ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 15, Issue, 12, pp.26715-26723, December, 2023
DOI: https://doi.org/10.24941/ijcr.46398.12.2023

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

ENTOMOPHAGIC STUDY OF THE LARVAE OF *RHYNCHOPHORUS PHOENICIS* IN SEVERAL LOCALITIES IN SOUTHERN TOGO

GANNYI Adoukoè Hortense[1*], KASSENEY Boris Dodji[2], TOZOOU Panawé[2], KADANGA Mawabena[1], HENEKOU Tovignon Daniel[1], MENSAH Labité Komlan[3] BANAKINAO Bawou Toussaint[4] and MELILA Mamatchi[5]

[1]Medical Assistants School (EAM), University of Lomé, 01BP: 1515, Lomé –Togo
[2]Departement of Zoology, Faculty of Sciences (FDS), University of Lomé, 01BP: 1515, Lomé –Togo
[3]Faculty of Health Sciences (FSS), University of Lomé, 01BP: 1515, Lomé – Togo
[4]Faculty of Agricultural Sciences (FSA), University of Abomey-Calavi, 01BP 526, Cotonou – Bénin
[5]Departement of Biochemistry, Faculty of Sciences (FDS), University of Lomé, 01BP: 1515, Lomé –Togo

ARTICLE INFO

Article History:
Received 20th September, 2023
Received in revised form
27th October, 2023
Accepted 15th November, 2023
Published online 30th December, 2023

Key words:

Rhynchophorus phoenicis,
Larvae,
Food uses, South – Togo

***Corresponding author:**
GANNYI Adoukoè Hortense

ABSTRACT

Meat consumption has almost tripled due to population growth and the rise of the middle class. It is expected to double again by 2050. Promoting entomophagy is therefore one way of covering food needs in animal-derived protein. Beyond the nutritional value and functional properties of comestible insects, it is also necessary to know the different ways in which these insects are used as food in order to better assess their contribution to cover nutritional needs. Thus, this study aims to assess the dietary uses of *Rynchophorus phoenicis* larvae in several localities in southern Togo. An analytical cross-sectional study was carried out in Hiheatro, Kouvé and Badja from 22 August to 8 September 2023 using survey forms. The results showed that these larvae are prized by various ethnic groups, principally the Ewe (42.86%), the Watchi (31.43%) and the Akposso (16.19%) for their taste. Moreover, people of all ages and occupations consume these larvae. The reasons for this consumption are feeding habits (88.57%), nutritional value (66.67%) and flavour (10.48%). The stage of the insect most consumed was the larval stage (94.29%). In 98.10% of cases, roasting was the method of preparation and preservation. The data from this study also showed that the larvae were associated with foods such as gari (cassava flour), sauces, rice and Djinkoumé (paste with roasted corn flour). These larvae were also said to be used therapeutically to treat a number of pathologies, including epilepsy, high blood pressure, heart disease, diabetes, whitlow and mouth sores, especially for infants. The larvae of *R. phoenicis* were well known and well consumed by the populations of the localities surveyed in the present study. Their contribution to the nutritional quality of the dishes in which they are used therefore remains an asset for meeting the nutritional needs of consumers.

Citation: ***GANNYI Adoukoè Hortense.*** **2023.** "Entomophagic study of *Rhynchophorus Phoenicis* in several localities in south of Togo.*". International Journal of Current Research*, 15, (12), 26715-26723.

INTRODUCTION

Food insecurity is one of the major challenges that the entire world is facing. Nearly 1 billion people in the world are chronically hungry (FAO, 2014). To overcome this challenge the Sustainable Development Goal (SDG) n°2, which aims to eradicate hunger, ensure food security, improve nutrition and promote sustainable agriculture by 2030, was established by the United Nations in 2015 (Billand & Caron, 2017). Since 1970, meat consumption has almost tripled due to population growth and the rise of the middle class (Yen, 2009). It is set to double again by 2050, which means that agricultural land resources will soon be exhausted (FAO/WHO, 2012).

Moreover, industrial livestock production has a heavy impact on the environment responsible for at least 15% of the greenhouse gases that cause global warming (FAO/WHO, 2012). However, it is essential to reconsider our diets and food habits and in particular our consumption of meat, to avoid depleting stocks. This situation is prompting us to think about other sources of animal-derived protein, such as "comestible insects", which could be an alternative (Cloutier *et al*., 2015). Indeed insect consumption, known as 'entomophagy', has been part of human diet for a long time, especially in the tropics. There are more than 1900 comestible insects, including at least 250 species in Africa (Cloutier *et al*., 2015). Furthermore, the countries where entomophagy is practised are attended around 2.5 billion people, representing approximately 35% of the world's population (Cloutier *et al*., 2015). Despite this large proportion, there are still many people who do not practise entomophagy.

Yet these insects are an endogenous food source that is rich in protein and has good nutritional value, while being less harmful to the environment than conventional meat (FAO, 2014). In addition, many insect species contain relatively more protein than the usual sources of meat such as chicken or pork. Insects also contain essential fatty acids and important minerals and vitamins (De Foliart, 1992). For example, termite alates contain up to 36% protein and 100 grams of shea caterpillars provide almost the daily protein and vitamin requirements of a human being (Rumpold & Schlüter, 2013). These species of comestible insects, including the African palm weevil (*R. phoenicis*), represent a significant source of affordable protein and could contribute to food security. The larva of African palm beetle *R. phoenicis* (known as African palm weevil) is one of the comestible insects belonging to the Curculionidae family.

