caves) | - Collect in caves during the day<br>- Build a fire and trap them in the flames | Adult |
| | | Vinnogo | September-november | November – may | Hill (caves) | Collect in caves during the day | |
| | | Boudtenga | September – october | September – december | Hill (caves) | Collect in caves during the day | |
| *Kraussaria angulifera* | Orthoptera | Pagou | - | June – november | Fields, bush | Capture by hand or tap with a stick | Adult |
| | | Vinnogo | - | June – november | Fields, roofs | Capture by hand or tap with a stick | |
| | | Boudtenga | - | June – october | Fields, bush | Capture by hand or tap with a stick | |
| *Macrotermes subhyalinus* | Blattodea | Pagou | May | June – july | - | Using a large container of water to trap near a light source | Winged adult |
| | | Vinnogo | June | June – july | - | Using a large container of water to trap near a light source | |
| | | Boudtenga | June | June – july | - | Using a large container of water to trap near a light source | |
| *Sternocera interrupta* | Coleoptera | Pagou | - | June – october | Bush | Capturing on thorny plants | Adult |
| | | Vinnogo | - | June – october | Bush | Capturing on thorny plants | |
| *Gryllus campestris* | Orthoptera | Vinnogo | | June – july | Fields | Capturing by digging in the ground | Adult |

### 3.3 Post-harvest processing and commercialization of edible insects

The insects collected were generally cleaned of debris and other insects. *Carbula marginella* and desiccated adults of *M. subhyalinus* were then soaked in hot water to remove droppings and impurities (Table 3). Finally, they were roasted in a pot or pan. *Kraussaria angulifera*, *G. campestris* and *S. Interrupta* were stripped of their wings and then roasted over coals. However, *K. angulifera* is often fried when large quantities were collected. In the study localities, the main trade focused C. marginella. The other species were collected occasionally for family consumption. The quantities of C. marginella collected per day vary according to the locality. In Pagou, the quantities collected per person per day range from half a dish to six dishes “yorouba”. In Vinnogo, they vary from half to 12 dishes “yorouba”. In Boudtenga, they vary from half to three dishes “yorouba”. The population generates income from the sale of C. marginella. Women are the main actors in the commercialization of the insect. The insect is sold in roasted form. A kilogram of the insect is sold for between 5,000 and 15,000 FCFA in Pagou, while in Vinnogo it is sold for between 4,000 and 7,500 FCFA. In Boudtenga, C. marginella is not sold. This would appear to be due to a ban on the bug in this locality.

Table 3: Post-harvest processing, quantity collected and sales price

| Species | **Locality** | **Post-collection processing and storage** | **Consumption type** | **Approximate consumption** | **Quantity collected per person / day** | **Price of a dish** |
|---|---|---|---|---|---|---|
| *Carbula marginella* | Pagou | Winnow, sort, clean with water and grill | Grilled | ≤ 1 kg | ½ to 6 dishes | 2,500 to 7,500 FCFA |
| | Vinnogo | Soak in hot water, then toast. | Grilled | ≤ 1 kg | ½ to 12 dishes | 2,000 to 3,000 FCFA |
| | Boudtenga | Soak in hot water, then toast. | Grilled | ≤ 1 kg | ½ to 3 dishes | - |
| *Kraussaria angulifera* | Pagou, Vinnogo Boudtenga | Remove wings and grill | Grilled or fried | - | - | - |
| *Macrotermes subhyalinus* | Pagou, Vinnogo Boudtenga | Sort, remove wings, then grill | Grilled | - | - | - |
| *Sternocera interrupta* | Pagou Vinnogo | Remove wings and grill | Grilled | - | - | - |
| *Gryllus campestris* | Vinnogo | Remove wings and grill | Grilled | - | - | - |

### 3.4 Benefits of eating *C. marginella* in the three localities

Consumers of *C. marginella* cited many virtues (Table 4). Citations varied from one locality to another. In Vinnogo and Boudtenga, some respondents believed that that the consumption of *C. marginella* helped to calm sickle-cell crises, while in Pagou it was said to combat hypertension, joint and stomach aches, coughing and nausea, and sexual weakness. In Pagou, some respondents suspected that *C. marginella* was involved in cleaning women's uteruses after childbirth. In Vinnogo, some people believe that the consumption of C. marginella attenuates the effect of alcohol on the nervous system, while others believe that it wards off evil spirits.

Table 4: Frequency of citations of the virtues associated with the consumption of C. marginella according to locality

| Therapeutic properties | Pagou (n) | Vinnogo (n) | Boudtenga (n) | Frequency of citations (%) |
|---|---|---|---|---|
| Calms sickle cell crises | 0 | 2 | 15 | 9.29 |
| Soothes bone pain | 0 | 7 | 0 | 3.83 |
| Hypertension remedy | 10 | 0 | 0 | 5.46 |
| Treats joint pain | 1 | 0 | 0 | 0.55 |
| Reduces nausea and coughing | 4 | 0 | 0 | 2.19 |
| Treats stomach ache | 13 | 0 | 0 | 7.10 |
| Cleanses uterine blood after childbirth | 4 | 0 | 0 | 2.19 |
| Fighting sexual weakness | 2 | 0 | 0 | 1.09 |
| Improves the taste of dolo | 0 | 10 | 0 | 5.46 |
| Reduces the effect of alcohol on the nervous system | 0 | 3 | 0 | 1.64 |
| Dispels evil spirits | 0 | 3 | 0 | 1.64 |

### 3.5 Cultural particularity with C. Marginella

The cultural particularities identified during this study relate to the collection and sale of C. marginella (Table 5). Collecting *C. marginella* is a traditional activity in all three localities. Access to collection sites was forbidden to outsiders and specific groups. In Vinnogo, the hill on which *C. marginella* was collected is off-limits to the natives of the town of Meguet. In Boudtenga, marketing the insect goes against custom.

