



Youth Knowledge on the Utilization of Edible Insects as Food and Feed

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ABSTRACT

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The utilization of edible insects as food and feed is not a new concept, it is a practice that has been part of the tradition of many communities around the world. They have been primarily used as supplementary food in most African countries. However, there has been a significant decline in the consumption of insects over the years, especially among young people. Therefore, this study aimed to investigate the knowledge on entomophagy and the utilization of insects among the youth. The study revealed that the majority of youth had limited knowledge about consumption, nutrition, harvesting, preparation and use of edible insects as livestock feed. From the Chi-square analysis it was observed that age and education level have a significant relationship to the familiarity of consumption of edible insects, $P=0.014$ and $P=0.009$ respectively. The results also show that there is a significant association between awareness on the nutritional value of insects with age and education level, $P=0.001$ and $P=0.009$ respectively. Logistic regression analysis was used to find the association between demographic characteristics, knowledge and the utilization of edible insects. The results revealed that education level, age and knowledge have an impact on the utilization of edible insects. Lack of knowledge contribute to the unwillingness of youth to consume insects. It is noticeable that indigenous knowledge on entomophagy is slowly disappearing with the shift in eating habits and changes in the socio-economic environments. As such, it is imperative that indigenous knowledge is preserved and educational interventions are done to raise awareness on the benefits of entomophagy in order to improve the utilization of insects among the youth.

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Introduction

The world population is considered to be comprised of about 50% of young people, of which 3.3 billion are below 25 years (Sommers, 2010). Gupte et al (2014) stated that Africa is experiencing more rapid growth in its youth population than any other continent in the world. Many countries including Kenya have the highest population of youth; in the Policy brief of 2017 (NCPD), the population of youth in Kenya for people between 15 and 34 years of age was projected to reach 17.8 million in 2020 while 22.3 million is expected by the year 2030. The youth population constitutes a larger share of Kenya's asset for the present and future. But due to these high numbers there is a great competition for resources, opportunities, facilities and youth related issues. The world population is expected to increase by about one percent in the next two decades with the highest growth in developing countries (Guine et al., 2021; Gatecki et al., 2021). Africa is one of the continents in the world that is experiencing rapid growth in its population accompanied by social and economic

challenges. High rates of population increase are putting Africa under the pressure of mitigating hunger. Malnutrition is a major issue in Africa; the undernourished population is about 35% in Africa compared to all of the developing countries which have about 14 % of undernourished people (Min-harris, 2009).

FAO has projected that in the year 2030 about 40% of the population will have a high possibility of hunger. In Sub-Saharan Africa which is the most affected area there has been a significant decline of undernourishment cases but now facing high levels of obesity and overweight. All the countries in Sub-Saharan Africa have been working hard towards achieving food and nutrition security but it has proven to be difficult due to the issues of climate change and degraded environments (Fischer, 2009).

FAO (2009) reported that by the year 2050 for all human life to be sustained worldwide, food production must increase by 70% (Lensvelt and Steenbekkers, 2014). The estimated population of humans in 2050 will be around

9 billion, and as a result, there will be a tremendous rise in demand for food, particularly animal protein. In growing and developing economies where there are severe food shortages, this is increasingly obvious. Due to high pricing and a change in the climate that has reduced livestock production, animal protein is currently difficult to get in these nations. Despite these difficulties, it is anticipated that future demand for animal-based protein will rise even higher. Therefore, in order to meet the demand, it is essential that protein output increases (Alemu et al., 2015).