Their larvae are eaten in a variety of dishes: in sauces, fried, grilled, raw or crushed (Womeni *et al*., 2012; Ogbalu and Williams, 2015; Tamesse *et al*., 2016). It is also one of the most widely consumed beetle species in the world (FAO, 2014) with an interesting nutritional value. In fact, 100 g of larvae of African palm weevil contains 182 kilocalories, 6.1% protein, 13.1% fat, 9% carbohydrates, 4.3 mg iron, 461 mg calcium, vitamins and minerals (FAO, 2014, Fessard, 2020). However, although palm weevils are highly valued from a nutritional point of view and have been the subject of numerous studies, little data is available on the dietary and therapeutic uses of this food stuff. Prior to any valorisation, it is necessary to have data on the endogenous knowledge and to identify the dishes to which these larvae are associated. This would make it possible to analyse the production processes for these larvae of palm weevil-based dishes in order to identify the critical points that need to be monitored for consumer health safety. In addition, these data could be used to improve the acceptability of the larvae in the interests of food safety. Thus, this study aims to contribute to the valorisation of African palm weevils in order to promote their use in the interests of food safety.

MATERIAL AND METHODS

Study areas

The study was carried out in three (3) localities: Hiheatro and Badja in the Plateaux region and Kouvé in the Maritime region (Figure 1). Hiheatro is located in the Amou prefecture and is included in the municipality of Amou 3. It has a population of 23,330 inhabitants. It is bordered to the south-west by the village of Adéta, to the north-east by the village of Etse Kopé, to the west by the village of Elavagnon and to the east by the city of Atakpamé. Badja is located in the Avé prefecture, and belong to the municipality of Avé 1. It has a population of 9,413 inhabitants.

It is bordered to the south by the village of Bagbe, to the north by the locality of Kevé, to the west by Ghana and to the east by the prefecture of Zio. Kouvé is located in the prefecture of Yoto and in the municipality of Yoto 1. It has a population of 21,986 inhabitants. The survey was carried out in Kouvé-Gboli. This locality is bordered to the south by the prefecture of Vo, to the north by the prefecture of Haho, to the west by the prefecture of Zio and to the east by the city of Tabligbo. These localities were chosen on the basis of their relatively high production of African palm weevils.

Methodology

Type of Study: This was a descriptive and analytical cross-sectional study.

Survey Method: The survey was carried using a questionnaire during the period from 22 August to 8 September 2023. The survey made it possible to assess people's level of knowledge about the larvae of African palm weevils, to identify the different foods (with which the larvae are associated) and to describe the different production processes. A total of 105 participants were randomly selected after a free consent to be involved in the survey.

RESULTS AND DISCUSSION

Social and demographic characteristics of participants

- **Distribution of participants by locality**

Among the localities surveyed, that of Badja was the most represented with 35.24% of respondents (Figure 2).

Distribution of participants by sex and age

Among the surveyed participants, 50.48% were men and 49.52% women (Table 1), with a sex ratio of 1.02.

Table 1. Distribution of participants by gender

Gender	N	Proportion (%)
Female	52	49.52
Male	53	50.48
Total	**105**	**100.00**

These results were similar to those reported by Kadanga *et al*. (2022a) in the prefecture of Agoé with 50.7% males and 49.3% females on the food usages of *Macrotermes* alates. These results showed an equitable participation between men and women in these two studies. In the present study, this distribution could be explained by the distribution of tasks carried out in the treatment of the African palm weevils.

In fact, the collection of palm weevils is carried out more by men while women are in charge of cooking. This justifies the participation of both sexes in the treatment of these larvae. The majority of surveyed people (84.76%) were between 18 and 55 years old (Table 2), indicating that the participants in this study were relatively young.

Table 2. Distribution of participants by age group

Age group	Number of participants	Proportion (%)
[18-25]	10	09.52
[26-30]	18	17.14
[31-35]	11	10.48
[36-40]	15	14.29
[41-45]	18	17.14
[46-50]	07	06.67
[51-55]	10	09.52
[56-60]	05	04.76
[61-65]	04	03.81
> 65	07	06.67
Total	105	100.00

Distribution of participants by profession: The data obtained indicate that 33.33% of respondents were farmers, followed by 28.57% palm wine producers, 25.71% traders and 12.38% representing participants in other areas of activity (Table 3).

