Int. j. adv. multidisc. res. stud. 2026; 6(5):267-282

Received: 18-07-2026
Accepted: 28-08-2026

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Reviving Nutrition and Food Security Through Indigenous Insect Consumption: A Case Study of Giant Longhorn Beetle Larvae *(Tithoes Confinis)* in Morogoro Rural District, Eastern Tanzania

[1] Patrick Cleophace Mpombeye, [2] Dennis Ochuodho Otieno, [3] Arnold Onyango Watako, [4] Andrea Malima Kigeso

[1, 3, 4] Department of Plant, Animal and Food Sciences, School of Agricultural and Food Sciences, Jaramogi Oginga Odinga University of Science and Technology, P.O Box 201-40601, Bondo, Kenya

[2] Department of Biological Sciences, Jaramogi Oginga Odinga University of Science and Technology, P.O Box 201-40601, Bondo, Kenya

Corresponding Author: **Patrick Cleophace Mpombeye**

How to Cite This Article

Mpombeye, P. C., Otieno, D. O., Watako, A. O., Kigeso, A. M. (2026). Reviving Nutrition and Food Security Through Indigenous Insect Consumption: A Case Study of Giant Longhorn Beetle Larvae *(Tithoes Confinis)* in Morogoro Rural District, Eastern Tanzania. International Journal of Advanced Multidisciplinary Research and Studies, 6(5), article 26-6-5-15.

Abstract

In Morogoro Rural District of Eastern Tanzania, insects consumed as delicacies rather than staple foods. However, with increasing challenges posed by climate change, population growth, and food insecurity, edible insects are gaining renewed attention as sustainable and nutritious alternatives to conventional protein sources. This study investigated the consumption and indigenous knowledge surrounding giant beetle larvae (*Tithoes confinis*), particularly among the Luguru ethnic group, known for its traditional practices of insect consumption. A cross-sectional study was conducted from June 2023 to April 2024, involving 385 respondents; 47.3% male (n = 182) and 52.7% female (n = 203) drawn from three villages: Mazizi (53.6%), Mgodini (27.3%), and Maseyu (19.1%). Data collected through structured questionnaire; key informant interviews (KIIs), Focus Group Discussions (FGDs), and purposive sampling techniques. Descriptive statistics and Chi-square tests employed to analyze the data, which presented using tables and figures. The results showed a significant association between socio-demographic variables (age, gender, education, and occupation) and the consumption of beetle larvae. Despite the presence of entomophagy traditions, a decline in insect consumption observed, attributed to factors such as western dietary influences, religious beliefs, lack of awareness, and stigma. The study underscores the importance of promoting edible insects by raising public awareness about their nutritional and environmental benefits, preserving indigenous knowledge through education and media, and incorporating insects into mainstream diets. These efforts could enhance food security and support sustainable dietary transitions in Eastern Tanzania and beyond.

Keywords: Cultural Practices, Edible Insects, Entomophagy, Food Security, Giant Longhorn Beetle Larvae, Insect Consumption, Luguru Ethnic Group

Introduction

Food insecurity remains a critical issue in developing countries, disproportionately affecting women and children. In 2009, women accounted for 60% of the undernourished global population (FAO, 2013). Contributing factors include limited access to income, agricultural technologies, education, and land ownership (Sida, 2015) [64]. Food security defined by the FAO (2006) [18] as having continuous access to adequate, safe, and nutritious food that meets dietary needs and preferences. Despite global efforts, over 820 million people remained undernourished by 2018, with rural women most severely affected (FAO, 2013). Malnutrition has affected Asia and Africa, affecting more than 500 million people (FAO, 2009) [19], with about 260 million of Africa's population living in food-insecure conditions, particularly in Sub-Saharan Africa (FAO, 2018). Undernourishment in

Sub-Saharan Africa rose from 20.7% in 2014 to 23.2% in 2017, affecting over 237 million people (Mariod, 2020; FAO *et al.,* 2018) [42, 21]. Rising global populations have intensified food demand, prompting the exploration of alternative protein sources, including edible insects (Dickie, 2019; FAO, 2009; Gałęcki, 2021; UN, 2012) [14, 19, 21, 71]. Insects are already part of the diet for over 2.5 billion people globally (Melgar-Lalanne *et al*., 2019) [44] and are gaining attention for their low land-use and sustainability in food production systems (De Boer, 2012; Tao & Olive Li, 2018) [13, 69]. Countries like Uganda and Kenya are piloting entomophagy initiatives, such as the INSFEED project, to support food security (Van Huis *et al*., 2015; Tao & Li, 2018) [75, 69]. The larvae of *Tithoes confinis*, the giant longhorn beetle a species known for its ecological and economic importance (Kariyanna, 2017) [33] and are consumed traditionally in Gabon, Senegal, Congo, and Tanzania (Araujo *et al*., 2021; Ruby, 2015 [60]). Among the Luguru people of Eastern Tanzania, food insecurity exacerbated by erratic rainfall, declining soil fertility, and limited farming technology (Massawe *et al*., 2018) [43]. Seasonal shortages are especially severe during the rainy season when staples like maize and cassava are scarce. Household food insecurity in similar Tanzanian contexts can spike to 80% in rainy seasons (Hadley & Crooks, 2012) [29].

In response, the Luguru and other Eastern Tanzanian communities have turned to edible insects like beetle larvae as a readily available, nutrient-dense alternative. Insects could offer a suitable and sustainable alternative to food insecurity challenges (FAO, 2010; Tao and Li, 2018 [69]). Insects have been recognized as valuable sources of nutritious food in the battle against food insecurity and malnutrition (Faast and Weinstein, 2020; Si & Turpin, 2015; Rich, 2006). In recent years, the larvae of the giant longhorn larvae *(Tithoes confinis)* have been gaining popularity as part of a broader diversification of insect-based foods. These larvae provide protein, healthy fats, and key micronutrients like iron and zinc, comparable to conventional meat sources (FAO, 2013; Mmari *et al*., 2017 [47]; The Citizen, 2022 [70]).

The consumption of insect deeply rooted in Eastern Tanzanian culture and serves both nutritional and cultural functions (Kinyuru *et al.,* 2010 [37]; FAO, 2013; Van Huis, 2013 [73]). Yet several challenges threaten the sustainability of this practice. Deforestation and habitat loss are reducing beetle populations (Gahukar, 2011) [26], while urbanization and western dietary influences have diminished acceptance, particularly among youth (Meyer-Rochow, 2009 [45]; FAO, 2013). The lack of policy support further undermines the promotion of edible insects as viable food sources (van Huis, 2013) [73]. Health concerns, including improper preparation leading to foodborne illness, also deter consumption (FAO, 2013).

Matrials and Methods

Study Area

The study conducted in Morogoro Rural District, located in the Eastern part of Tanzania. According to the National Bureau of Statistics (NBS), the district is home to a significant population, with communities spread across various ecological zones. Geographically, Morogoro Rural lies between latitudes 6°30′8°00′ S, and longitudes 37°30′ 39°00′ E, encompassing a diverse range of altitudes from 300 to 2,000 meters above sea level, which contribute to its ecological and climatic variability (URT, 2013) [72]. Morogoro Rural District had a total population of 387,736 people, showing a notable increase from the 2012 census figure of 286,248 (NBS, 2022) [50]. The study conducted in three villages: Mazizi, Maseyu, and Mgodini. These villages selected due to their location within low to mid altitude zones of the district and their proximity to ecological relevance and natural habitats suitable for longhorn beetle larvae. The Luguru people, a Bantu ethnic group indigenous to the Uluguru Mountains and surrounding lowland areas, primarily inhabit these villages. The Luguru have long held traditional ecological knowledge related to forest resources, including entomophagy, the cultural practice of consuming insects including the giant longhorn beetle larvae (Chakravorty, 2013; Van Huis, 2013) [10, 73]. This cultural practice formed an important ethnographic context for the study, linking insect biodiversity with indigenous knowledge and food systems.

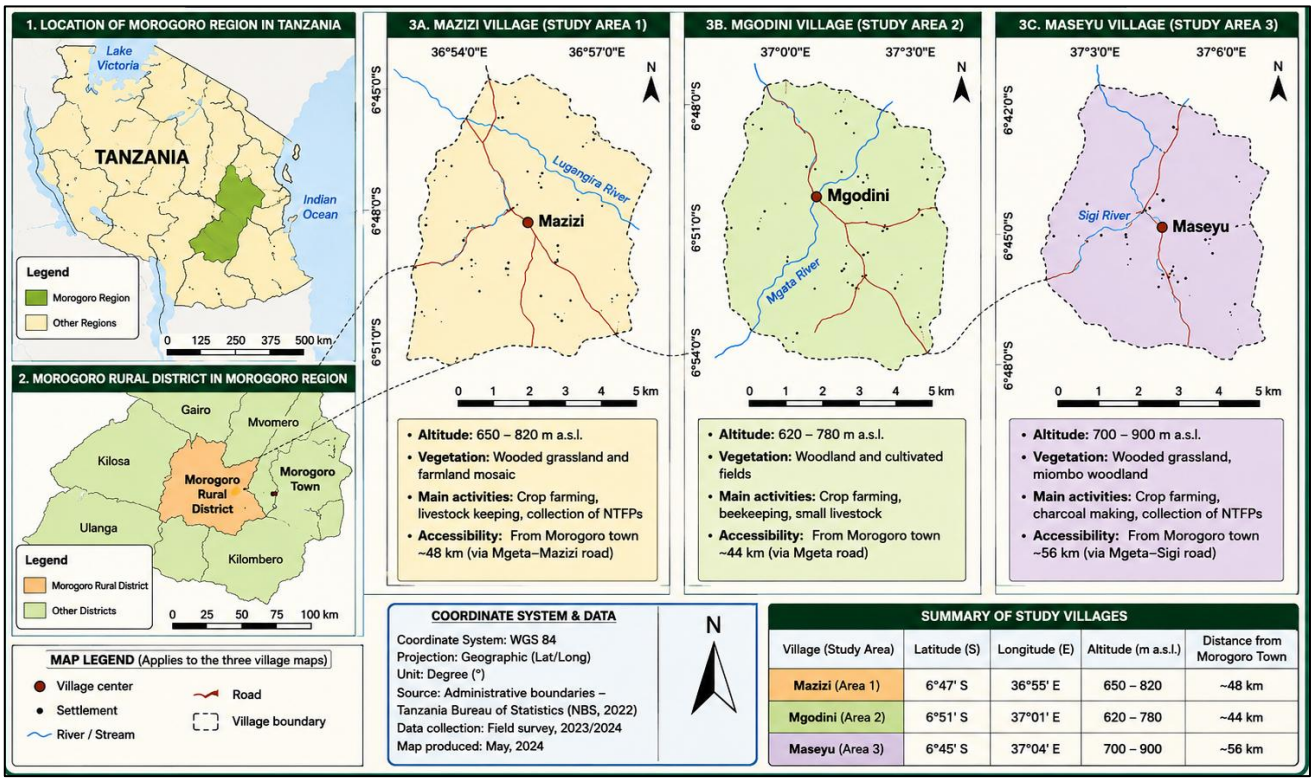

Fig 1: Map of Eastern Tanzania: Morogoro Rural District (NBS; 2022) [50]

