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A SURVEY ON ENTOMOPHAGY PREVALENCE IN ZIMBABWE

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ABSTRACT

This study was to determine the prevalence of entomophagy in the post independence era (after 1980) in Zimbabwe given that the social status of many families has changed. A cross-sectional non probability sampling was used to determine who ate which insect and how much they ate and where they came from. The availability of each insect was determined at provinces and through key informants. Data were collected through questionnaires and physical visits to all provinces of Zimbabwe to collect empirical data. The population of those that never participated in entomophagy was less than 10% across the age groups in the sampled populations. In the order, Lepidoptera, which comprises several species the larval stages are mostly consumed in the fourth instar after degutting. The caterpillars are known locally as *madora*. *Imbrasia belina* was consumed by more than 90% of the respondents. In the order Isoptera *Macrotermes sp.* [ishwa] were consumed by more than 80% of the respondents. In the order Coleoptera *Eulepida sp,* [mandere] and *Sternocera orissa* [zvigakata] are also widely consumed. In the order Hemiptera only, *Encosternum delegorguei* [Haruwa] adult is consumed. In the order Homoptera only *Loba leopardina* [Nyeza nyeza] adult is consumed. In the order Hymenoptera only *Carebara vidua* [Tsambarafuta] adult is consumed. In the order Orthoptera *Brachytrupes membranaceus* [Gurwe], *Locusta migratoria* [mhashu] and *Ruspolia differens* [Nswabanda] are consumed. Records of quantities of insects harvested are here presented. Protein content of fully grown *Imbrasia belina* done by the Kjeldahl method was 54-58%. Matebeleland province had the highest tonnage of insects, most of which were exported to other provinces even to neighbouring countries. Manicaland harvested the least quantities of insects. Most of those who consumed insects preferred them in the dried form which were said to have improved organoleptic properties. Drying the insects prolonged their shelf life. Food security strategies for Zimbabwe should include management of harvesting and storage of these insects.

Key words: Entomophagy, Food, Nutrition, Zimbabwe, insects

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INTRODUCTION

Food security stands on three pillars, namely food availability, food access and food use. In Zimbabwe it is imperative that entomophagy should be one of these key factors. Visits to the food markets show that insects or their products are sold in most of them. Entomophagy is a common practice among rural and urban Zimbabweans. Generally, the insects eaten are those, which can be collected in large numbers and meet the organoleptic preferences of the consumers. Entomophagy is commonly practiced around the world [1- 6]. Insects have been used as food as far back as history of mankind. John the Baptist at the beginning of the first millennium lived on locusts. Chinese consume the larvae of the silk worm *Bombyx mori.* Australians eat the larvae of the *Euploea hamata*. Egyptians eat the beetle *Scarabaeus sacer* [6]. In Zimbabwe, a variety of insects are not only consumed in certain localities but they are also sold for money or exchanged for other necessities [1, 5, 7, 8]. Insects are some of the most abundant class of organisms in the world with a biomass exceeding 30% of that of all other animals put together. Their life cycle and food requirements are relatively simple, making them an easy to culture group [6]. Over 80% of all living animals are insects. About one million species of insects are known and over 7,000 new species are described every year worldwide. Prominent reasons for their success are: ability to live in and adapt to diverse habitats, high reproductive capacity, ability to consume different kinds and qualities of food, and the ability to escape quickly from their enemies [4, 6, 9].

Insects play both negative and positive roles in the lives of humans. They may destroy crops as pests and transmit diseases to man as vectors. It was the association of some insects to disease in the last century that triggered revulsion to entomophagy [6]. A number of insects including winged termites, grasshoppers, locusts, crickets, beetle grubs, ants and caterpillars are edible [1, 6]. They convert plant materials such as leaves, flowers, wood and others that are not available in palatable or digestible forms, making them available to humans in usable forms whose nutrients are readily available just as is the case with cattle and other large animals [9, 10, 11]. Insects are high in protein, energy and various vitamins and minerals. Food insects are eaten raw or roasted or are dried and added to other foods. The mature larvae of the palm weevil, *Rhynchophorus* species, have been utilized as food source by people of the tropical areas of Africa, Asia and Neotropics for centuries [1, 2, 6, 8]. Different ethnic groups in Africa may consume insects based on preference and abundance of particular insect species. The natives of southern Africa have used a number of insects as food, including caterpillars, locusts/grasshoppers, ants, termites and beetles [12, 13, 14]. Since insects are so abundant and contain many useful nutrients, including proteins and calories, they may contribute to solving the problem of malnutrition in Africa. Malnutrition continues to kill many children, act as a catalyst in various childhood diseases, exacerbate rates of illiteracy, unemployment and impede overall socio-economic development [1, 2, 3, 6, 9]. The present state of food security in Africa makes it obligatory to search for new food alternatives that could enrich the basic diet and fit within traditional African food habits. Studies in the traditional lifestyles of southern Africa suggest that insects may have supplied a substantial amount of 'animal' protein in the diet [1, 2, 5, 8]. The aim of this study was to