Table 3. Distribution of participants by profession

Profession	Number of participants	Proportion (%)
Farmers	35	33.33
Palm wine producers	30	28.57
Traders	27	25.71
Other	13	12.38
Total	105	100.00

Table 4. Distribution of participants by level of education

Level of education	Number of participants	Proportion (%)
Not attending school	18	17.14
Primary	45	42.86
Secondary	36	34.29
Higher	06	05.71
Total	105	100.00

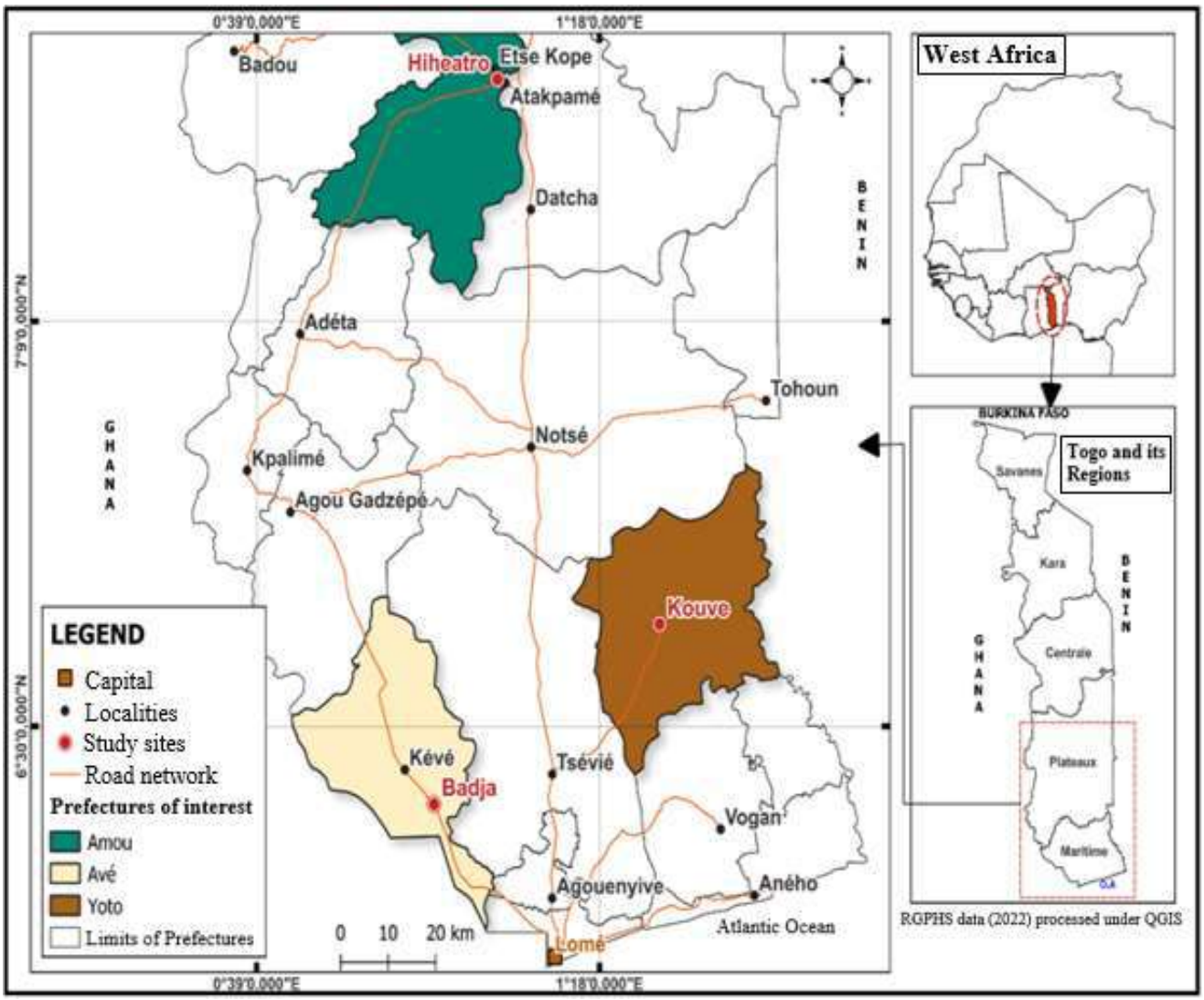

Figure 1. Map indicating the prospected localities

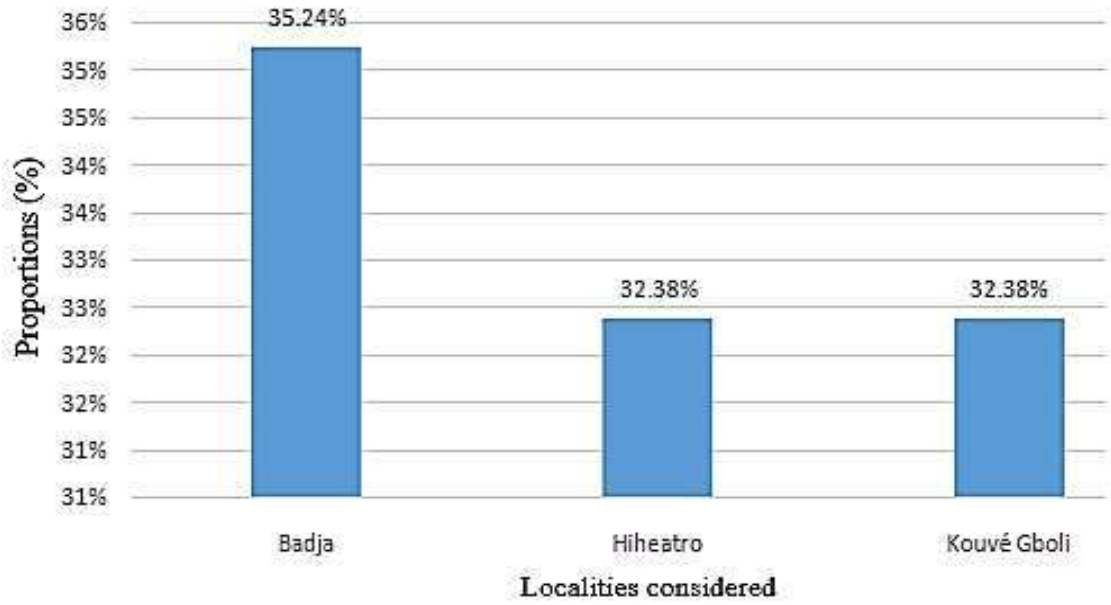

Figure 2. Proportions of participants according to the localities surveyed

This predominance of farmers and palm wine producers, with around 62% of participants, can be explained by the fact that the palm tree is the preferred substrate for the African palm weevils, as the name suggests.

Distribution of participants by level of education: Table 4 shows that 42.86% of participants had a primary education, while 5.71% had a higher education.

School attendance is developed in both rural and urban areas in Togo. However, the low representation of higher education in this study could be explained by the predominance of people working in the agricultural sector, who have little interest in higher education, especially in rural area in Togo. In fact, most activities in rural areas are in the informal sector and do not require long studies.

Distribution of participants by marital status: Around 81.90% of participants were married (Table 5). The actors, in a context of subsistence farming, requires a lot of labour, which remains mainly family labour in order to minimise production costs (Anaïs, 2017). In this sense, marriage is relatively important for producers.

Table 5. Distribution of participants by marital status

Marital status	Number of participants	Proportion (%)
Married	86	81.90
Single	16	15.24
Widowed	03	02.86
Total	105	100.00

Distribution of participants by ethnic group

The majority ethnic groups surveyed in this study were Ewe, Watchi and Akposso, with 42.86%, 31.43% and 16.19% respectively (Table 6).

Table 6. Distribution of participants by ethnic group

Ethnic groups	Number of participants	Proportion (%)
Ewé	45	42.86
Watchi	33	31.43
Akposso	17	16.19
Kabye	04	03.81
Tchamba	02	01.90
Adelé	01	00.95
Ifê	01	00.95
Akebou	01	00.95
Moba	01	00.95
Total	105	100.00

These three ethnic groups, which were numerically important in the present study, were indeed the most representative of the surveyed localities.

People's level of knowledge about the palm worm

-Knowledge of the larvae of *R. phoenicis*

The larvae of *R. phoenicis* (Figure 3) are very well known by all the surveyed people (Table 7).