Table 5: Cultural particularities according to the locality

| Cultural particularity | Pagou | Vinnogo | Boudtenga |
|---|---|---|---|
| **Collect** | An ancestral tradition; Forbidden to pregnant women | An ancestral tradition | An ancestral tradition |
| **Access to collection sites** | Reserved for local residents | Reserved for local residents | Reserved for local residents |
| **Commercialization** | - | - | Prohibition of sale |

## 4. DISCUSSION

### 4.1 Local knowledge extent on edible insects

Our results showed that in addition to *C. marginella*, which is widely consumed in all three localities, four other edible insect species were cited, belonging to three orders. These insects had already been cited by Séré et *al.* (2018) in the northern Sudanian region. However, to our best knowledge *S. interrupta* is cited for the first time as an edible insect in this region. Insect consumption could be linked to the fact that insects are an abundant and very cheap source of protein. Indeed, according to Katz, (1996), insects are an interesting protein supplement for rural populations whose consumption of animal proteins is low and mainly festive. Insects are eaten for their taste and tradition. Our results showed that the Bissa and Mossi were the ethnic groups that consumed the most C. marginella in the three localities. This could be due to the fact that C. marginella consumption is cultural in these localities. However, the frequency with which edible insects were cited varied according to locality and ethnic group. Edible insects were cited very low among the Peulh. Riggi et *al.* (2016) also observed a difference in edible insect preferences between ethnic groups in Benin. Oryctes spp. larvae, appreciated by the Anii and Fon ethnic groups, are not eaten by the Waama in Benin (Riggi et *al.*, 2016). According to Séré et *al*. (2018), the diversity of insects consumed is associated to the availability of species and the dietary and cultural habits of populations. This could explain the variation in citation frequencies from one ethnic group to another in the localities surveyed. Preference has also been reported to be associated with appetence (Chakravorty et *al*., 2013) and seasonality (Kinyuru et *al.*, 2013). Insect citation frequencies have not varied according to religious group. This could be due to the fact that insect consumption is not rejected by religion and is even encouraged in the books of the three major monotheistic religions (Much, 2012).

### 4.2 Seasonal availability of insects, collection methods and consumption stages

The seasonal occurrence of edible insects varied according to species. Our results showed two groups of insects: dry-season species (*C. marginella*) and rainy-season species (*G. campestris, M. subhyalinus, S. interrupta* and *K. angulifera*). All the insects consumed are harvested in the wild and are not bred for consumption. Séré et al., (2018) have shown that the availability of certain edible insect species is dependent on the availability of hosts. Environmental factors such as temperature and humidity, in connection with the month of year, can also influence the availability of edible insects.

*Carbula marginella* has been observed in caves in the hills. It is a dry-season species, appearing at the end of the rainy season (October) and disappearing at the end of the dry season (May). This could be explained by the insect's biology related to the season.

Collection methods varied according to the edible insects, but were the same in all three localities. Termites (*M. subhyalinus*) are collected during swarming and *C. marginella* is collected in caves. It should be noted that the collection of edible insects is an ancestral tradition in the communities studied.

Women are traditionally involved in the collection, processing and commercialization of edible insects. This result was similar to that reported by Séré et *al.* (2018) in Burkina Faso and to that reported by Nsevolo et *al.* (2016) in Kinshasa. The sale of edible insects, in this case C. marginella, provides income for these women and their families. This income is used for food, children's education and other family expenses.

Edible insects are processed in a wide variety of ways. They are generally eaten fried or grilled. These results were similar to those of Ekpo & Oningbinde, (2007) in Nigeria. However, according to these authors, insects are eaten in association with cassava. According to Boko & Angaman, (2021) cooking improves insect appetence and nutrient availability, but some insects are enjoyed raw.

Populations associate insect consumption, particularly C. marginella, with various medicinal practices in addition to nutrition and cultural practices. The use of insects to treat certain pathologies was mentioned by Raheem et *al.*, (2018). Chen et *al.* (2019) have recognized the immunostimulant and anticancer properties of caterpillars. Traditional Chinese medicine prescribes Antheraea pernyi males as aphrodisiacs and termites as immunostimulants (Chen et *al.*, 2009).

## 5. CONCLUSION

Our survey revealed five edible insect species in the three villages studied, namely *C. marginella*, *M. subhyalinus, G. campestris, K. angulifera* and *S. Interrupta.* Knowledge of edible species varied from one locality to another and according to ethnicity. *Carbula marginella M. subhyalinus* and *K. angulifera* were the most frequently cited edible insects in all three villages. The Peuhls and Bissa ethnic groups of the localities studied do not consume *G. campestris. Carbula marginella* remains the most cited group in all three localities. Edible insects represent a potential source of income. The use of insects is part of the cultural habits of the local populations. The consumption of insects can be a solution to the problems of famine or malnutrition among the populations in the affected areas. However, insects are only available for part of the year and a solution must be found for their permanent availability.

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