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determine the prevalence of entomophagy in Zimbabwe and assess if it is a declining practice in post independence period (1980 and after).

MATERIALS AND METHODS

A cross-sectional survey of entomophagy in Zimbabwe was performed in capitals of all provinces where 100 individuals were sampled in each capital. Key informants in the study were the harvesters, the marketers, the consumers of various insects and community leaders. In the case of harvesters, a non-probability method, the purposive sampling was used to select the participants who then completed an open-end questionnaire seeking to answer questions on quantities of each insect harvested. It would then be possible to calculate weight harvested the stage of the insect at harvest, postharvest preparation techniques and taboos if any on harvesting procedures. For those not articulate in English, the questions were interpreted to Shona or Ndebele, the two local languages.

For marketers, a non-probability method, the haphazard sampling was used to select the participants who then completed a closed ended questionnaire seeking to answer questions on quantities sold per unit time, the cost of the insects per unit mass, (20 litre, 5 litre, 1 litre containers are common units used by the sellers for measuring quantity). Contents of each measuring unit were weighed to get the average mass which was then used to calculate mass and cost handled by the marketers.

For consumers, a non-probability method, the multistage sampling was used to select the participants who were further stratified to create specific age groupings. The participants then completed a close ended questionnaire seeking to answer questions on the percentage of individuals actively consuming specific insects, and also give reasons why some persons did not eat certain insects. Results were analysed using Graph pad prism4 statistical package. Fifteen open food markets were visited and 12 Chain Super Markets in the provincial capitals where insects are sold were also considered as informants.

In order to determine the quantities of insects, the people who harvest the specific insects were asked to provide the amounts they gather on a yearly basis. Regularly used containers for measuring quantities of insects gathered are the 20 litre, 5 litre and 1 litre buckets. These units were converted to mass by weighing 10 samples to come up with an average estimate of mass per collecting unit of each particular insect. The mean mass gathered by an average harvester was then multiplied by the population of harvesters. The quantities sold by the vendors, and the amounts of insects arriving by local buses from various collecting points were used to confirm the quantities of insects in Zimbabwe.

Districts such as Gwanda and Masvingo which were the source of large quantities of insects were visited in order to obtain information from key informants, such as community leaders, which was used to construct a food availability calendar. Information acquired included harvesting procedures, postharvest preparations and storage. The available protein of *Imbrasia belina* harvested at different stages was

determined by the Kjeldahl method and infrared food analyser from Ostrindo Laboratories. Modification of methods of preparation was done on samples collected from the *mopane* trees in areas where these occur in large quantities. The organoleptic properties for *Imbrasia belina* were determined by individuals who regularly consumed these insects at their homesteads using a nominal scale. Some worms were heated in an electric oven at 280ºC for 20 minutes, others were microwaved at high heat for 3 minutes and others boiled in salted water for 1 hour and then dried. The organoleptic properties were then compared with those of insects prepared by traditional methods using a nominal scale. Water was used to rinse the mouth between tasting the different samples.

RESULTS

Some of the insects consumed in Zimbabwe are shown in Figures 2A-2J. The population of those that never participated in entomophagy was less than 10% across the age groups in all the provinces. The reasons were varied such as religion, social, stigma, and unspecified repulsion. Most of those who had eaten insects had eaten at least more than one species. Dried insects were preferred by all consumers. The order Lepidoptera had the largest quantities consumed across Zimbabwe as shown in Table 1.