Research and Sampling Design

Research Design

The research combined qualitative and quantitative methods to provide a comprehensive understanding of both the social-cultural and nutritional dimensions of insect consumption. A concurrent cross-sectional survey captured villagers' knowledge via structured questionnaires (n=150), key informant interviews (KIIs, n=10), and Focus Group Discussions (FGDs, n=5) to explore cultural beliefs, preparation methods, and the symbolic importance of beetle larvae. The design also collected data to assess frequency and duration of consumption, demographic correlations, and nutritional awareness. This research design served as a valid and effective alternative to exclusively employing quantitative or qualitative research designs in integrating numerical data and qualitative insights (Creswell, 2012 [11]; Frels & Onwuegbuzie, 2013 [24]; Hong & Espelage, 2011 [31]; Plano Clark, 2007).

Sampling Design

This study employed a multistage sampling design to ensure comprehensive representation of communities engaging in the consumption of longhorn beetle larvae (*Tihoes confinis*). In the first stage, purposive sampling used to select villages with known traditional practices of insect consumption, particularly those located near forested areas such as the Uluguru Mountains. In the second stage, systematic random sampling applied to select households within the chosen villages, ensuring that each household had an equal chance of participation. Then purposive sampling used to identify key informants, including village elders, local foragers, and traditional food vendors, who provided in-depth knowledge through key informant interviews (KIIs, n=10), and Focus Group Discussions (FGDs, n=5). This approach allowed the study to capture both the prevalence of insect consumption and the cultural significance attached to it, while ensuring a balanced representation of demographic groups involved in the practice.

Study Population

The study population consisted of residents of Morogoro Rural District, particularly those living in communities situated near forested areas such as the Uluguru Mountains, where traditional practices of insect foraging are still prevalent. The focus was on household members who are directly or indirectly involved in the collection, preparation, and consumption of giant longhorn beetle larvae (*Tihoes spp),* which are considered a seasonal delicacy in the region. The study included key community stakeholders, such as village elders, traditional insect collectors, food vendors, and local health and agricultural officers, whose insights were crucial in understanding the cultural, nutritional, and socio-economic dimensions of insect consumption. Special emphasis placed on the Luguru ethnic group, the predominant indigenous community in the area, due to their longstanding cultural practices and knowledge related to entomophagy. This population selected to provide a comprehensive view of both the traditional significance and contemporary relevance of edible insects in local food systems.

Target Population and Sample Sizes

According to the 2022 Population and Housing Census conducted by the National Bureau of Statistics (NBS), Morogoro Rural District had a total population of 387,736 people, showing a notable increase from the 2012 census figure of 286,248 (NBS, 2022) [50]. This population growth reflects both natural increase and internal migration patterns as people seek agricultural land and economic opportunities.

The Luguru ethnic group, who have rich cultural traditions, including the consumption of edible insects such as giant longhorn beetle larvae *(Tihoes spp.),* predominantly inhabits the district. The practice of entomophagy among the Luguru community represents both a cultural food preference and an adaptive strategy to enhance household nutrition and food security, particularly in rural and resource-constrained settings.

The study used (Krejcie & Morgan, 1970) which is widely applied for estimating sample sizes in finite populations. This method is widely used for determining the appropriate sample size for large populations, accounting for population size (N), desired confidence level, margin of error (e), and estimated population proportion (p). Based on this approach, a sample size of 385 respondents obtained, as illustrated below.

$$n = [\chi^2 NP(1 - P)] / [e^2(N - 1) + \chi^2 P(1 - P)],$$

Where $\chi^2 = 3.841$ (Chi-square value at 95% confidence), $e = 0.05$ (margin of error), $P = 0.5$ (assumed population proportion for maximum variability), and $N = 387{,}736$ (total population of Morogoro Rural District). Substituting these values:

$$n = [(1.96)^2 \times 387{,}736 \times 0.5 \times (1 - 0.5)] / [(0.05)^2 \times (387{,}736 - 1) + (1.96)^2 \times 0.5 \times (1 - 0.5)]$$

Data Collection Procedures

Questionnaire method

Questionnaires employed as a primary method of data collection to gather information on the consumption of giant longhorn beetle larvae among the rural population of Morogoro District. Questionnaire selected due to the efficiency in collecting standardized data from a relatively large and dispersed sample. The structured format enabled the collection of both quantitative and qualitative data related to demographic characteristics, dietary habits, cultural beliefs, and attitudes toward edible insect consumption. Questions designed to be clear, concise, and culturally appropriate, with translation into Kiswahili "Swahili language" and local dialects such as Luguru to ensure full comprehension by respondents. Trained enumerators administered the questionnaires face-to-face to minimize misinterpretation and to accommodate respondents with low literacy levels. The use of this method not only facilitated consistency in data collection but also enabled comparisons across different households and villages. Additionally, the anonymity and structured nature of the questionnaire encouraged respondents to provide honest and unbiased answers, thereby enhancing the reliability and validity of the collected data.

Focus Group Discussion (FGDs) and Key Informative Interview (KII)

These study included Key Informant Interviews (KIIs), Focus Group Discussions (FGDs), and direct observations. KIIs conducted with local leaders and traditional elders to gather in-depth insights into the cultural, nutritional, and economic relevance of consuming giant longhorn beetle larvae. These interviews allowed for the exploration of contextual knowledge that not captured through structured questionnaires. 5 FGDs each FGD consisted of 20 participants held with community members of different age groups, to explore collective attitudes, beliefs, and practices related to entomophagy. These discussions facilitated the identification of social norms and cultural influences on insect consumption.

Data Analysis

The data initially entered into Microsoft Excel for data cleaning, validation, and preliminary coding. The cleaned dataset imported into the Statistical Package for the Social Sciences (SPSS), version 25, for further statistical processing. Descriptive statistics computed to summarize respondents' sociodemographic characteristics, consumption frequencies, and other relevant variables. Results presented in tabular form, including measures such as frequencies, percentages, means, and standard deviations. To assess associations between categorical variables such as consumption and respondent characteristics such as; age group, gender, educational, and occupation status, Pearson's Chi-square (χ^2) tests were performed, with a significance level set at $p < 0.05$.

Results and Discussions

Results

Socio-Demographic Descriptive Results

This section presents the findings from socio-demographic analysis, which comprised of gender, age, education level, occupation, and location. Total 385 individuals participated in a questionnaire survey. Among them, 47.27% (n = 182) were male and 52.72% (n = 203) were female. All respondents were from three villages, 53.76% (n=207) from Mazizi village, 27.01% (n=104) from Mgodini village, and 19.23% (n=74) from Maseyu village. Most of the respondents were aged 21 to 30 years, followed by those aged 31 to 40 years. Large percent of the respondents, 64.67% (n = 249) had primary school education, 19.22% (n = 74) had secondary school education, and 16.36% (n = 63) had informal education. About 90.91% (n = 350/385) were self-employed, 7.27% (n = 28) were in gainful employment, and 1.82% (n = 7) were unemployed.

Table 1: Socio-demographic characteristics of the respondents, Eastern Tanzania (n=385)

Characteristics	Category	Male (N)	Male (%)	Female (N)	Female (%)	Total (N)	Total (%)
Village	Mazizi	109	52.65%	98	47.34%	207	53.76%
	Mgodini	38	36.53%	67	64.42%	104	27.01%
	Maseyu	35	47.29%	39	52.70%	74	19.22%
Age Group	<21	0	0.00%	4	100.00%	4	0.91%
	21–30	49	36.84%	84	63.16%	133	34.55%
	31–40	28	34.56%	53	65.22%	81	20.91%
	41–50	32	91.42%	3	10.00%	12	9.09%
	51–60	31	52.54%	28	47.45%	59	17.27%
	61–70	14	100.00%	0	0.00%	14	3.64%
	71–80	18	54.55%	15	45.45%	33	8.57%
	>80	0	0.00%	49	100.00%	49	12.73%
Education	Primary school	119	47.89%	130	52.11%	249	64.55%
	Secondary	49	66.67%	24	33.33%	73	19.09%
	Informal level	14	22.22%	49	77.78%	63	16.36%
Occupation	Unemployed	0	0.00%	7	100.00%	7	1.82%
	Self-employed	175	50.00%	175	50.00%	350	90.91%
	Employed	7	25.00%	21	75.00%	28	7.27%

Gender-Related role on giant long-horned beetle larvae consumption

The results revealed the relatively small proportion (27.3%, n=105) of the respondents having experience of eating giant longhorn beetle, compared to 72.7% (n=280) of those lacking the same experience. Total number of males sampled, 28.83% (n=111) had such experience and 71.15% (n= 274) had no such experience. Moreover, 25.97% (n=100) of the total number of female respondents, had experience of consuming the giant longhorn beetle, while 74.14% (n=285) had no such experience**.** In general, more female respondents (n=151, 53.8% of the total number of respondents) lacked experience of consuming the giant longhorn beetle than male sampled (46.3%, n=178) of the total number of respondents). Therefore, there was no significant association between giant longhorn beetle consumption and the sex of respondent (χ^2=0.123, df =1, p=0.726) (Table 1).