Table 7. Knowledge of the Taste of the larvae of *R. phoenicis* according respondents

Knowledge	Number of participants	Proportion (%)
Yes	105	100.00
No	00	00.00
Total	105	100.00

This result is similar to that reported by Mabossy-Mobouna and Malaisse (2020) in Congo in 2020, who indicated that this foodstuff was well identified by the participants. This situation can be explained by the fact that the surveyed localities are palm wine production areas and that the palm wine production is directly associated with the production of the larvae of *Rynchophorus phoenicis*, which is therefore collected and consumed by the local population. In fact, 94.29% of participants recognised that the larvae of *Rynchophorus phoenicis* host plant is the palm oil tree (Table 8).

Table 8. Names of the host plant in French and local languages

Names of the host plant in French	Number of participants	Proportion (%)
No answer	06	05.71
Palm oil tree	99	94.29
Total	105	100.00
Names of the host plant in local languages	Number of participants	Proportion (%)
Edeti (Ewé)	38	36.19
Edé (Watchi)	35	33.33
Editsou (Akposso)	17	16.19
Déti (Ewé)	08	07.62
Paw (Kabyè)	04	03.81
Kpakpayi (Tchamba)	02	01.90
Kaarig (Moba)	01	00.95
Total	105	100.00

Therefore the palm seemed to be the only host plant for these larvae in surveyed localities. The larvae of *Rynchophorus phoenicis* develops in decomposing palm trees, in most cases after the extraction of palm wine. The palm tree is called édéti in Ewé, édé in Watchi, Editsou in Akposso, Paw in Kabyè, Kpakpayi in Tchamba and kaarig in Moba (Table 8). This study illustrated the diversity of ethnolinguistic groups. In fact, the surveyed localities are cosmopolitan agglomerations where several of Togo's ethnic groups are represented. Table 8 also shows that larvae of *Rynchophorus phoenicis* are known and consumed by all the ethnic groups represented.

Consumption stage of the insect: *R. phoenicis* are mainly eaten at the larval stage (94.29%) and 5.71% of participants said they had eaten this beetle at the adult stage (Table 9). This means that *R. phoenicis* is most appreciated at the larval stage. This result is similar to what was reported by Badanaro (2015) in Togo and Mabossy-Mobouna and Malaisse (2020) in Congo.

Table 9. Stages during which the insect was consumed

Consumption stage	Number of participants	Proportion (%)
Larvae	99	94.29
Adult	06	05.71
Total	105	100.00

The adult of African palm weevils are beetles which fly off from host plant, whereas the larvae are crawlers and always remain in the decomposing palm. This justifies their availability in comparison with the adult.

