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CONSUMPTION OF INSECTS AS FOOD IN THREE VILLAGES OF NORTH WEST DISTRICT,BOTSWANA

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Abstract

This study investigated the consumption of edible insects in Nxaraga, Sehithwa and Shorobe villages of the North West district of Botswana. Information was gathered using a structured questionnaire which was administered to 60 respondents across the three villages and also through direct observation. A total of six insect species were identified belonging to six families and four orders (i.e., Coleoptera, Isoptera, Lepidoptera and Orthoptera) with the two most consumed orders being Lepidoptera and Coleoptera. Carebara vidua F. Smith (33.3%) was the most consumed followed by Sternocera orissa Buq. (21.7%), Agrius convolvuli L. (15.0%), Oryctes boas Fabr.(13.3%), Imbrasia belina Westwood (10.0%) and Locusta migratoria (6.7%). The study revealed that insects were abundant during and/or immediately after the rainy season. This implies that insects can be harvested and preserved during the time of abundance to maximize their utilization in meeting the human protein needs. The common methods of collecting insects were hand picking, trapping and digging. Insects were prepared for consumption by boiling, frying or roasting. Insects were used for consumption (52%) and sale (48%). Entomophagy is a source of food and income indicating that it plays an important role in the rural economy.

Keywords: Botswana; edible insects;entomophagy; food, income; livelihoods

I. INTRODUCTION

Protein deficiency is a nutritional problem in most developing countries (Muller and Krawinkel, 2005) due to over-dependence on conventional animal protein sources such as beef, mutton, pork and poultry, which are in limited supply (Jacob *etal.,* 2013). One of the Millennium Development objectives of the United Nations was to fight world hunger by ensuring affordable protein consumption that aims at reducing the amount of land, water and other resources used, as well as, preservation of biodiversity (Mackiewicz, 2010). However, with the global shortage of animal protein, there are emerging future prospects that focus on exploring unconventional protein sources including insects. Xiaoming*et al.* (2010) reported that edible insects are rich in protein and amino acids, especially essential amino acids for the human body.Additionally, Maurer*et al.* (2015) suggested that insects are likely to play an important role as sources of protein for livestock in the future.

Entomophagy is the consumption of insects by humans (Jacob *et al.*, 2013; van Huis *et al.*, 2013; Pal and Roy, 2014) and this practice has been part of the human history for many centuries. However, Durst and Shono (2010) observed that entomophagy has declined in many societies, and that it has often been shunned as old-fashioned, dirty or unhealthy. Entomophagy is associated with the hungry and the poor (Bertrand, 2014) perhaps explaining why it is commonly practised in the Developing countries. In many western societies, entomophagy was and still is a taboo (van Huis *et al.*, 2013). Insects form part of most traditional diets of at least 2 billion people worldwidemainly in

Asia, Africa and Latin America (FAO, 2013; Pal and Roy, 2014). In most African countries, insects are gathered from the forest habitats by women and children for consumption (Solomon and Prisca, 2012). It is estimated (van Huis, 2013) that there are about 1900 edible insect groups that provide nutrition to humans with the most common groups being beetles, caterpillars, bees, ants, grasshoppers, crickets, larvae, termites, wasps, locusts, moth, bugs and cicadas. Tsvangirayi (2013) found that *Mophane* worm *(Imbrasia belina* Westwood*)* known in Botswana as *phane* contains five times the amount of protein as beef. The protein content of edible insects ranges from 30% (wood worms) to 80% (some wasp species) (Melo *et al*., 2011).

Although the consumption of insects has great benefits, there is lack of awareness of entomophagy and its advantages as part of the solution to protein deficient malnutrition in the Developing countries (Jacob *etal*., 2013). van Huis (2003) observed that insects as a source of food have been neglected in the past and should receive more attention in the future. Food shortages particularly animal protein, are predicted for the 21stcentury, hence it is necessary to look for new sources of animal protein (Mitsuhashi, 2010). Therefore, a study was undertaken to document information on insects used for human consumption and their contribution to the livelihoods of people in Nxaraga, Sehithwa and Shorobe in the North West District of Botswana.