Age Differences in Consumption of Giant Longhorn Beetle Larvae

Unlike the sex of respondents, there was significant association between their age and experience on giant longhorn beetle larvae consumption (χ^2=24.034, df =7, p=0.001). Most elders had an experience on giant longhorn beetles larvae consumption than youth. For stance, total number of respondents having experience on giant longhorn beetle larvae consumption, 33.3% (n=128) aged between 51 and 60, and between 41 and 50. Most youth (41.3%) aged 21-30 years old, and 31-40 years had no experience of consuming the giant long horn beetle (Table 2).

Influence of Educational status on larvae consumption

There was a significant association between the respondent's level of education and giant longhorn beetle larvae consumption (χ^2=6.637, df =2, p=0.036). About, 76.7% of those having experience of consuming the beetles had primary level of education, 20% did not go to school (had informal education), while 3.3% had up to secondary school education (Table 2).

Influence of Occupation status on larvae consumption

There was a statistical significant association between respondents' occupational status and the consumption of giant longhorn beetle larvae (χ^2 = 6.217, df = 2, p = 0.045). Among respondents who reported having consumed giant longhorn beetle larvae, 90% were farmers (most self-employed). (Table 2).

Table 2: Factors affecting choices of giant long horn beetle larvae consumption

Social Cultural Factors	Response	Chi-Square	Df	p Value
Gender/sex	Male	0.123	1	0.726
	Female			
Age of Respondents	<21	24.034	7	0.001
	21-30			
	31-40			
	41-50			
	51-60			
	61-70			
	71-80			
	>80			
Educational background	Primary school	6.637	2	0.036
	Secondary school			
	Informal education			
Occupation status	Unemployed	6.217	2	0.045
	Self-employed			
	Employed			

Consumption and traditional preparation practices of giant longhorn beetle larvae

Perceived Benefits of Consumption

The study identified several key factors that encouraged the consumption of giant longhorn beetle larvae among respondents. The most frequently cited reason was the perceived nutritional benefits, reported by 50.9% of respondents (n = 196), who recognized the larvae as a rich source of protein and other essential nutrients. Food insecurity also played a significant role, with 49.1% (n = 189) indicating consumption due to shortages of other food sources, particularly during lean seasons. Traditional beliefs and cultural practices were noted by 24.5% (n = 95), with some respondents stating that consumption of the larvae is embedded in ancestral customs and rites. A smaller proportion, 20.9% (n = 80), mentioned ease of access and affordability, highlighting that the larvae are readily available in the wild and require minimal cost to obtain (Fig 2).

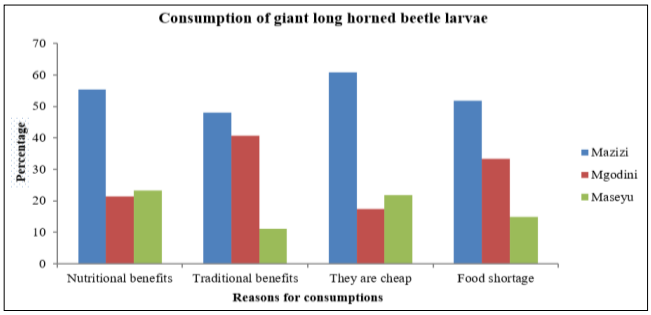

Fig 2: Respondents-related factors for giant longhorn beetle larvae consumption

Social Cultural and Nutritional Drivers of Edible Insect Consumption

The results depicted that; 44.5% of respondents reported that they were economically accessible, as they could be collected from nearby forests or obtained from neighbors without purchasing. Health and nutritional value was reiterated by 40.9% (n = 158), affirming the larvae's role in supplementing dietary needs. Taste was another factor, cited by 7.3% (n = 28), with some describing the larvae as flavorful when roasted or boiled. 7.3% (n = 28) highlighted the environmentally friendly nature of larval harvesting, it has minimal ecological impact compared to conventional livestock farming (Fig 3).

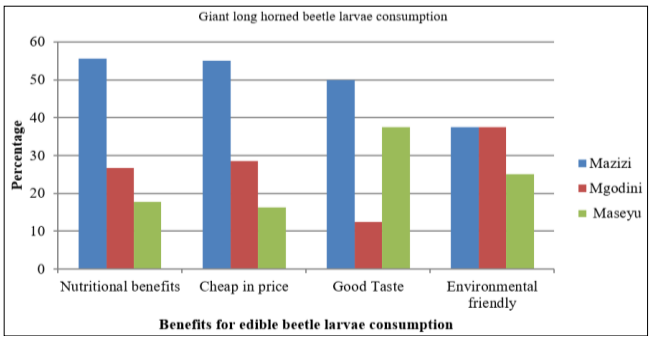

Fig 3: Respondents related benefits for giant longhorn beetle larvae consumption

Consumer Perceptions on the Giant Longhorn Beetle Larvae versus Other Insects

Respondent's perception on insect's edibility and appeal; Table 3 presents data on respondents' awareness and consumption of various edible insect species, based on a list derived from *The Guide to Insects of Tanzania* and other sources. Participants identified species currently or formerly consumed in their villages, allowing for comparison of consumer familiarity with giant longhorn beetle larvae versus other edible insects. Photographic presentation provided to simplify insect's identification to respondents (Table 3).

Table 3: Data on respondents' awareness and consumption of various edible insect species

Winged termites (Swahili: Kumbikumbi/Nswa)

Vitemvu (Swahili/Local name)

Long-horned grasshopper (Senene)

Palm weevil larvae

Cricket (Swahili:Ndegere/ Fukafuka)

Long-horned beetle larvae (Sondo/Madimu)

The results indicated that; only 20% (n = 77) of the respondents expressed willingness to consume food products mixed with giant longhorn beetle larvae, whereas the majority, 80% (n = 308), reported no interest. Regarding to consumption habits, 89.09% (n = 343) of respondents continued to consume giant longhorn beetle larvae, while not 10.91% (n = 42). 70% (n = 270) of respondents indicated a willingness of consuming other types of edible insects. In contrast to 30% (n = 115) reported disinterest. The study revealed that 18.47% (n = 67) were willing to consume winged termites (*kumbikumbi*), 12.73% (n = 49) "Vitemvu," and 4.55% (n = 28) were open to consume crickets. The long-horned grasshopper (*Senene*) emerged as the most preferred alternative, with 54.8% (n = 203) of respondents indicating interest on its consumption (Table 4 & Fig 4).

Table 4: Respondent's perception on insect's appeal; beetle larvae versus other Insects

Stopped Eating Beetle Larvae	Number (N)	Percentage (%)	Other Insects Consumed	Number (N)	Percentage (%)
Yes	42	10.91	Termites	67	18.47
			Grasshoppers	203	54.80
			Crickets	28	7.27
			Vitemvu	49	12.73
			Palm weevil larvae	39	10.13
			Total	385	100.00
No	343	89.09			
Total	385	100.00			
Beetle larvae in food mix	Number (N)	Percentage (%)	Other edible insects	Number (N)	Percentage (%)
Yes	77	20%	Yes	270	70%
No	308	80%	No	115	30%
Total	385	100	Total	385	100

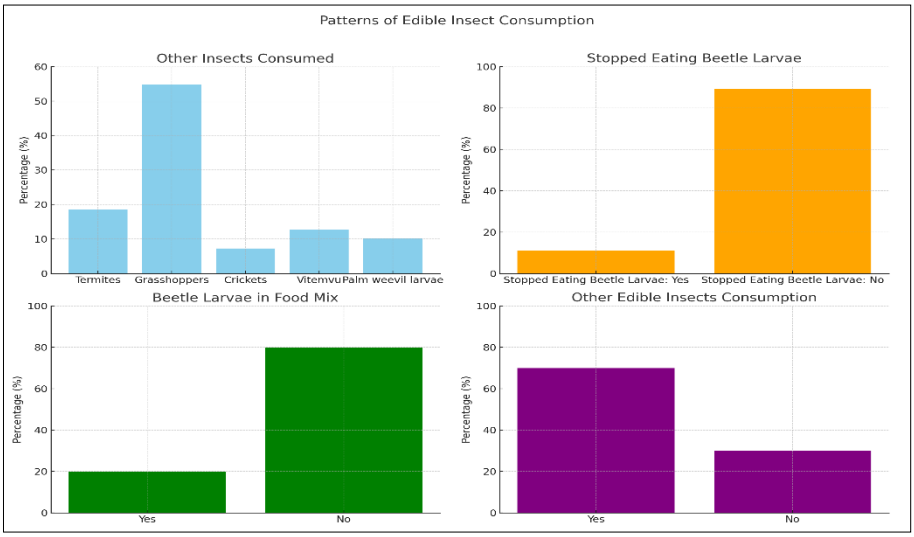

Fig 4: The graphs depicts: (1) types and proportions of other insects consumed, (2) proportion of individuals who had stopped eating beetle larvae, (3) inclusion of beetle larvae in mixed food preparations, and (4) prevalence of other edible insect consumption

Table 5: Ethno-Entomological Knowledge of Harvesting and Preparing Alternative Edible Insects

	Other edible insects consumed during shortage of food and long-horn beetle larvae			
Insects name	**Insets Details**		**Referenced tribes**	**Referenced regions**
Long-horned grasshoppers	Order name	Orthoptera	Haya	Bukoba
	Local name	Senene	Sukuma	Mwanza
	Consumption stage	Adult	Luguru	Morogoro
	Collection method	Picked from grassland		
	Collector	Women and children		
	Preparation methods	Fried and roasting		
Crickets	Consumption stage	Adult		
	Local name	Fukafuka		
	Order name	Orthoptera		
	Collection method	Farm land		
	Collector	Children		
	Preparation methods	Fried and roasting		
Winged termites	Order name	Blattodea	Luguru	Morogoro
	Local name	Kumbikumbi/Nswa	Sukuma	Mwanza
	Consumption stage	Winged Adult	Ha “Waha”	Kigoma
	Collection method	From Termite Hills		
	Collector	Women and children		
	Preparation methods	Frying		
Vitemvu	Order name		Ha “Waha”	Kigoma
	Local name	Vitemvu		
	Consumption stage	Winged Adult		
	Collection method	From Termite Hills		
	Collector	Women and children		
	Preparation methods	Frying and roasting		
Palm weevil larvae	Order name	Coleoptera	Ha “Waha”	Kigoma
	Local name			
	Collection method	Picked from palm trees		
	Consumption stage	Larvae		
	Collector	Women and Children		
	Preparation methods	Frying, boiling, roasting		

Dietary and Palates comparison: Giant Longhorn Beetle *versus* Other Edible Insects

The results found that; majority, 52.5% (n = 203), indicated that other edible insects such as winged termites (*kumbikumbi* or *nswa*) and East African long-horned grasshoppers (*senene*) were more popular and widely recognized across the country, making them more socially accepted and familiar. 17.4% (n = 63) attributed their preference to personal familiarity and self-awareness regarding the edibility and nutritional value of these insects. Meanwhile, 30.9% (n = 119) consumed other edible insects primarily because it has been common among other ethnic groups. The most frequently cited alternative insects included *senene* and *kumbikumbi*, both of which mentioned as culturally accepted delicacies, especially during their respective seasonal appearances. Cultural exposure, social norms, and perceived acceptability significantly influenced insect consumption preferences within the study population (Fig 5).