Domestication of the insect: Overall (98.09%), the respondents indicated that the larvae of *R. phoenicis*, although appreciated, were not domesticated (Table 10), as reported by Badanaro (2015).

Table 10. Domestication of the insect

Domestication	Number of participants	Proportion (%)
Don't know	22	20.95
No	81	77.14
Yes	02	01.90
Total	105	100.00

Local language names for the larva and adult of *R. phoenicis*: Among the Ewe, the larva is called Gbomi or Gbamido, among the Watchi, it is called Asra, while the Akpossos call it Ouwolo (Table 11). The adult is called Sablidjo, Assomodjoe, Ataklui, Sisribisi or Sramidjro by the Ewe, Konokounou by the Watchi and kokotchoni by the Akposso (Table 12).

Collection methods and equipment: larvae of *R. phoenicis* are collected by hand (Table 13). The equipment used for collection includes cutters, axes, pickaxes and basins (Table 13). The larvae develop within a felled and decomposing palm trunk. The equipment used by the operators is therefore needed to open the palm trunk in order to find and collect the larvae.

Figure 3. Photo of the larvae of *R. phoenicis*

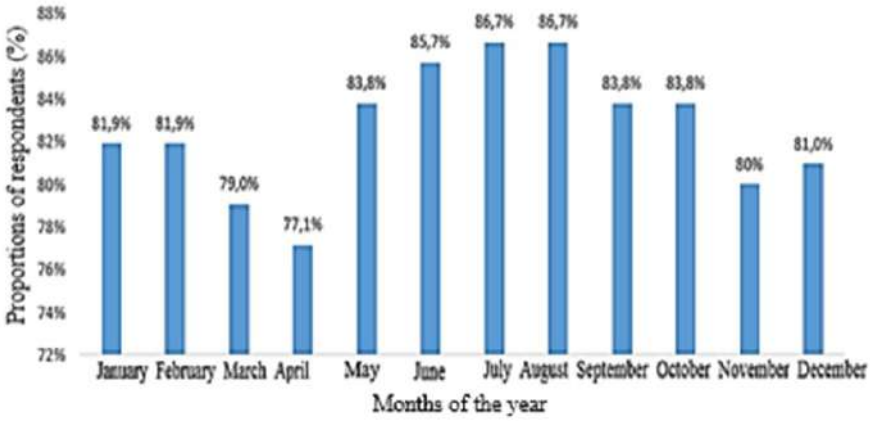

Figure 4. Availability of the larvae of *R. phoenicis* throughout the year

Figure 5. Some forms of the larvae of *R. phoenicis* consumption in association with other foods (A): dish of 'Djinkoumé' (paste seasoned with roasted maize) with tomato sauce and green pepper accompanied by larvae of *R. phoenicis*; (B): dish of 'Djinkoumé' (paste seasoned with roasted maize) with green pepper accompanied by larvae of *R. phoenicis*; (C): vegetable sauce accompanied by larvae of *R. phoenicis*; (D): rice in a tomato sauce with larvae of *R. phoenicis*; (E): foufou (pounded yam) in a white sauce with larvae of *R. phoenicis*; (F): cooked yam with a tomato sauce with larvae of *R. phoenicis*; (G): "Gari Foto" (seasoned cassava flour) mixed with roasted larvae of *R. phoenicis*; (H): cooked cassava with roasted and seasoned larvae of *R. phoenicis*

Table 11. Distribution according to the local name of the larva consumed

Local name of the larva	Number of participants	Proportion (%)
Asra (Watchi)	32	32.38
Gbomi (Ewé)	28	26.67
Gbamido (Ewé)	16	15.24
Ouwolo (Akposso)	16	15.24
No answer	07	06.66
Konokounou (Ewé & Watchi)	02	01.90
Kpando (Kabyè)	01	00.95
Sousoyé (Tchamba)	01	00.95
Koutong-nassakpella (Moba)	01	00.95
Total	105	100.00

Table 12. Distribution according to the name of the adult insect in local languages

Name of the adult insect in local languages	Number of participants	Proportion (%)
No answer	35	33.33
Konokounou (Watchi)	31	29.52
Sablidjo (Ewé)	14	13.33
Kokotchoni (Akposso)	10	09.52
Sramidjro (Ewé)	06	05.71
Ataklui (Ewé)	02	01.90
Ekotsoni (Akposso)	02	01.90
Asra (Watchi)	01	00.95
Assomodjoe (Ewé)	01	00.95
Kpando (Kabtè)	01	00.95
Midimiou (Tchamba)	01	00.95
Sisribisi (Ewé)	01	00.95
Total	105	100.00

Table 13. Insect collection methods and equipment

Methods	Number of participants	Proportion (%)
Hand picking	105	100.00
Other collection methods	00	00.00
Total	105	100.00
Equipment	Number of participants	Proportion (%)
Basins	94	89.52
Cutters	104	99.05
Axes	06	05.71
Pickaxes	01	00.95

Availability of larvae of *R. phoenicis*: the larvae were reported to be available throughout the year, with greater availability in June, July and August (Figure 4). These results were similar to those reported by Badanaro (2015) who also indicated that larvae of *R. phoenicis* were available throughout the year. These results indicated that the Togolese population in general, and those surveyed in particular, had a very good knowledge of the larvae of *R. phoenicis*, and that this knowledge is not related to age or level of schooling. These data are consistent with those reported by Mabossy-Mobouna and Malaisse (2020) in Congo. This is also an asset for the development of these larvae as an endogenous source of healthy and sustainable food security in the era of food transition in developing countries, where the prevalence of chronic diseases is constantly increasing.