The insects were exported to the areas where they did not occur in substantial quantities within and outside the country. For Lepidoptera, which comprises several species, the larval stages are mostly consumed in the fourth instar after degutting. The larval stages are rich in protein (54-58%). The species regularly consumed are as follows: *Imbrasia belina* [madora], *Cerina forda* [harati], *Gonanisa maia* [magandari], *Gynanisa maia* [mapipi] and *Anaphe panda* [Hondokotowa]. The following are consumed as and when they occur: *Anthoaera zambezina, Athletes gigas, Athletes semialba, Bombycomorpha pallida, Bunaea alcinoe, Bunaea caffra, Bunaeopsis aurantica, Gonimbrasia zambesina, Gonometa postica, Heniocha dyops, Imbrasia epimethea, Imbrasia ertli, Lobobunaea satumus, Nudaurelia belina* and *Pseudobunaea irius*. Larvae of Lepidoptera cannot fly and are therefore easy to harvest. Harvesting them before they were fully mature reduces their potential in protein supply. Using the electric oven to prepare and dry the worms improved the hygiene of *Imbrasia belina*, so did boiling in salt water. However, the organoleptic properties on the ordinal scale were comparable with those prepared by a traditional method. For the worms prepared by non traditional methods, the spines remained a challenge to the consumer. Microwaving *Imbrasia belina* separated the chitin from the yellow protein and was perceived to have improved the organoleptic properties of the worms. *Imbrasia belina* was still being eaten by more than 90% of the respondents. The frequency percent of consumption of the most abundant species by various age groups in Zimbabwe are shown in Table 2.

In the Order Coleoptera, the following adult insect species were eaten by some Zimbabweans: *Eulepida anatine, Eulepida mashona, Eulepida nitidicollis*. The shona name for the three speices is mandere. These insect resembles the dung beetle and as a result young people shun them. Another species in this order consumed is *Sternocera*

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orissa [zvigakata] which does not need degutting. They are fried in large pans and subsequently dried before being sold to consumers. In the order Hemiptera only, *Encosternum delegorguei* [Haruwa] adult is consumed. These stink and are bitter even to the regular consumers. Here too, there is no degutting. The insects have assembly points for winter and here they are collected in tonnes with little effort by communities especially in Bikita district. They are fried in large metal pans and subsequently dried on mats before selling them to consumers. In the order Homoptera, only *Loba leopardina* [Nyeza nyeza] adult is consumed especially in the Plumtree area and there is no degutting. In the order Hymenoptera, only *Carebara vidua* [Tsambarafuta] adult is consumed. These are rich in fat which is concentrated in the abdomen. They are fried, dried and sold to consumers. There is no degutting. In the order Isoptera, the following species are the most consumed *Macrotermes falciger*, *Macrotermes natalensis* and *Macrotermes subhyalinus* in the adult stage. They all share the same local name [ishwa]. *Macrotermes* sp were still being eaten by at least 80% of the respondents. Several tonnes are harvested and sold especially in the eastern parts of Zimbabwe (Table 1). On collection from their nests, they are salted, fried and dried. They tend to be rich in protein and fats. There is no degutting. The availability calendar for fresh and dried insects consumed in Zimbabwe is shown in Figure 1. Most consumers preferred insects that had been dried and kept for at least 3 weeks. The dried insects were perceived to present improved organoleptic qualities. The insect provided protein, fat, minerals and carbohydrates for the population throughout the year. The use of the local name for insect when referring to edible ones was unwelcome by those who consumed the insects; they preferred local specific names which are in square bracts throughout this paper.