II. MATERIALS AND METHODS

2.1 Selection of study sites

This study was carried out in Sehithwa, Nxaraga and Shorobe in the North West District (Figure 1) during December 2014. The following are location coordinates for each village: Sehithwa 20º 28' 00" S and 22 43' 00" E, Nxaraga 19º 33 '42 21" S and 23º 12 '23 32" E, and Shorobe 19° 45' 43" S and 23º 40' 37" E (CSO 2011). The distances of Sehithwa, Nxaraga and Shorobe from Maun (the capital of North West District) are 97 km, 35 km and 45 km, respectively. Furthermore, Sehithwa, Nxaraga and Shorobe have estimated human populations of 1478, 232 and 955, respectively (CSO, 2011).

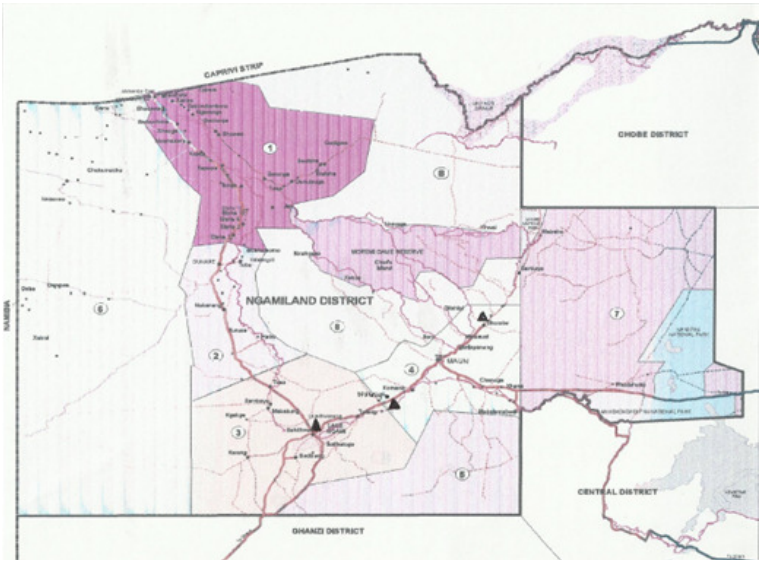

Figure 1: Map of North West District showing research sites which are indicated by triangles
Source: http://www.orc.ub.bw

2.2 Sample design

A random sampling technique was used to select 60 respondents (Sehithwa - 30, Shorobe - 20 and Nxaraga- 10) from the study area. The sample size was proportional to the human population of the three villages.

2.3 Data collection and analysis

A structured questionnaire was administered to 60 respondents in order to gather information on edible insects in the study area. Interviews were conducted in Setswana (a local language) and responses written in English. Data were also collected through direct observation and from secondary sources. The following data were collected: socio-economic characteristics (*i.e.*, age, sex, educational level) of the respondents, edible insects, time of insects' availability, how insects were prepared or processed before consumption, how insects were preserved, who was involved in insect collection, marketing and sale of insects.Data were analysed using Statistical Package for Social Sciences (SPSS) for Windows, version 15.0 (2015). Summary statistics were presented by tables and figures.

III. RESULTS AND DISCUSSIONS

3.1 Socio-economic characteristics

Table 1 gives socio-economic characteristics of respondents. About 57% of the respondents were males. Previous study ofObopile and Seeletso (2013) showed that the majority (65.27%) of the respondents were females. In this study, the majority (31.7%) of the respondents were aged 41-55 years with fewer (13.3%) respondents aged over 70 years (Table 1). Previous study by Moreki (2014) showed that 31.03% of the respondents were aged >60 years while Obopile and Seeletso (2013) found that 23.95% of the respondents were aged 46-55 years. About 37% of the respondents in this study never attended formal school while only 1.7% of the respondents had tertiary education. Similarly, Obopile and Seeletso (2013) and Moreki (2014) reported that the majority (37%) of the respondents had no formal education. The respondents that never attended formal school are likely not to comprehend technical extension message.