Dietary and therapeutic uses of the larvae of *R. phoenicis*

Taste of the larvae: Overall, consumers said that larvae of *R. phoenicis* have a good taste (Table 14), similar to that of beef.

Table 14. Taste of the larvae of *R. phoenicis* according to respondents

Taste	**Number of participants**	**Proportion (%)**
Good taste	102	97.14
Bad taste	03	02.86
Total	105	100.00

Organoleptic characteristics are a source of motivation and have a major influence on food acceptability. The aroma, taste and visual appearance of a food are highly appetising and stimulate consumption (Bauer *et al*., 2010). Comestible insects such as the alates of termites form *Macrotermes* genus have a very thin cuticle that is less crunchy and more pleasant to eat (Kadanga *et al*., 2022b). They also contain important nutrients for the population due to their richness in nutrients. These insects are therefore often eaten by populations instead of meat and fish (Tango, 1981).

Types of larvae of *R. phoenicis* consumers: The survey revealed that all the participants were interested in eating the larvae of *R. phoenicis* (Table 15), regardless of age. These results confirm that the larvae are eaten by the population even at an early age. From the age of six months, children are fed with supplementary food. Most families in rural areas eat the same meal with their young children, who are still breast-feeding.

Table 15. Consumers of the larvae of *R. phoenicis*

Type of consumers	Number of participants	Proportion (%)
Child	90	85.71
Young people	88	83.81
Adults	90	85.71
Seniors	90	85.71

This explains the introduction of the larvae of *R. phoenicis* into the diet of young children in the surveyed areas. In addition, the larvae are an interesting source of animal protein for these young children.

Allergy linked to the consumption of the larvae of *R. phoenicis*: The majority of participants (95.24%) said that eating the larvae of *R. phoenicis* did not cause allergies (Table 16).

Table 16. Allergies linked to the consumption of larvae of *R. phoenicis*

Allergies	Number of participants	Proportion (%)
Don't know	04	03.81
No	100	95.24
Yes	01	00.95
Total	105	100.00

While some comestible insects often cause allergies to some consumers, the larvae of *R. phoenicis* were related to be save from causing such allergies, justifying its consumption by young children in the surveyed areas.

Therapeutic uses of larvae of *R. phoenicis*: 80.95% of the surveyed people said they had no knowledge of the therapeutic uses of the insect and 19.05% said they used it (Table 17) to treat a number of illnesses, including epilepsy, mouth sores, high blood pressure and heart disease (Table 18).

Table 17. Therapeutic use of the insect

Therapeutic use	Number of participants	Proportion (%)
Don't know	67	63.81
No	18	17.14
Yes	20	19.05
Total	105	100.00

Table 18. Pathologies treated with larvae of *R. phoenicis*

Pathologies	Number of participants (N=20)	Proportion (%)
Diabetes	01	05.00
Asthma	01	05.00
Epilepsy	05	25.00
Sexual weakness	01	05.00
High blood pressure	02	10.00
Joint disease	01	05.00
Heart disease	01	05.00
Whitlow	02	10.00
Mouth sore	07	35.00

Figure 6. Some forms of the larvae of *R. phoenicis* consumption without association with other foods (A): roasted larvae of *R. phoenicis*; (B): dish of larvae of *R. phoenicis* cooked in water and spiced; (C) and (D): braised larvae of *R. phoenicis* in the form of brochettes

These uses show that the larvae of *R. phoenicis* had pharmacological interest (Raheem *et al*., 2018), as are most other insects. Chen *et al*. (2009) reported that caterpillars, for example, has immune stimulant and anticancer properties. In traditional Chinese medicine, the male *Antheraea pernyi* is also prescribed as an aphrodisiac (Chen *et al*., 2009).

Larvae consumption patterns and various associated foods: The survey revealed that larvae of *R. phoenicis* are often consumed after being heat-processed, roasted (98.10%), braised (29.52%) or steamed (19.05%) (Table 19).

These larvae are freely eaten without taboo for the majority of participants (87.62%) (Table 19) and are therefore freely consumed (Badanaro, 2015; Mabossy-Mobouna and Malaisse, 2020).

Table 19. Forms of the larvae of *R. phoenicis* consumption and related taboos

Form of consumption	Number of participants	Proportion (%)
Raw	22	20.95
Cooked	20	19.05
Roasted	103	98.10
Fried	07	06.67
Braised	31	29.52
Taboos associated with consumption	Number of participants	Proportion (%)
Don't know	08	07.62
No	92	87.62
Yes	05	04.76
Total	105	100.00

Table 20. Foods associated with larvae of *R. phoenicis*

Foods associated	Number of participants	Proportion (%)
Sauce	35	33.33
Rice	12	11.43
Vegetable	01	00.95
Gari	57	54.29
Djinkoumé	01	00.95
Cowpeas	01	00.95
Cooked yam	01	00.95
Cooked cassava	02	01.90
Maize paste	01	00.95

These data are similar with those reported by Van Huis (2003), who indicated that in sub-Saharan Africa, the larvae of *R. phoenicis* are often eaten grilled or fried. Furthermore, the food most associated with the larvae of *R. phoenicis* in the study area was 'gari' (cassava flour) as a substitute for eggs or small fish (Table 20).