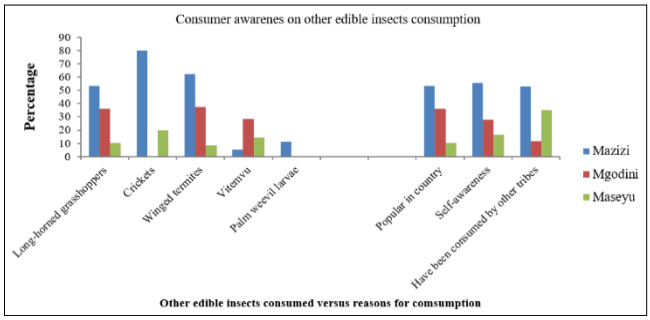

Fig 5: Respondents and consumers awareness on consumption of other edible insects

Respondent's perception on insect's taste and acceptability

Respondents in terms of taste and acceptability perceive insects as follows; winged termites (Kumbikumbi) generally viewed favorably, with 59.6% of participants describing them as tasty, while only a small proportion (6.3%) found them disgusting. Longhorn grasshoppers (Senene) received the most favorable response, with 81.3% of respondents considering them tasty. This strong preference linked to their crisp texture and unique flavor, which often enhanced through traditional preparation methods such as roasting or frying. Crickets also relatively received, with 40.7% of respondents rating them as tasty, although they appeared less popular than grasshoppers and termites, possibly due to less frequent consumption or unfamiliarity among certain groups (Fig 6).

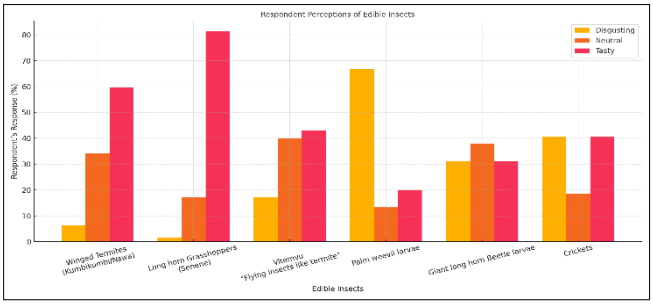

Fig 6: Comparative Consumer Perceptions; Giant Longhorn Beetle versus Other Edible Insects

In contrast, the giant longhorn beetle larvae (*Tithoes* spp.) and palm weevil larvae less favorably perceived. Only 31% and 20% of respondents, respectively, described them as tasty. A similar pattern observed on *Vitemvu*, a flying insect compared to winged termites with 42.9% rating them as tasty. Interview data provided insight into these perceptions, particularly regarding the giant longhorn beetle and palm weevil larvae. Respondents frequently cited the insects' physical appearance, thick-bodied, segmented, and often slimy as unappetizing. Such characteristics likely contribute to psychological discomfort or aversion, especially among individuals not accustomed to their consumption from a young age. This association further reinforced negative attitudes and feelings of disgust.

Table 6: Perception of Insects as food (edible beetle larvae vs other edible insects)

Edible Insects List	Respondent's response (%)		
	Disgusting	Neutral	Tasty
Winged Termites (Kumbikumbi/Nswa)	6.3%	34.1%	59.6%
Long horn Grasshoppers (Senene)	1.6%	17.2%	81.3%
Vitemvu "Flying insects like termite"	17.1%	40%	42.9%
Palm weevil larvae	66.7%	13.3%	20%
Giant long horn Beetle larvae	31.0%	37.9%	31.0%
Crickets	40.7%	18.5%	40.7%

Seasonal patterns on the availability and sources of Beetle Larvae

Results identified the mid-year dry season (24.5%, n = 94) and year-round availability (23.6%, n = 91) as the peak periods for beetle abundance. Only a small fraction (3.6%, n = 14) indicated rain season. Regarding to sources of acquisition, 52.7% of respondents (n = 203) reported purchasing the larvae from neighbors, indicating the existence of informal local trade networks. 30.9% (n = 119) stated collection of beetle larvae from the wild, primarily in forests or uncultivated areas, while 16.4% (n = 63) reported harvesting the larvae directly from trees, especially those known to serve as host plants for the beetle (Table 7).

Table 7: Seasonal availability, collection and traditional preparation

Questions	Responses	Respondents	Percentage
Availability	Rain season	14	3.6%
	The mid-year dry season	94	24.5%
	Throughout the year	21	5.5%
	I don't know/Not familiar	186	48.2%
	Total	385	100
Place of collection	Purchased (Neighbors, local markets & Vendors	203	52.7%
	On trees (nearby surrounding)	63	16.4%
	In the forest/Wild	119	30.9%
	Total	385	100
Main collector	Women	269	867.0%
	Men	28	7.8%
	Children	88	25,2%
	Total	385	100
Preparation	Frying	266	69.1%
	Roasting	91	20.9%
	Boiling and frying	39	10.0%
	Boiling	21	25.6%
	Total	385	100

Collecting for the Plate: Edible Insect Harvesters in Local Food Systems

The results also shed light on gender and age dynamics in larva collection practices. The majority of collectors were women, accounting for 67% (n = 269) of respondents who reported engaging in larva harvesting. Children represented 25.2% (n = 88) of the collectors, while men constituted only

7.8% (n = 28). These findings emphasize the central role of women and children play in the foraging and procurement of edible insects, particularly in subsistence contexts (Table 7).

From forest to plate: Culinary Practices and preparation

The most preferred method was frying, cited by 69.1% of respondents (n = 266), who noted that frying enhances the flavor and texture of the larvae, making them more palatable. Roasting was the second most common method, reported by 23.6% of respondents (n = 91), often described as a traditional technique used during outdoor or communal gatherings. Boiling (6.7%, n = 26), which is typically done before frying or as a standalone preparation method in households that prefer softer textures. Frying followed by boiling, or vice versa, was mentioned by 10.1% (n = 39), indicating a combined method used to improve taste and ensure thorough cooking. Interestingly, no respondents reported using sun drying as a method of preparation or preservation for the larvae (Fig 7).

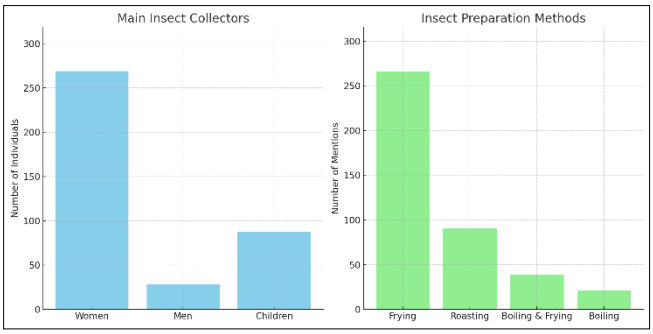

Fig 7: Traditional Roles in Insect Harvesting and Preparation for consumption

Cultural Traditions and Historical Duration of giant beetle Larvae Consumption

The finding revealed varying durations of consumption among respondents who reported eating giant longhorn beetle larvae. The largest proportion, 24.5% (n = 95), indicated that they had been consuming the larvae for between 1 to 5 years. A significant number, 15.5% (n = 90), reported more than 10 years of consumption, suggesting long-term integration of the larvae into their diets. Meanwhile, 9.1% (n = 35) had consumed the larvae for 6 to 10 years, and new consumers those who had started eating the larvae within the past year comprised only 6.4% (n = 25) of respondents. These figures suggest that while there is a mix of both new and long-term consumers, the majority have engaged with the practice for at least several years. A majority (69.9%, n = 269) confirmed the existence of cultural traditions linked to larval consumption. Conversely, 7.3% (n = 28) denied any cultural association, and 22.7% (n = 88) were unaware of such traditions. (Fig 8).

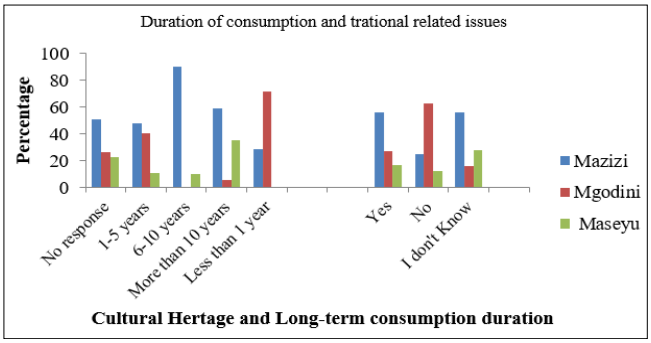

Fig 8: Cultural Traditions and Historical Duration of giant beetle Larvae Consumption

Association between Cultural Attitudes and Insect Larvae Consumption

The study conducted a Chi-square test of association to determine if there was existed significant differences in respondents' cultural attitudes as it related to insect consumption. **Table 8 presents** the results.