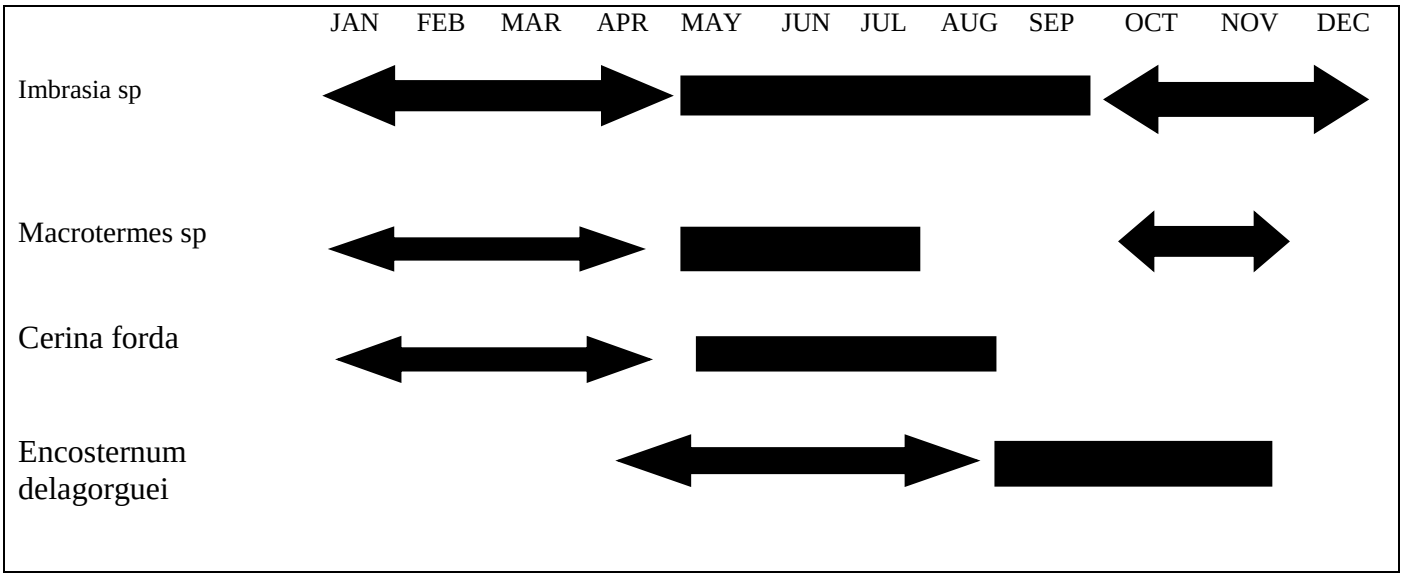

Figure 1: Availability calendar for fresh (double arrow) and dried insects (solid bar) consumed in Zimbabwe

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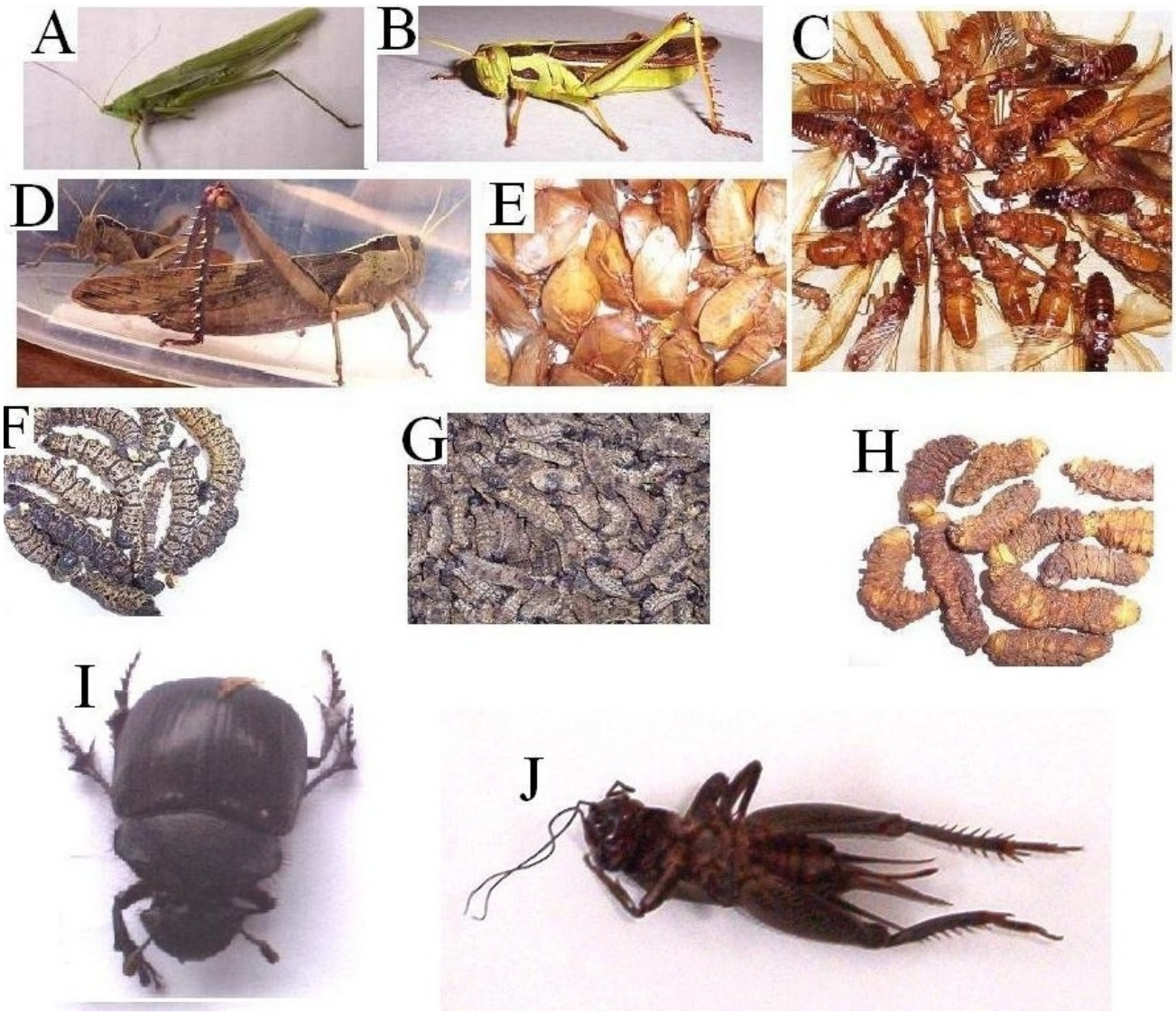