Table 21. Conservation and storage life of the larvae of *R. phoenicis*

Storage methods	Number of participants (N =105)	Proportion (%)
Drying	17	16.19
Smoking	03	02.86
Salting	11	10.48
Others	01	00.95
Roasting	67	63.81
Braising	16	15.23
Storage life	Number of participants	Proportion (%)
Don't kown	40	38.10
Three days	25	23.81
One week	33	31.43
Two weeks	07	06.67
Total	105	100.00

Table 22. Reasons and limiting factors for larvae of *R. phoenicis* consumption

Reasons	Number of participants (N = 105)	Proportion (%)
Curiosity	2	1.90
Nutritional Value	70	66.67
Flavour	11	10.48
Others	3	2.86
Limiting factors	Number of participants (N = 105)	Proportion (%)
Ignorance	2	1.90
Fear linked to the insect's appearance	98	93.33
Lack of opportunities	3	2.86

Figures 5 and 6 show some photos of different dishes prepared using the larvae of *R. phoenicis*, combined with other foods or not, as reported by Badanaro (2015). Other forms of edible insect consumption have also been reported in some African countries, where children are fed with flour made with dried caterpillars to overcome malnutrition (FAO, 2004). Overall, the larvae of *R. phoenicis* processing observed in the present study make it possible to reduce water activity and thus limit the presence of germs in this foodstuff, as in the case of roasted termites (Kadanga *et al*., 2022a). In addition, the diversity of the larvae of *R. phoenicis* processing methods confirms that this foodstuff is well known to all the surveyed populations. Due to the importance of these larvae as a foodstuff, we need to investigate the processes used to produce the dishes in which they are incorporated. Figures 5 and 6 show some photos of different dishes prepared using palm worms, combined with other foods or not, as reported by Badanaro (2015). Other forms of edible insect consumption have also been reported in some African countries, where children are fed with flour made from dried chenille to overcome malnutrition (FAO, 2004). Overall, the forms of palm worm processing observed in the present study make it possible to reduce water activity and thus limit the presence of germs in this foodstuff, as in the case of roasted termites (Kadanga *et al*., 2022a). In addition, the diversity of palm worm processing methods confirms that this foodstuff is well known to all the populations surveyed. Given the importance of palm worms as a foodstuff, we need to investigate the processes used to produce the dishes in which they are incorporated.

Conservation of the **larvae of *R. phoenicis*:** The participants stated that the larvae of *R. phoenicis* can be preserved by drying, smoking, salting, roasting or braising as in the case of fish, with a storage life of up to two weeks (Table 21). The data from the present study are similar to those reported by Ekpo and Oningbinde (2005) in Nigeria on comestible insects preserved in cooked or grilled form in their own fat and eaten with cassava sticks. Furthermore, according to the FAO (2004), comestible insects are subjected to a variety of culinary treatments. They are generally dried to improve their preservation. These forms of cooking improve the palatability of the insects and the availability of nutrients. Previous studies have also noted aroma and nutritional value as factors motivating the consumption of these larvae (Obopile and Seeletso, 2013; Boko and Angaman, 2021) and still others have also indicated flavour (Ehounou *et al*., 2017). These factors therefore vary from one people to another.

CONCLUSION

This study is a contribution to food security through the use of **the** larvae of *R. phoenicis*, as entomophagy is a solution to the growing demand for protein resources. This study enabled us to assess the level of knowledge in a number of localities in southern Togo and to highlight a number of dishes prepared using **the** larvae of *R. phoenicis*. These larvae are eaten in all three surveyed localities and are prized by various ethnic groups, mainly the Ewé, Watchi and Akposso for its taste. People of all ages and occupations ate the larvae of *R. phoenicis* because they are aware of their nutritional quality and flavour. The surveyed people have mastered the local name for the larvae, which is the most commonly consumed stage of the insect. Consumption is often in roasted form, which is the main form of preservation, with a storage life of up to two weeks. **The** larvae of *R. phoenicis* are also associated with foods such as gari (cassava flour), sauce, rice and Djinkoumé (roasted maize paste).

REFERENCES

Anaïs V. T. 2017. Mobilités, foncier et système de production. *In :*Partir et cultiver *; Essor de la quinoa, mobilités et recompositions rurales en Bolivie. Edition IRD, 195-221. Available on line at : https://books.openedition.org/irdeditions/9194?lang=en. Accessed October 27, 2023.*

Badanaro, F. 2015. les insectes comestibles au Togo : ethnoentomologie et potentiel nutritionnelle. PhD Thesis in Biochemistry Applied to Nutrition and Food, University of Lomé Togo) ; 180p.

Bauer W., Badou R., Loliger J., Etournaud A. 2010. Science et technologie des aliments : Principes de chimie des constituants et technologie des procédés. Ed. Presses polytechniques et universitaires Romandes ; 720p.