Table 8: Association between Cultural Attitudes and Insect Consumption

Related Ethno-Cultural Tradition		Edible Insect Consumption			
		(N)	%	χ^2	p-value
Attitudes	Yes	269	69.9	22.622	0.010**
	No	28	7.3		
	Don't know	88	22.8		
Total		385	100		

Note ** indicates a significant association at a 95% confidence level

Table 8 indicates that cultural attitudes were significantly associated with the consumption of edible giant long horn insect χ^2=22.622, *P*= 0.010. The results from cross-tabulation show that positive cultural attitudes had the highest response associated with the consumption of edible insects.

Ethno-Cultural Narratives and Social Norms in Insect Consumption: A Qualitative Perspective from FGDs and KIIs

As presented in (Figure 8 & Table 8), approximately 69.9% (n = 269) of respondents acknowledged the existence of ethno-cultural traditions related to the consumption of giant longhorn beetle larvae (*Tithoes confinis*). In contrast, 7.3% (n = 28) reported that no such traditions were present, while 22.7% (n = 88) expressed uncertainty or lack of awareness regarding these practices. These results underscore the deeply rooted cultural and social norms that influenced insect consumption in Eastern Tanzania. Insights drawn from Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs), as detailed in (Table 11; Cultural Knowledge on Consumption), further illuminated the symbolic, ritual, and gendered dimensions of *T. confinis* consumption. Participants

described traditional ceremonies, intergenerational knowledge transfer, and community norms that frame the collection and preparation of the larvae. Together, the quantitative and qualitative findings reflect a strong ethnographic foundation that supports the continued, though evolving and role of edible insects (*T. confinis*) in local food-ways.

Table 9: Ethnographic Perspectives on Giant Longhorn Beetle Larvae Use

Ethno-Cultural Tradition & Social Norms	Respondents' Explanations on Ethno-Cultural Practices
1. Cultural Acceptance of Insect Consumption; *T. confinis*	Insect consumption considered as a traditional practice among many African communities, including the Luguru of Eastern Tanzania. Respondents indicated *T. confinis* perceived as nutritious and integrated into local diets. The results indicated that; only 20% (n = 77) of the respondents, expressed willingness to consume food products mixed with giant longhorn beetle larvae (Table 4). These findings reflected broader regional attitudes shared by the Eastern Tanzanian communities.
2. Gender Roles in Insect Consumption; *T. confinis*	Gender norms influenced insect consumption; in some Eastern Tanzanian communities, *T. confinis* are taboo for women and children. However, variation exists; urbanized or progressive households often show inclusivity. As awareness of *T. confinis* larvae nutritional and economic value grows, women are increasingly involved in harvesting, preparation, and selling, challenging traditional roles. See (Table 5 & Fig: 7) on roles of women in insect collection where the results depicted that; 67% (n=269) of respondents collected *T. confinis* larvae, 7.8% (n=28) were men whereas 25.2% (n=88) of the total collectors were children
3. Preparation and Consumption Practices; *T. confinis* larvae	Respondents indicated preparation methods: boiling, frying, roasting, and drying reflect indigenous knowledge passed down through generations, particularly by elder women. These techniques ensure food safety, enhance taste and texture, extend shelf life, and reinforce cultural identity, especially during communal meals. Results were depicted in (Table 7 & Fig: 7)
4. Perceived Health Benefits and Risks; *T. confinis* larvae	Some household has believed *T. confinis* larvae consumption improves health and immunity whereas others associate insects with filth or decay if harvested from unsanitary places, raising concerns about hygiene and safety. Results (Figure: 2) cited nutritional benefits by (50.9%, *n* = 196), whereas 7.2% (n=28) of respondents (Figure: 9) mentioned allergic scared of them; frequently cited the insects' physical appearance, thick-bodied, segmented, and often slimy as unappetizing. Such characteristics likely contributed to psychological discomfort or aversion,
5. Influence of Religion and Belief Systems; *T. confinis* larvae	Respondents also indicated, religious beliefs influence dietary habits. Some religions may restrict consumption of *T. confinis* larvae. Traditional Luguru belief systems may support or limit larvae consumption based on taboos or symbolic meanings. Figure (2) above indicated; traditional beliefs and cultural practices were cited by (24.5%, *n* = 95) of households,
6. Status Symbol and Hospitality	Beetle larvae like *T. confinis* larvae are rare delicacies with deep cultural significance. Due to seasonality and harvesting effort, they are reserved for events like weddings or hosting dignitaries symbolizing respect, generosity, and cultural pride. Elders often served first as a mark of honor.
7. Knowledge Secrecy and Protection of Traditional Practices	Collection and preparation knowledge often kept within families and passed down through trusted individuals. This preserves cultural control and supports sustainability of insect harvesting.
8. Food Hierarchies and Social Identity	While elders see insect larvae as heritage food, younger Luguru especially in urban settings may associate it with poverty or primitiveness. This reflects how food choices mirror evolving social identities.
9. Intergenerational Attitudes	Urbanization, education, and globalization are reshaping dietary preferences. Younger Luguru often view traditional foods like *T. confinis* larvae as outdated. Elders continue to value their nutritional and cultural importance, highlighting a generational divide. Results on social demographic characteristics indicated: (χ^2 = 24.034, df = 7, p = 0.001) depicting elder respondents were more likely to have experience of consuming giant longhorn beetle larvae than young individual (Table 2)

Consumption Trend of Longhorn Beetle Larvae and Underlying Reasons

The study found a decline in the consumption of giant longhorn beetle larvae among some community members. The leading reason, cited by 44.5% (n = 171), was a lack of knowledge or awareness about the larvae's nutritional, cultural, or ecological importance. Additionally, 24.5% (n = 95) attributed the shift to the influence of western cultural values that discourage insect consumption. Other reasons included fear or discomfort (7.4%, n = 39), concerns about allergies or health risks (7.2%, n = 28), and decreased availability of the larvae due to environmental pressures (16.4%, n = 63). These finding (Fig 13) reflect a multifaceted combination of socio-cultural, psychological, and ecological factors driving the decline (Fig 9).

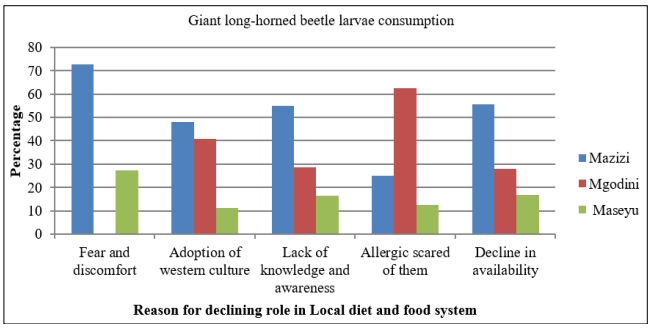

Fig 9: From Forest Foods to Table: Declining Role of in Local Diets and food system

Proposed Strategies to Reduce Underutilization of Longhorn Beetle Larvae

To promote the use of giant longhorn beetle larvae as food, respondents proposed several strategies. The results (Fig 10) indicated that; the most common was public mobilization and community sensitization (43.6%, n = 168), followed by integrating the larvae into national and local food policies (35.5%, n = 136) to ensure institutional support. Other suggestions included further scientific research on their benefits (10%, n = 39), educational campaigns targeting

schools and rural areas (9.1%, n = 35), and commercialization through retail outlets (1.8%, n = 7). These recommendations emphasize the need for both policy-level action and grassroots awareness to enhance acceptance and utilization of the larvae (Fig 10).

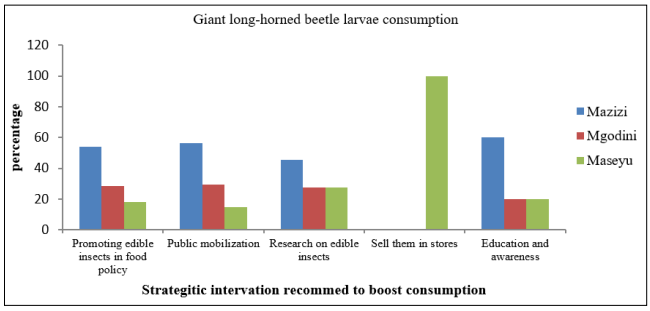

Fig 10: Strategic Approaches to Enhance Acceptance and Use of Giant Longhorn Beetle Larvae

Discussion

Role of Socio-Demographic Factors on the Consumption of Longhorn Beetle Larvae

The study reveals that socio-demographic factors significantly shape the consumption of *Tithoes confinis* larvae in Eastern Tanzania. Older individuals, particularly women, were more familiar with traditional practices of insect consumption, including harvesting and preparation (*Pambo et al.,* 2018). In contrast, younger respondents (aged 21–40) had limited experience, often influenced by education and cultural perceptions (Florênça *et al.,* 2021) [23]. Those with lower education levels were more likely to view the larvae as nutritious and traditional, while individuals with higher education expressed concerns about hygiene and leaned toward modern dietary preferences (Barsics *et al.,* 2017) [7]. Income also played a role, with low-income households relying more on the larvae as an accessible protein source (Van Huis *et al*., 2013) [77]. These findings align with studies showing a generational and socio-economic shift away from entomophagy among educated and urban youth adopting western dietary norms (Imathiu *et al*., 2020; Anankware *et al.,* 2017 [2]). Overall, the results highlight the complex influence of age, gender, education, and income on insect consumption and underscore the need for culturally sensitive interventions to promote insects as sustainable food (Manditsera *et al.,* 2018; Niassy *et al*., 2016; Schäufele *et al.,* 2019) [41, 52, 62].