Figure 2: Some insects consumed in Zimbabwe. A) *Ruspolia differens* B) *Locusta sp.* C) *Macrotermes natalensis* D) *Locusta migratoria* E) *Encosternum delegorguei* F) *Imbrasia belina* microwaved, G) *Imbrasia belina* boiled and salted H) *Gynanisa maia* I) *Eulepida anatine* J) *Brachytrupes membranaceus*

In the order Orthoptera **(**Crickets) *Brachytrupes membranaceus* [Gurwe] the adult stage is consumed. They are prepared by frying and then dried before being sold to consumers. *Locusta migratoria* [mhashu], the adult is roasted and consumed. *Ruspolia differens* [Nswabanda] adult is consumed. These insects occur all over the country but outbreaks are not predictable and are highly attracted to street lights in urban areas. It is only when they occur that they are caught and sold in open markets. *R. differens* has a *high* fat content and is popular with consumers. They are not harmful to crops as their counterparts, the red locusts. The gravid ones are considered to be delicious. It's

considered that outbreaks must not be permitted as these outweigh any benefits that could arise from eating them. There is no degutting. All the insects in this study feed on plant material.

DISCUSSION

Entomophagy, especially for Lepidoptera and Isoptera, is a long standing practice in Zimbabwe whose continuity has not been affected by changes in lifestyles with passage of time. This is consistent with other records, particularly for *Imbrasia* and *Macrotermes* species for which young and old individuals still eat these insects regularly [1, 5, 10, 11, 14]. Poverty did not contribute significantly to the consumption of insects as suggested earlier, the consumers just perceived them as other arthropods like crabs and shrimps consumed elsewhere [1, 5, 9]. Religion did contribute to rejection of insects as food, which is also consistent with other records [1, 2, 6, 13]. Other than Lepidoptera, the other insects are not eviscerated, which might account for their shorter shelf life as expected with normal microbiological deterioration of foods [15]. For Lepidoptera, the larval stage is the one most consumed but a few people consume also the pupa stage [2, 3]. Insects depend on a variety of specific trees, thus the current spate of cutting trees in agrarian reform might deplete the numbers of some of these valuable food sources. The uncontrolled harvesting of some species such as *G. maia* and deforestation has contributed to some species dwindling to near extinction as also noted in other studies [2, 16, 17]. Western values have reduced consumption of some insects but has not significantly affected *I. belina* [madora] *Macrotermes sp.* [Ishwa] *C. forda* [harati] as also earlier noted by other authors[1, 5, 9]. *R. differens* occur as outbreaks in some years and only then are they gathered for food. The consumption of certain species is confined to some geographical regions, for instance *G. maia* in Tsholotsho [2, 17, 18].