Billand, A., Caron, P., 2017. In le choix de réunir faim, sécurité alimentaire et agriculture durable, IRD Éditions. Chapitre 6. ODD 2. Available on line at : https://doi.org/10.4000/books.irdeditions.21531. Accessed May 15, 2023.

Boko A.C.E., Angaman D. M., 2021. Evaluation de L'entomophagie dans Quatre Grandes Villes de Côte d'Ivoire. European Scientific Journal, ESJ; 1737),1.

Chen, X., Feng, Y., & Chen, Z. 2009. Common edible insects and their utilization in China. Entomological Research; 395. 299–303.

Cloutier, J., Amevoin, K., Ayieko, M. 2015. Insectes comestibles en Afrique : Introduction à la collecte, au mode de préparation et à la consommation des insectes. Agrodok ; 54 :19-23.

DeFoliart, G.R. 1992. Insects as Human Food. Elsevier Science publishers), pp: 295-399.

Ehounou, G.P., OualiN'goran, S.W., & Niassy, S. 2017. Assessment of entomophagy in Abidjan Côte D'ivoire, West Africa). African Journal of Food Science; 12:614.

Ekpo, K.E., & Onigbinde, A.O. 2005. Nutritional potentials of the larva ofRhynchophorus phoenicis. Pakistan Journal of Nutrition,45. 287–290.14.

FAO 2004. Etat de l'insécurité alimentaire dans le monde ; Suivi des progrès accomplis en vue de la réalisation du Sommet mondial de l'alimentation et de la Déclaration du Millénaire ; 43p.

FAO 2014. Insectes comestibles, perspectives pour la sécurité alimentaire et l'alimentation animale. Etude FAO forêts.; Rome, 224 pp.

FAO/WHO 2012 Expert consultation meeting: assessing the potential of insects as food and feed in assuring food security. P. Vantomme, Summary report; 23–25 January 2012, Rome.

Fessard, R., 2020): Le ver de palmier : un insecte bénéfique pour la santé. Available on line at: https://blog.insectescomestibles.fr/le-ver-de-palmier-un-insecte-benefique-pour-la-sante/. *Accessed May 01, 2023.*

Kadanga M., Kasseney D.B, Dossou B.R., Awi T., Melila M., Paka E., Tchacondo T., Glitho I.A. 2022a. Hygienic Quality of *Macrotermes* Isoptera, Termitidae) alates consumed in Lomé Togo). Asian J Biol Life Sci.; 112. 586-93.

Kadanga M., Kasseney D.B, Dossou B.R., Awi T., Melila M., Tchacondo T., Glitho I.A. 2022b. Food Usage of Macrotermes Isoptera, Termitidae) Alates in Lome Southern Togo); Int. J. Adv. Res.; 1004), 628-635.

Mabossy-Mobouna, G. et Malaisse, F. 2020) : La consommation par l'homme de Coléoptères en République du Congo

Obopile, M., & Seeletso, T.G. 2013). Eat or not eat: An analysis of the status of entomophagy in Botswana. Food security; 56. 817-824.

Ogbalu, O. K. and Williams, J. O., 2015. The Edibility, Methods of Preparation of the Raphia Palm Beetle, *Rhyncophorus Phoenicis* [Coleoptera: Curculionidae] In the Niger Delta and Associated

Microorganisms Journal of Pharmacy and Biological Sciences; 102; 125 – 129.

Raheem, D., Carrascosa, C., Oluwole, O.B., Nieuwland, M., Saraiva, A., Millan, R., & Raposo, A. 2018). Traditional consumption of and rearing edible insects in Africa, Asia and Europe. Critical Reviews in Food Science and Nutrition; 394. 521-540.

RGPH5-INSEED 2023) : 5ème Recensement Général de la Population et de l'Habitat au Togo ; Présentation des principaux résultats définitifs. Available on line at : https://inseed.tg/category/rgph5/. *Accessed September 08, 2023.*

Rumpold BA. and Schlüter OK., 2013. Potential and challenges of insects as an innovative source for food and feed production. Innovative Food Science and Emerging Technologies ; 17.1-11.

Tamesse, J.L., S. Kekeunou, L.J. Tchatchouang, O.L.M. Ndegue, L.M. Aissatou, D. Tombouck, and B. Youssa. 2016. Insects as food, traditional medicine and cultural rites in the west and south regions of Cameroon. Journal of Insects as Food and Feed; 23. 153-160. https://doi.org/10.3920/JIFF2015.0088.

Van Huis, A. 2003). Medical and stimulating properties ascribed to arthropods and their products in sub-Saharan Africa. In É. MotteFlorac & J.M.C. Thomas, eds. Insects in oral literature and traditions, Paris, Peeters; pp. 367–382.

Womeni HM, Tiencheu B, Linder M, Nabayo CME, Tenyang N, Mbiapo TF, Villeneuve P, Fanni J and Parmentier M., 2012. Nutritional value and effect of cooking, drying and storage process on some functional properties of *Rhynchophorus phoenicis*. International Journal of Life Science and Pharma Research; 23: 203–219.

Yen, A.L. 2009. Entomophagy and insect conservation: some thoughts for digestion. Journal of Insect Conservation, 13 : 667–670.

****