Perceived Benefits and Drivers on Consumption of Longhorn Beetle Larvae

The study identified several key factors influencing the consumption of *Tithoes confinis* larvae among communities in Eastern Tanzania. Nutritional value was the most cited reason, with 50.9% of respondents (n = 196) noting the larvae's high protein and micronutrient content, consistent with findings that insects are rich in iron, zinc, and high-quality protein (Kinyuru *et al.,* 2013) [38]. Food scarcity was another major driver, reported by 49.1% (n = 189), supporting the view that edible insects offer a reliable, accessible, and cost-effective alternative during periods of shortage (Mwanri *et al.,* 2020) [49]. Cultural traditions also influenced consumption, with 24.5% (n = 95) citing ancestral practices, underscoring entomophagy's cultural significance in rural Tanzania. 20.9% (n = 80) emphasized the ease of access and availability, as the larvae are often collected from the wild at little to no cost, an observation echoed by Ramos-Elorduy (2009) [58], who noted that insects are "free" food sources requiring no commercial distribution.

Respondents also cited various perceived benefits: 44.5% highlighted economic accessibility, 40.9% noted nutritional and health advantages, and 7.3% (n = 28) mentioned both taste and environmental sustainability. Taste was particularly relevant among those accustomed to insect consumption from a young age (Tan *et al.,* 2015) [67], while the environmental benefits reflect growing recognition of insects as sustainable protein sources with low resource demands (Van Huis *et al*., 2013) [77]. Overall, consumption of *T. confinis* driven by nutritional, economic, cultural, sensory, and ecological factors, aligning with global research on entomophagy's role in sustainable and culturally appropriate food systems.

Seasonal availability, collection and sources of Giant Longhorn Beetle Larvae

The study found that many community members in Eastern Tanzania lack detailed knowledge about the seasonal availability of *Tithoes confinis* larvae, with 42.7% unable to identify the peak season. This aligns with Kelemu *et al.* (2015), who noted that awareness of insect seasonality often fragmented in rural African contexts, particularly where entomophagy not integrated into formal systems. Among those who did provide a response, 24.5% cited the mid-year dry season as the peak season, 23.6% indicated year-round availability, and only 3.6% mentioned rain season suggesting variability in ecological knowledge, potentially due to regional climate differences (van Huis *et al*., 2013; Ayieko *et al*., 2010) [77, 4].

Sourcing of the larvae is largely informal, with 52.7% obtaining them through local purchases from neighbors, reflecting the presence of small-scale, community-based insect trade systems similar to those in Zambia and the DRC (Kelemu *et al*., 2015; Ghosh *et al.,* 2017 [28]). Additionally, 30.9% harvested larvae from wild habitats like forests, consistent with traditional foraging practices critical to rural food security (Durst *et al*., 2010; Raheem *et al*., 2019) [17, 57], while 16.4% collected them directly from trees, indicating some awareness of habitat preferences.

Gender and age significantly influenced larval collection, with women making up 67% of collectors, followed by children (25.2%) and men (7.8%). This supports earlier findings that women and children play key roles in edible insect collection, processing, and commercialization across sub-Saharan Africa (Van Huis, 2013; Obopile & Seeletso, 2013) [73, 54]. These role; tied to household food provisioning and contribute to the intergenerational transfer of ecological knowledge (Ayieko *et al*., 2010; Ssepuuya *et al.,* 2017) [4, 66]. Overall, ecological knowledge, gender roles, informal trade, and social norms shape the collection and use of *T. confinis* larvae. However, gaps in seasonal and habitat awareness highlight the need for better education and ecological documentation (FAO, 2013; Halloran *et al*., 2016 [30]). Recognizing the gendered labor involved in insect collection is also vital for strengthening the role of edible insects in food security and rural livelihoods.

Preferred Preparation Methods for Giant Longhorn Beetle Larvae consumption

The preparation methods for *Tithoes confinis* (giant longhorn beetle larvae) in Eastern Tanzania reflect both cultural traditions and evolving culinary preferences. Frying was the

most preferred method, reported by 69.1% (n = 266) of respondents, due to its ability to enhance flavor, aroma, and texture making the larvae more palatable. This preference is consistent with findings across sub-Saharan Africa, where frying is widely practiced to improve taste and reduce microbial risks (Raheem *et al.,* 2019; Van Huis *et al.,* 2013) [57, 77]. Roasting, reported by 23.6% (n = 91), commonly used in communal or ceremonial settings and valued for extending shelf-life without additives, a practice also observed across East and Central Africa (Kelemu *et al*., 2015; Mlamba & Mtui, 2022 [46]).

Boiling, cited by 6.7% (n = 26), used either alone or as a preliminary step, especially among those seeking softer textures or more hygienic preparation. Boiling recognized for its role in reducing parasites and anti-nutritional factors (Payne *et al*., 2016) [56]. 10.1% (n = 39) of respondents reported combining boiling and frying to balance safety and taste, a dual method similarly practiced in Thailand and Nigeria to enhance both sensory and nutritional qualities (Rumpold & Schlüter, 2013; Yhoung-Aree *et al.,* 1997) [61, 78]. Notably, none of the respondents reported using sun drying a common preservation technique in countries like Zambia and the DRC (Chakravorty *et al.,* 2011; Kinyuru *et al*., 2010) [9, 37]. This absence may indicate a preference for fresh consumption or reduced need for long-term storage due to local accessibility and seasonal availability. Overall, the study underscores that preparation practices for *T. confinis* shaped by taste, safety, and socio-cultural context, mirroring broader trends in African entomophagy where edible insects serve as both nutritional resources and cultural markers (Niassy *et al.,* 2016; Van Huis & Oonincx, 2017) [52, 76].

Cultural Traditions and Historical Duration of giant beetle Larvae Consumption

The consumption of *Tithoes confinis* larvae in Eastern Tanzania reflects a blend of enduring cultural practices and recent dietary adaptations. The study revealed that 24.5% (n = 95) of respondents have consumed the larvae for 1–5 years, indicating recent adoption, while 15.5% (n = 90) have been consuming them for over a decade, and 9.1% (n = 35) for 6–10 years. Only 6.4% (n = 25) were new to the practice, having started within the past year. These findings align with research showing that entomophagy often evolves from cultural practice to habitual consumption when factors like availability and social acceptance are favorable (Raheem *et al.,* 2019; Van Huis & Oonincx, 2017) [57, 76]. This pattern fits into a larger global revival of interest in edible insects, driven by nutritional, ecological, and cultural factors, as well as the renewed appreciation of indigenous food traditions (Durst & Hanboonsong, 2021; Halloran *et al*., 2016) [16, 30]. In African contexts, edible insect consumption is often seasonal and intergenerational, shaped by traditional ecological knowledge and perceptions of health (Kelemu *et al*., 2015; Ayieko *et al*., 2010 [4]).

Culturally, 69.9% (n = 269) of respondents acknowledged that *T. confinis* consumption is rooted in traditional beliefs and practices, supporting findings by Meyer-Rochow (2009) [45] and Niassy *et al.* (2016) [52], who emphasized the cultural symbolism and ritual value of insects in African communities. These larvae consumed during ceremonies, offered to guests, or featured in communal meals, especially in rural or homogeneous settings (Kinyuru *et al.,* 2013; Mlamba & Mtui, 2022) [38, 46]. However, 7.3% (n = 28) denied any cultural associations, and 22.7% (n = 88) were unsure indicating a generational or knowledge gap possibly caused by modernization, urbanization, or shifts in family dynamics. Similar disruptions to traditional food knowledge have reported due to globalization and changing aspirations among youth (Srivastava *et al.,* 2020; Roos *et al.,* 2010) [65, 59].

Socio-economic factors such as rural-to-urban migration and evolving livelihood strategies also contribute to the decline in traditional knowledge transmission, reducing engagement with insect foraging and communal food practices (Rumpold & Schlüter, 2013) [61]. Studies in Kenya and Zambia similarly found that younger people are less familiar with insect-related knowledge than older generations (Kelemu *et al*., 2015; Ayieko *et al*., 2012 [5]). In summary, the consumption of *Tithoes confinis* larvae in Eastern Tanzania and neighboring communities spans a spectrum from deeply rooted tradition to emerging adaptation. This continuity highlights the cultural legitimacy of insect consumption and underscores the importance of preserving traditional knowledge to promote edible insects as sustainable, culturally appropriate food sources.

Consumption Trends of Giant Longhorn Beetle Larvae and the Need for Revitalization

The study shows a gradual decline in the consumption of *Tithoes confinis* larvae in Eastern Tanzania, raising concerns for food security, cultural continuity, and biodiversity. Although 24.5% of respondents reported consuming the larvae for 1–5 years, only 15.5% had done so for over a decade, and just 6.4% were recent adopters. This indicates weak generational uptake, reflecting broader patterns across Africa where modernization, urbanization, and shifting food preferences are eroding traditional food knowledge (Barennes *et al.,* 2015; Srivastava *et al.,* 2020; Obeng-Ofori & Khamala, 2017) [6, 65, 53]. Reasons for discontinuation included fear, disgust, concerns over hygiene, allergic reactions, and western-influenced dietary aspirations barriers that noted among youth and educated groups in other African contexts (Imathiu *et al.,* 2020; Roos *et al.,* 2010 [59]). Reduced availability of *T. confinis*, possibly due to habitat degradation, deforestation, and seasonal shifts, has also contributed to declining consumption (Kelemu *et al.,* 2015; Mlamba & Mtui, 2022 [46]). Despite this, the larvae remain culturally and nutritionally important for ethnic groups like the Luguru and Pimbwe (Seel & Mgawe, 2014) [63]. However, knowledge of their nutritional richness high in protein, fats, and micronutrients remains limited, echoing global concerns that traditional foods are often overlooked in national nutrition strategies (Durst & Hanboonsong, 2021 [16]; Van Huis, 2020 [74]; FAO, 2013).

Respondents showed greater preference for other insects such as termites (*kumbikumbi*), palm weevil larvae, *vitemvu*, crickets, and grasshoppers (*senene*), due to taste, availability, and ease of harvesting. Malaisse (2005) [40] and Obopile & Seeletso (2013) [54], who highlight Africa's vast edible insect biodiversity, with over 30 species commonly consumed in countries like Angola, Zambia, Namibia, and Botswana, support this preference. Yet, entomophagy across the continent is declining due to rising western dietary influences, cultural taboos, and growing disgust toward insect foods (Dobermann *et al.,* 2017; Tan *et al*., 2022) [68, 15]. This decline threatens not only nutritional diversity but also the survival of indigenous ecological knowledge, which relies heavily on oral transmission and household practices (Barennes *et al.,* 2015; Adebayo *et al.,* 2011) [6, 1].