Both the November and April generations of *Imbrasia belina* had the highest mass and nutritional value when harvested at the end of the larval stage, which calls for organized harvesting. The high protein content of these worms significantly supplements the low protein content in the food consumed in the areas where they occur as also noted earlier [8, 9]. The drying of these caterpillars prolongs their shelf life to almost a year, therefore maintaining a steady supply of protein in the diet of the people in the area [2, 3, 5, 12]. However, the rush to harvest the caterpillars results in high losses to both the individual and the community as this action lessens the protein mass harvested. This calls for community controlled harvesting. For example, if there were harvesting rights for specified areas shared equally among the residents of the area, there would be no need for the rushed harvest, which is a result of the first-come-first-harvest system currently practiced. Harvesters can wait until the worms have attained full size before starting to harvest. This is both nutritionally and economically sustainable and prevents the elimination of advantageous genes in future generations. Eggs can be laid on one woodlot from where larvae can be propagated. A community or individuals can then manage their own woodlots. This would reduce people walking long distances to harvest worms. A good reason to continue entomophagy is because *Macrotermes natalensis* and *Macrotermes goliath* have a lipid content averaged 25% in both male and female alate(winged) on a fresh

weight basis. Moisture content was 47%while lipid content on a dry basis was 47%. Size of both sexes ranged from 180-280 mg; based on the average weight of 250 mg, lipid content averaged 60 mg per termite [9]. Semi-quantitative determinations showed about 60% of the total body lipids contained in the fat body, 6% in thoracic muscle, 5% in the gut, 5% in the reproductive organs, 2% in the head, and 22% in other parts of the body. All organs contained the same fatty acids, C16:0, C18:0, C18.1, and C18:2, in variable proportions, but C18:1 was the predominant fatty acid in all organs of these insects [9]**.** Since the organisms are eaten whole all the nutrients become available to the consumer. In *M. natalensis*, 72% of the total body lipids are contributed by the reproductive organs while only 22% comes from the fat bodies. In *M. falciger*, the percentages are 83% and 11%, respectively. The eggs, which constitute the bulk of the reproductive organs, are responsible for the large quantities of lipids in those organs. The protein quality and fat composition of the alate (winged form of the termite) *M. falciger* was found to be 21.2 and 22.5%, respectively, and of wingless dry mass 41.8 and 44.3%, respectively. The calorific value reported for *M. falciger*, 761 kcal/100 g on an ash-free basis was extremely high and possibly the highest yet reported for an insect [19]. Protein content of *Imbrasia belina* has been documented as 62% [14]. In this study, the quantity of protein in *I. belina* was between 54 and 58%, which is consistent with other studies [5, 9, 10, 11, 19].

CONCLUSION

The study concluded that consumption of Lepidoptera and Isoptera has remained undiminished over the years across the country. The consumption of other insects is limited in certain geographical localities for example Nyeza in Plumtree, harati and mandere in Mashonaland. Dried insects are preferred to fresh ones. The very process of drying lengthens the shelf life of the insects thus keeping a continuous supply of protein to the population throughout the year.

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Table 1: Annual tonnage of harvested insect orders in some provinces of Zimbabwe calculated from gathered quantities and points of sale

Order\ Province	Matebeleland	Maswingo	Midlands	Mashonaland	Manicaland
Lepidoptera	230±30.8	12±3.7	31±5.4	35±5.2	10±3.1
Isoptera	8±1.5	70±7.4	20±4.1	30±6.1	5±0.9
Hemiptera	0	40±6.5	0	3±1.2	5±1.5
Orthoptera	5±1.3	7±3	4±3.3	10±6.1	4±1.8
Coleoptera	0	0	0	4±1.2	3±0.4
Hymenoptera	2±0.6	3±0.6	2±0.4	5±0.9	3±0.5

Table 2: Frequency percentage of consumption of the most abundant edible insect species by age groups in Zimbabwe

Age of consumer/ Insect species	N(100) <15	N(300) 16-25	N(100) 26-35	N(120) 36-45	N(200) 46-55	N(100) >55
Imbrasia belina	50	60	70	80	85	95
Macrotermes sp	50	60	70	80	85	95
Cerina forda	2	5	5	8	55	50
Encosternum delagorguei	5	5	10	30	35	35
Ruspolia differens	5	5	10	80	90	95
Eulepida sp	1	1	3	6	10	10

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