Table 1: Socio-economic characteristics of the respondents in the study area

Attributes	**Number of responses**			
	Nxaraga	**Sehithwa**	**Shorobe**	
Gender	Nxaraga	Sehithwa	Shorobe	**Total**
Male	6 (60.00)	15 (50.00)	13 (65.00)	**34 (56.6)**
Female	4 (40.00)	15 (50.00)	7 (35.00)	**26 (43.3)**
Age (years)				
10-25	1 (14.20)	4 (57.14)	2 (28.57)	**7 (11.7)**
26-40	1 (9.09)	4 (36.26)	6 (54.54)	**11 (18.3)**
41-55	3 (15.79)	9 (47.37)	7 (36.84)	**19 (31.7)**
56-70	4 (26.67)	4 (26.67)	8 (53.33)	**15 (25.0)**
>70	1 (12.50)	5 (62.50)	2 (25.00)	**8 (13.3)**
Educational level				
Never attended formal school	3 (13.64)	15 (68.18)	4 (18.18)	**22 (36.7)**
Primary	3 (16.67)	7 (38.89)	8 (44.44)	**18 (30.0)**
Junior Certificate	4 (23.53)	6 (35.29)	7 (41.18)	**17 (28.3)**
O level/BGCSE	0 (00.00)	1 (50.00)	1 (50.00)	**2 (3.3)**
University/college	0 (00.00)	1 (100.00)	0 (00.00)	**1 (1.7)**
Employment status				
Employed	5 (50.00)	7 (23.33)	8 (40.00)	**20 (66.7)**
Unemployed	5 (50.00)	23 (76.67)	12 (60.00)	**40 (33.3)**
Marital status				
Married	3 (12.00)	12 (48.00)	10 (40.00)	**25 (41.7)**
Single	4 (23.53)	7 (41.17)	6 (35.29)	**17 (28.3)**
Widowed	3 (16.67)	11 (61.11)	4 (22.22)	**18 (30.0)**

*Values in brackets are percentages

The majority (67%) of the respondents in this study were unemployed while the remainder was employed perhaps indicating that the respondents did not have economic power to purchase conventional protein sources such as beef, mutton and chicken; and are therefore likely to suffer from protein deficiency. Table 1 shows that 41.7% of the respondents were married followed by widowed (30%) and single (28.3%).

3.2 Edible insect species and stage of utilisation

Data on taxonomic position andconsumption stage of insects by the respondentsare given in Table 2. Eggs, immature (larvae) and adult stages of insects were consumed. According to Okore *et al.* (2014), insects are consumed either in one or more of stages of development (*i.e.*, egg, larva, pupa and adult) in their life cycle. Obopile and Seeletso (2013) in Botswana identified 27 edible species of insects (beside the *mophane* worm) consumed in Kgalagadi, Kgatleng, Kweneng, North-East, Central and Southern districts. In a related study, Moreki (2014) identified 22 insect species that are consumed as human food in Mogonono in Kweneng District.

Table 2: Inventory of insects in the study area

Order	Family name	Scientific name	English Name	Local Name	Mode of intake
Isoptera	Formicidae	*Carebara vidua* Smith	African thief ant	Ntlhwa	Winged adult
Coleoptera	Buprestidae	*Sternocera orissa* Buq.	Giant jewel beetle	Lebezana	Winged adult and eggs
Coleoptera	Dynastidae	*Oryctes boas* Fabr.	Scarab larvae	Thethe	Larvae
Lepidoptera	Sphingidae	*Agrius convolvuli* L.	Hawk moth	Monakamongwe	Larvae
Lepidoptera	Saturnidae	*Imbrasia belina* Westwood	Mophane worm	Phane	Larvae
Orthoptera	Hodotermidae	*Locusta migratoria*	Locust	Tsie	Winged adult

According to Johnson (2010), entomophagy appears to be culturally universal, only varying with location, insect populations and ethnic group. Table 3 shows that the three most consumed insects in the study area *C. vidua* F. Smith(33.3%), *S. orissa* Buq. (21.7%) and *A. convolvuli* L. (15.0%). In Sehithwa, the two most consumed insects were *S. orissa* Fabr. (36.67%) and *C. vidua* F. Smith (26.67%) while the least consumed was *L. migratoria* (10.0%). For Nxaraga, the two most consumed insects were *A. Convolvuli* L. (50.0%) and *C. vidua* F. Smith (30.0%) while the least consumed was *S. orissa* Buq. (20.0%). The two most consumed insects in Shorobe were *C. vidua* F. Smith (45.0%) and by *I. belina* Westwood (30.0%) with *L. migratoria* (0.05%) being the least consumed. *Imbrasia belina* Westwood was only consumed in Shorobe but not in Sehithwa and Nxaraga. This could be because Shorobe is dominated by *mophane* trees which *I. belina* Westwood feeds on while *Acacia* tree species are predominant in Sehithwa and Nxaraga. It is apparent that the consumption of insects varied between the villages. Dube *et al.* (2013) reported that the consumption of *mophane* worms in Botswana varies depending on their availability. For Fleshman (2007) concentrations and diversity of insects are determined by their food plants and seasonal conditions.