To reverse this trend, targeted education campaigns needed to highlight the nutritional and cultural value of edible insects, combat neophobia and stigma, and normalize their consumption (Van Huis & Oonincx, 2017; Melgar-Lalanne *et al.,* 2019) [76, 44]. School feeding programs and community kitchens could play a role in reintroducing insects to younger generations (Imathiu *et al.,* 2020). Additionally, preserving traditional knowledge through documentation, participatory research, and local archives is vital to maintaining cultural identity and food sovereignty (Ngulube *et al*., 2002; Srivastava *et al.,* 2020) [51, 65]. At the policy and market level, promoting insect-based foods through product development (e.g., insect flours, fortified snacks), improved supply chains, and food safety regulation could revalorize insects like *T. confinis* (Lange & Nakamura, 2021; Dobermann *et al.,* 2017) [39, 15]. Such integrative approaches are essential to ensure the sustainability, acceptance, and cultural relevance of edible insects in future food systems.

Conclusion and Recommendation

Edible insects play a vital role in ensuring food and nutrition security in rural communities such as Mazizi, Mgodini, and Masaju villages in the Eastern Zone of Tanzania. This study identified edible insect species; giant long-horned be the nutritious insect with strong long standing cultural hertage in Estern part of Tanzania. The indigenous knowledge surrounding the harvesting and preparation of these insects should be valuable and preserved, as it can significantly support the promotion and acceptance of edible insects as a sustainable food source. Despite entomophagy practiced in Morogoro Rural District, there is a noticeable decline in both the availability and consumption of edible insects. This decline attributed to factors such as the adoption of western dietary habits, religious beliefs, discomfort or stigma associated with insect consumption, and the decreasing presence of insects in the wild. The loss of these traditional practices is alarming, given their contribution to nutrition and livelihoods in rural areas. Edible insects are not only highly nutritious but also have a significantly lower environmental impact compared to conventional livestock. To promote entomophagy, it is essential to raise awareness and educate the public about the nutritional and environmental benefits of edible insects. This could help reduce stigma and encourage broader acceptance. Documenting indigenous knowledge through media and academic literature will help preserve this cultural heritage and shift public perception, while also contributing to national and global understanding of edible insects as a viable food source. Such knowledge can inform food policies, encouraging the integration of insects into daily diets and addressing food security challenges, particularly in developing countries. Future research should explore the nutritional profiles of edible insects and the feasibility of farming them to enhance availability and accessibility. Incorporating insects into familiar food products may further support public acceptance. Moreover, government initiatives should encourage vulnerable populations to adopt edible insects in their diets and support research into consumer acceptance of insect-based food products.

Declarations

Ethics Approval: The study permitted by the Morogoro Rural District and ethically approved by Jaramogi Oginga Odinga University of Science and Technology (JOOUST).

Authors Contributions: I hereby verify that all authors mentioned on the title page have made substantial contributions to the conception and design of the study, have thoroughly reviewed the manuscript, confirm the accuracy and authenticity of the data and its interpretation, and consent to its submission.

Competing Interests: The authors have no competing interests to declare that are relevant to the content of this article.

Availability of Data and Materials: All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

Funding: Jaramogi Oginga Odinga University of Science and Technology (JOOUST) through the African Centre of Excellence (ACE II) in Sustainable Use of Insects as Food and Feed (INSEFOODS) funded this research, with support from the World Bank Group under the ACE II initiative Project.

Acknowledgements: This study was possible with the financial support of Jaramogi Oginga Odinga University of Science and Technology (JOOUST), through the African Centre of Excellence (ACE II) for sustainable use of insects as food and feed (INSEFOODS) in collaboration with the World Bank.

References

1. Adebayo, S. E., Malomo, G. A., & Popoola, K. (2011). Traditional methods of processing edible insects in Africa and their implication for nutrition and food security. *African Journal of Food, Agriculture, Nutrition and Development*, 11(2), 5017–5033.
2. Anankware, J. P., Fening, K. O., Osekre, E. A., & Obeng-Ofori, D. (2017). Insects as food and feed: A review. *International Journal of Agricultural Research and Review*, 5(1), 1–10.
3. Araujo, J. (2021). Nutritional and ecological aspects of edible insects in Africa. *Journal of Insects as Food and Feed*, 7(2), 203–216.
4. Ayieko, M. A., Kinyuru, J. N., Ndong'a, M. F., & Kenji, G. M. (2010). Nutritional value of selected edible insects in the Lake Victoria region, Kenya. *African Journal of Environmental Science and Technology*, 4(12), 794–802.
5. Ayieko, M. A., Oriaro, V., & Nyambuga, I. A. (2012). Processed products of termites and lake flies: Improving entomophagy for food security within the Lake Victoria region. *African Journal of Food, Agriculture, Nutrition and Development*, 10(2), 2085–2098.
6. Barennes, H., Phimmasane, M., & Rajaonarivo, C. (2015). Insect consumption to address undernutrition, a national survey on the prevalence of insect consumption among adults and vendors in Laos. *PLOS ONE*, 10(8), e0136458.
7. Barsics, F., Megido, R. C., Brostaux, Y., Barsics, C., Blecker, C., Haubruge, E., & Francis, F. (2017). Could new information influence attitudes to foods supplemented with edible insects? *British Food Journal*, 119(9), 2027–2039.
8. Casteel, A., & Bridier, N. J. (2021). Describing populations and samples in doctoral student research. *International Journal of Doctoral Studies, 16*, 339–362. https://doi.org/10.28945/4801
9. Chakravorty, J., Ghosh, S., & Meyer-Rochow, V. B. (2011). Practices of entomophagy and entomotherapy by

tribes of Arunachal Pradesh, India. *Journal of Ethnobiology and Ethnomedicine*, 7(1), 5.
10. Chakravorty, J., Ghosh, S., & Meyer-Rochow, V. B. (2013). Comparative survey of entomophagy and entomotherapeutic practices in six tribes of Eastern Arunachal Pradesh (India). *Journal of Ethnobiology and Ethnomedicine, 9*, 50. https://doi.org/10.1186/1746-4269-9-50
11. Creswell, J. W. (2012). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th ed.). Boston, MA: Pearson Education.
12. Creswell, J. W., & Plano Clark, V. L. (2007). *Designing and conducting mixed methods research*. Thousand Oaks, CA: Sage Publications.
13. De Boer, I. J. M. (2012). Environmental sustainability of animal-sourced food production in perspective. *Animal*, 6(3), 346–356.
14. Dickie, L. (2019). *Food Insecurity and Global Health*. In *Global Health 101* (3rd ed.). Jones & Bartlett Learning.
15. Dobermann, D., Swift, J. A., & Field, L. M. (2017). Opportunities and hurdles of edible insects for food and feed. *Nutrition Bulletin*, 42(4), 293–308.
16. Durst, P. B., & Hanboonsong, Y. (2021). *Edible forest insects: Cultural delicacies and potential food resources*. FAO and RECOFTC. https://www.fao.org/documents/card/en/c/cb4093en
17. Durst, P. B., Johnson, D. V., Leslie, R. N., & Shono, K. (2010). *Forest insects as food: Humans bite back*. FAO Regional Office for Asia and the Pacific. https://www.fao.org/3/i1380e/i1380e.pdf
18. Food and Agriculture Organization of the United Nations. (2006). *Food security: Policy brief* (Issue 2). FAO. https://www.fao.org/fileadmin/templates/faoitaly/documents/pdf/pdf_Food_Security_Cocept_Note.pdf
19. Food and Agriculture Organization of the United Nations. (2009). *How to feed the world in 2050*. FAO. https://www.fao.org/3/k9825e/k9825e.pdf
20. Food and Agriculture Organization of the United Nations. (2013). *The state of food and agriculture: Food systems for better nutrition*. FAO. https://www.fao.org/3/i3300e/i3300e.pdf
21. Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, United Nations Children's Fund, World Food Programme, & World Health Organization. (2018). *The state of food security and nutrition in the world 2018: Building climate resilience for food security and nutrition*. FAO. https://www.fao.org/3/I9553EN/i9553en.pdf
22. Food and Agriculture Organization of the United Nations. (2013). *Edible insects: Future prospects for food and feed security* (FAO Forestry Paper No. 171). FAO. https://www.fao.org/3/i3253e/i3253e.pdf
23. Florênça, S. G., Costa, C. A., Correia, P. M. R., & Mafra, I. (2021). Edible insects: Preliminary study about perceptions, attitudes, and knowledge on a sample of Portuguese citizens. *Foods*, 10(4), 709.
24. Frels, R. K., & Onwuegbuzie, A. J. (2013). Administering quantitative instruments with qualitative interviews: A mixed research approach. *Journal of Counseling & Development, 91*(2), 184–194. https://doi.org/10.1002/j.1556-6676.2013.00085.x
25. Fusch, P. I., & Ness, L. R. (2015). Are we there yet? Data saturation in qualitative research. *The Qualitative Report, 20*(9), 1408–1416. https://doi.org/10.46743/2160-3715/2015.2281
26. Gahukar, R. T. (2011). Entomophagy and human food security. *International Journal of Tropical Insect Science*, 31(3), 129–144.
27. Gałęcki, R. (2021). *Edible Insects in the Human Diet: Review and Recommendations*. *Nutrients*, 13(11): 3832. https://doi.org/10.3390/nu13113832
28. Ghosh, S., Lee, S. M., Jung, C., & Meyer-Rochow, V. B. (2017). Nutritional composition of five commercial edible insects in South Korea. *Journal of Asia-Pacific Entomology*, 20(2), 686–694.
29. Hadley, C., & Crooks, D. L. (2012). Coping and the biosocial consequences of food insecurity in the 21st century. *American Journal of Physical Anthropology*, 149(S55), 72–94.
30. Halloran, A., Flore, R., Vantomme, P., & Roos, N. (2016). *Edible insects in sustainable food systems*. Springer International Publishing.
31. Hong, J. S., & Espelage, D. L. (2011). A review of mixed methods research on bullying and peer victimization in school. *Educational Review, 63*(1), 115–126. https://doi.org/10.1080/00131911.2010.483052
32. Imathiu, S. (2020). Benefits and food safety concerns associated with consumption of edible insects. *NFS Journal*, 18, 1–11.
33. Kariyanna, B. (2017). Ecological and economic significance of longhorn beetles (Coleoptera: Cerambycidae). *Journal of Entomology and Zoology Studies*, 5(2), 608–612.
34. Kelemu, S., Niassy, S., Torto, B., Fiaboe, K., Affognon, H., Tonnang, H.,... & Ekesi, S. (2015). African edible insects for food and feed: Inventory, diversity, commonalities and contribution to food security. *Journal of Insects as Food and Feed*, 1(2), 103–119.
35. Kelemu, S., Niassy, S., Torto, B., Fiaboe, K., Affognon, H., Tonnang, H., & Ekesi, S. (2015). African edible insects for food and feed: Inventory, diversity, commonalities and contribution to food security. *Journal of Insects as Food and Feed*, 1(2), 103–119.
36. Kinyuru, J. N. (2010). Nutritional potential of longhorn grasshopper (*Ruspolia differens*) consumed in Kenya. *Journal of Agriculture, Science and Technology*, 12(1), 32–46.
37. Kinyuru, J. N., Kenji, G. M., & Njoroge, S. M. (2010). Process development, nutrition and sensory qualities of wheat buns enriched with edible termites (Macrotermes subhylanus) from Lake Victoria region, Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, 10(2), 2085–2098.
38. Kinyuru, J. N., Mogendi, J. B., Riwa, C. A., & Ndung'u, N. W. (2013). Edible insects – A novel source of essential nutrients for human diet: Learning from traditional knowledge. *Animal Frontiers*, 3(1), 58–64.
39. Lange, L., & Nakamura, S. (2021). Enabling sustainable food systems through insect farming. *Current Opinion in Green and Sustainable Chemistry*, 27, 100416.
40. Malaisse, F. (2005). *Nourrir l'Afrique: Enjeux écologiques et perspectives*. Presses agronomiques de Gembloux.
41. Manditsera, F. A., Lakemond, C. M. M., Fogliano, V., Zvidzai, C. J., & Luning, P. A. (2018). Consumption patterns of edible insects in rural and urban areas of