Table 3: Insect species consumed in the three villages of North West District

Scientific name	Nxaraga		Sehithwa		Shorobe	
	Frequency	%	Frequency	%	Frequency	%
Carebara vidua F. Smith	8	26.7	3	30.3	9	45.0
Imbrasia belina Westwood	0	0	0	0	6	30.0
Oryctes boas Fabr.	4	13.3	0	0	4	20.0
Sternocera orissa Fabr.	11	36.7	2	20	0	0
Agrius convolvuli L.	4	13.3	5	50	0	0
Locusta migratoria	3	10	0	0	1	5
Total	**30**	**100**	**10**	**100**	**20**	**100**

Sixty-three percent of the respondents mentioned that they had eaten insects before while the remainder had never eaten insects (Table 3). The respondents that did not consume insects said they were not exposed to entomophagy during their childhoods; hence they were not comfortable eating insects. Mitsuhashi (2010) mentioned that many people dislike or are hesitant to eat insects because they believe that insects are dirty, harmful or inspire fear. In agreement with van Huis (2003) who reported that western civilizations think that entomophagy occurs because of starvation, 30% of the respondents in this study said that insects were eaten by the poor and less privileged members of the society. Similarly, Bertrand (2014) noted that entomophagy has been associated with the hungry and the poor. About 15% of the respondents in the present study mentioned that they used insects as baits during fishing activities. For example, *O. boas* Fabr.was used as bait for fishing activity in Lake Ngami and Thamalakane river. In agreement with the current results, Chakravorty *et al.* (2011) reported that Nyishi and Galo tribes in India used *Brachytrypes sp.* as baits to catch fowl, birds and fishes.

Nearly 80% of the respondents in this study had no knowledge of taboos and beliefs associated with entomophagy. However, the respondents in Nxaraga believed that houses should be left open all the time during the collection of *C. vidua* F. Smith as closing the houses resulted in the collectors not being able to collect enough insects or nothing at all. As a consequence, harvesters usually left their houses open during the collection of *C. vidua* F. Smith.

3.3 Seasonal availability

Table 4 shows that edible insects are available for collection during the rainy season *i.e.*, October to February. Moreki (2014) in Botswana observed that most insects are available immediately after the rainy season. In addition, Ayieko (2013) reported that edible insects occur seasonally, thus resulting in their consumption being seasonal. Of all the insects in Table 4, *L. migratoria* was said not to occur anymore in the villages probably due to the use of pesticides in croplands and also climate change. The respondents also mentioned that *I. belina* Westwood no longer occurred in abundance due to the reduction of rainfall amount which promotes vegetative production of *mophane* trees. Chiripasi *et al.* (2013) reported that the availability of the *mophane* worm relies mainly on the amount of rainfall to promote vegetative production of *mophane* trees. It appears that the nutrition of the respondents is detrimentally affected when insects are unavailable for collection from April to September (Table 4). This implies that the rural people are likely to suffer malnutrition during this period due to the decline in protein supply. The current results have shown that edible insects contribute to the socio-economic well-being of the people in the three villages. Harvesting and trade of insects provide important income to many rural families. For instance, *I. belina* Westwood, *C. vidua* F. Smith and the *A. convolvuli* L. generate income for the rural dwellers resulting in improvements in their livelihoods. During the months when insects are scarce and/or unavailable, there is no trade of insects and this has a bearing on livelihoods of the respondents.

Table 4: Seasonal availability of edible insects in the study area

Insect species	Months of the year											
	J	F	M	A	M	J	J	A	S	O	N	D
Carebara vidua F. Smith										X	X	X
Sternocera orissa Buq.	X	X								X	X	X
Agrius convolvuli L.	X	X	X							X	X	X
Imbrasia belina Westwood	X	X	X	X								X
Oryctes boas Fabr.	X	X	X							X	X	X
Locusta migratoria	X	X								X		

X = time of availability

3.4 Collection methods

Insects were collected or harvested by hand picking (51.6%), trapping using light (36.7%) and digging (11.7%). The scarab larvae (*O. boas* Fabr.) were collected by digging (15%) and were usually harvested from cattle and goat kraals (livestock enclosures). Thirty-six percent of the respondents said that they trapped *C. vidua* F. Smith at night just after the first rains by making fire next to the dug holes which insects will fall into, whereas the remainder used buckets with water under or near the light source to trapping the insects. van Huis (2003) reported that light trapping is the most common method used to catch edible insects in Africa.