Zimbabwe: Taste, nutritional value, and availability are key elements for acceptance. *Food Security*, 10(3), 561–570.
42. Mariod, A. A. (2020). *Food Security and Nutrition in Sub-Saharan Africa: Challenges and Interventions*. Springer.
43. Massawe, C. R., *et al*. (2018). Assessment of food insecurity among farming households in Morogoro, Tanzania. *African Journal of Food, Agriculture, Nutrition and Development*, 18(1), 13072–13089.
44. Melgar-Lalanne, G., Hernández-Álvarez, A. J., & Salinas-Castro, A. (2019). Edible insects processing: Traditional and innovative technologies. *Comprehensive Reviews in Food Science and Food Safety*, 18(4), 1166–1191.
45. Meyer-Rochow, V. B. (2009). Food taboos: their origins and purposes. *Journal of Ethnobiology and Ethnomedicine*, 5(1), 18.
46. Mlamba, F., & Mtui, E. (2022). Indigenous knowledge and the use of edible insects in rural Tanzania. *International Journal of Environmental Studies*, 79(2), 345–359.
47. Mmari, M. W., *et al*. (2017). Nutrient composition of commonly consumed edible insects in Tanzania. *Journal of Insects as Food and Feed*, 3(2), 105–114.
48. Morga, R. V. (1970). *Determining sample size for research activities*. *Educational and Psychological Measurement, 30*, 607–610.
49. Mwanri, A. W., Kogi-Makau, W., & Laswai, H. S. (2020). Nutritional value of edible insects and their potential contribution to human health: A review. *African Journal of Food, Agriculture, Nutrition and Development*, 20(2), 15749–15766.
50. National Bureau of Statistics (NBS). (2022). *Population and Housing Census 2022: Preliminary Results*. Dodoma: United Republic of Tanzania.
51. Ngulube, P., Mokwatlo, K., & Ndwandwe, S. C. (2002). Managing and preserving indigenous knowledge in the knowledge economy: Challenges and opportunities for Africa. *South African Journal of Libraries and Information Science*, 68(1), 1–9.
52. Niassy, S., Affognon, H., Fiaboe, K., Akutse, K., & Tanga, C. (2016). Insects for food and feed in Africa: Current perspectives and future directions. *Journal of Insects as Food and Feed*, 2(4), 205–214.
53. Obeng-Ofori, D., & Khamala, C. (2017). Entomophagy: Insects as food. In Ekesi, S., & Mohamed, S. A. (Eds.), *Insect pests and vector-borne diseases in Africa* (pp. 231–243). Springer.
54. Obopile, M., & Seeletso, T. G. (2013). Eat or not eat: An analysis of the status of entomophagy in Botswana. *Food Security*, 5(6), 817–824.
55. Pambo, K. O., Okello, J. J., Mbeche, R. M., & Kinyuru, J. N. (2018). Consumer attitudes towards edible insects in Kenya: The potential role of media and marketing communication. *African Journal of Agricultural and Resource Economics*, 13(4), 1–14.
56. Payne, C. L., Scarborough, P., Rayner, M., & Nonaka, K. (2016). Are edible insects more or less 'healthy' than commonly consumed meats? A comparison using two nutrient profiling models developed to combat over- and undernutrition. *European Journal of Clinical Nutrition*, 70(3), 285–291.
57. Raheem, D., Carrascosa, C., Oluwole, O. B., Nieuwland, M., Saraiva, A., Millán, R., & Raposo, A. (2019). Traditional consumption of and rearing edible insects in Africa, Asia and Europe. *Critical Reviews in Food Science and Nutrition*, 59(14), 2169–2188.
58. Ramos-Elorduy, J. (2009). Anthropo-entomophagy: Cultures, evolution and sustainability. *Entomological Research*, 39(5), 271–288.
59. Roos, N., Wahab, M. A., Chamnan, C., & Thilsted, S. H. (2010). The role of fish in food-based strategies to combat vitamin A and mineral deficiencies in developing countries. *The Journal of Nutrition*, 137(4), 1106–1109.
60. Ruby, M. B. (2015). Entomophagy and cultural acceptance: A review. *Anthrozoös*, 28(4), 575–598.
61. Rumpold, B. A., & Schlüter, O. K. (2013). Nutritional composition and safety aspects of edible insects. *Molecular Nutrition & Food Research*, 57(5), 802–823.
62. Schäufele, I., Barrera, C., & Janssen, M. (2019). Consumer attitudes toward insects as food: The role of product-associated affect and perceived risk. *Food Quality and Preference*, 77, 37–48.
63. Seel, T., & Mgawe, P. (2014). Biodiversity and local knowledge: Strengthening sustainable use of edible insects in Tanzania. *Tanzania Journal of Forestry and Nature Conservation*, 84, 45–52.
64. Sida (2015). *Food Security – Sida's Thematic Overview*. Swedish International Development Cooperation Agency. https://www.sida.se
65. Srivastava, S. K., Pradhan, R. P., & Sekhar, B. R. (2020). Traditional knowledge systems in food and nutrition: A case for inclusion in national policies. *Current Science*, 119(9), 1466–1473.
66. Ssepuuya, G., Mukisa, I. M., & Nakimbugwe, D. (2017). Nutritional composition, quality, and shelf life of edible insects. *African Journal of Food, Agriculture, Nutrition and Development*, 17(1), 11401–11417.
67. Tan, H. S. G., Fischer, A. R. H., Tinchan, P., Stieger, M., Steenbekkers, L. P. A., & van Trijp, H. C. M. (2015). Insects as food: Exploring cultural exposure and individual experience as determinants of acceptance. *Food Quality and Preference*, 42, 78–89.
68. Tan, H. S. G., Jung, L. S., Fischer, A. R. H., van Trijp, H. C. M., & Stieger, M. (2022). Tasty but weird: Exploring the socio-cultural barriers of insect food acceptance. *Food Quality and Preference*, 96, 104382.
69. Tao, J. & Olive Li, Y. (2018). Edible insects as a means to address global malnutrition and food insecurity issues. *Food Quality and Safety*, 2(1), 17–26.
70. The Citizen (2022). Tanzanians embrace edible insects amid food challenges. *The Citizen Tanzania*. https://www.thecitizen.co.tz
71. UN (2012). *World Population Prospects: The 2012 Revision*. United Nations, Department of Economic and Social Affairs, Population Division.
72. United Republic of Tanzania (URT). (2013). *2012 Population and Housing Census: Population Distribution by Administrative Areas*. Dar es Salaam: National Bureau of Statistics, Ministry of Finance.
73. Van Huis, A. (2013). Potential of insects as food and feed in assuring food security. *Annual Review of Entomology*, 58, 563–583.
74. van Huis, A. (2020). Insects as food and feed, a new emerging agricultural sector: A review. *Journal of Insects as Food and Feed*, 6(1), 27–44.
75. Van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens,

E., Halloran, A., Muir, G., & Vantomme, P. (2015). *Edible insects: Future prospects for food and feed security* (FAO Forestry Paper No. 171). Food and Agriculture Organization of the United Nations. https://www.fao.org/3/i3253e/i3253e.pdf

76. Van Huis, A., & Oonincx, D. G. A. B. (2017). The environmental sustainability of insects as food and feed. *A review*. *Agriculture*, 7(4), 1–15.
77. Van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G., & Vantomme, P. (2013). *Edible insects: Future prospects for food and feed security* (FAO Forestry Paper No. 171). Food and Agriculture Organization of the United Nations. https://www.fao.org/3/i3253e/i3253e.pdf
78. Yhoung-Aree, J., Puwastien, P., & Attig, G. A. (1997). Edible insects in Thailand: An unconventional protein source? *Ecology of Food and Nutrition*, 36(2–4), 133–149.