According to the respondents, *L. migratoria* were hand-picked from the crop lands. Similarly, the larval stage of *A. convolvuli* L. and *I. belina* Westwood were hand-picked from plants as they were found clinging onto the leaves. The adult stage of *S. orissa* Buq was also hand-picked from *Acacia* trees and prepared by roasting in hot ash. The current results are consistent with Obopile and Seeletso (2013) who reported that insects were harvested for food by hand picking, trapping and digging. About 78% of the respondents in this study mentioned that edible insects were collected by both men, women and children; women only (11.7%); children only (8.3%); and men only (1.7%). Similarly, Maufor *et al.* (2014) in Cameroon reported that children (33%), adult males (20%) and females (47%) were insect collectors. The two studies have shown that women and children play major roles in the harvesting of insects for food. Moreki (2014) reported that men, women and children participated in the harvesting of insects for human consumption.

Insects were used for home consumption (52%) and sale (48%) indicating that insects play important roles in the rural economy as suppliers of food and as a source of income. Insects that were commonly sold were *C. vidua* F. Smith and *I. belina* Westwood. Insects were sold mainly in Maun main market (*i.e.*, at the bus terminal and in front of shops) while some were sold from home. The average selling price for *C. vidua* F. Smith was P5.00 (USD0.5) per 15 g sample, *I. belina* Westwood was P10.00 (USD1) per 500 g sample, *A. convolvuli* L. P3.00 (USD0.3) per 250 g sample, whereas *S. orissa* Buq, *L. Migratoria* and *O. boas* Fabr. were not sold but consumed by families. *Imbrasia belina* Westwood is the most expensive of the insects sold in the village market and probably the most nutritious of the insects in the present study. It is estimated that the crude protein content of *I. belina* Westood is 48 to 55.41% (Ghaly, 2009; Kwiri *et al.*, 2014), thus making it highly nutritious. Moruakgomo (1996) reported that *I. belina* Westwoodis the most commercialized insect in Botswana that is often sold in villages and urban centres where it fetches a higher price. Previous study by Illgner and Nel (1982) reported that edible insects are not only sold widely in the village markets but have found their way to urban markets and restaurants of the developing world. In Zambia, Siulwapa *et al*. (2012) reported that people usually sell roasted *mophane* worms in the city markets in the Copperbelt, Lusaka, and Livingstone where they fetch a higher price. In this study, *S. orissa* Buq. and*O. boas* Fabr. were not abundant during the harvesting season; hence they were used mainly for human consumption.

3.5 Preparation and preservation of insects

In the present study, insects were prepared for consumption by frying (48%), roasting (30%) and boiling (21.7%). Similar methods of preparation were reported by Chakravorty *et al.* (2011) and Okore *et al.* (2014). In several parts of Nigeria, *Rhyncophorus phoenicis* Fabr. are fried while termites are roasted before they can be eaten (Okore *et al.,* 2014). In this study, *O. boas* Fabr.were often fried in little oil without salting. *Agrius convolvuli* L. and *I. belina* Westwood in this study were degutted by squeezing the head to the anal region with fingers. Thereafter, they were boiled in salty water, dried in the sun for 5 to 7 days and stored in various containers for later use. *Sternocera orissa* Buq.was prepared by roasting in hot ash followed by removal of the wings and heads prior to eating. The *S. orissa* eggs enclosed in the insect's body were also consumed and were said to be delicious. Dube *et al.* (2013) reported that in Zimbabwe, *S. orissa* Buq. are fried in large pans and later dried before they are sold. In this study, *C. vidua* F. Smith were fried in their own oil without

adding salt and thereafter sun-dried for 2 to 3 days and stored for later use. The current results are inconsistent with Obopile and Seeletso (2013) who found that *C. vidua* F. Smith are eaten raw or fried with salt in a saucepan and eaten as a snack. About 72% of the respondents in this study said that they did not store insects after preparation but consumed them immediately while the remainder stored them. This finding is in disagreement with Obopile and Seeletso (2013) who found that 89% of respondents stored insects for later use after preparation. About 88% of respondents in this study used insects as snacks while the remainder used them as relish.

IV. CONCLUSION

Six edible insect species were identified belonging to four orders: Coleoptera, Lepidoptera, Orthoptera and Isoptera. Insects were prepared for consumption by frying, roasting and boiling. Although insects form an important part of nutrition of the people in the three villages, entomophagy seems to be at risk of decline. Therefore, there is a need to raise awareness of the contribution of insects to human nutrition and to promote their cultivation using modern techniques in order to increase their commercial value and availability.

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