Capitalizing on the utilization of natural resources, particularly edible insects can be an approach to food diversification. Insects are the world's most abundant and diversified multicellular animals (Tang et al., 2019). Although insects are commonly thought of as pests that cause harm to plants, animal and human health, they can contribute significantly in reducing food poverty in addition providing ecosystem services (Bernard and Womeni, 2016). In an ever increasing human population hunger and malnutrition are usually major issues. People are suffering from chronic protein deficiency and are looking for alternative protein sources. Insects are seen as the best option as they could provide large amounts of multiple nutrients. The use of diverse insects in traditional communities could be the solution in achieving food security (Yen, 2009). Edible insects are an essential part of the human diet in many parts of Latin America, Africa and Asia. Many people in these regions (Latin America, Asia and Africa) live below the poverty line on a global scale; which is a daily income less than US\$1.90 as such they are not able to secure adequate and quality food resulting in under nutrition particularly protein deficiency (Moore, 2005), hence the consumption of insects has the ability to alleviate hunger worldwide. Burchi et al (2011) indicated that the accustomed diets in developing countries are often deficient in fundamental nutrients such as minerals, vitamins and proteins. Most of the times people are not able to afford farm products like domestic animals and vegetables. Insects, on the other hand, are normally affordable but with the nutrients that are lacking in conventional diets (Tang et al., 2019). For a long time edible insects have been used in livestock and aquaculture feeds, particularly in the tropics. Poultry fed on insects showed high growth rate, less susceptible to pathogens, and are more nutritional than those fed by plant based protein (Jozefiak et al., 2016). Insects contain valuable nutrients with fats, beneficial amino acids and micronutrients. Because insects can be mass produced sustainably in different methods they are a good alternative protein source for animal feed (Chia et al., 2020).

With the rising cost of feed ingredients around the world, the industry is exploring new protein sources. The cost of feeding domestic animals on conventional feeds that are made of fish meal, soy, fish oil etc. is becoming increasingly difficult for industries. There is a lot of interest in finding replacement for these high-priced ingredients by using Black soldier fly larva, maggots and yellow mealworm (Van Huis, 2012). In developing nations, the traditional utilization of edible insects as feed and food keep on providing rural communities with important benefits; nutritional, economic and ecological.

There are over 200 million Africans that consume insects on regular basis. Studies have revealed that insects are

essential to various food systems. They can provide a direct input to food and nutrition security through their high protein and calorie content and the income generated from their trading is overly important as an indirect contribution to food security (Raheem et al., 2019). Insects use fewer resources such as water and land, making them attractive for domestication. Not only do they require less resources but insect farming lead to reduction of pollution due to their high food conversion rate they produce a smaller amount of greenhouse gases as compared to livestock production which contributes about 18 percent of the total greenhouse gases released into the atmosphere. Therefore, rearing insects for human consumption can help in addressing protein demands and also contribute to the conservation of the environment (Van Huis and Oonincx, 2017). In Kenya, edible insects' consumption is popular in the western part of the country, where insects are collected for eating, feeding poultry or fish and some members of the community use them in traditional medicine. Diversity and abundance of insects are found around the lake region which includes; winged termites, grasshoppers, locusts, and crickets and they form an integral part of their diets (Ayieko et al., 2010a). Termites are one of the most abundant and widely consumed insect in Western and Lake Victoria region of Kenya and they are part of their traditional diets. The insects are commonly consumed as relish, a snack or can be used as an ingredient in other foods (Kinyuru et al., 2013).

Despite entomophagy presenting a sustainable alternative protein food source, there is a challenge of consumer acceptance. There has been a decline in entomophagy over the years, which is mostly evident in urban centers. Awareness/ familiarity, phobia, food preferences and culture are some of the reasons attributed to the adoption of insects as food (Babarinde et al., 2020).

In a research study carried out by Ghosh et al (2020) in Ethiopia and Korea it was discovered that Ethiopians were not ready to accept insects as human food unlike the Koreans. The main reason was little or no knowledge about insects being used as food as well as issues of culture and religion. The findings showed that at least the elderly population of 50 years of age had a bit of knowledge on the consumption of insects than the younger generation. The younger generation lacks or has little understanding about the consumption of edible insects. According to (Sogari et al., 2019) lack of interest and knowledge on insects lead to unwillingness to eat them. The limited distribution of knowledge on edible insects has motivated this study in order to promote entomophagy among the youth. Therefore, the aims of the study; (1) to determine the level of knowledge of youth on consumption, nutritional benefits, harvesting, preparation and use of edible insects as livestock feed, and (2) determine factors influencing youth to use of edible insects as food and feed.

Materials and Methods

Study Area

The research was carried out in Vihiga County, Western Kenya. Vihiga County is divided into five sub counties; Hamisi, Vihiga, Emuhaya, Luanda and Sabatia. Approximately 590,013 people were living in the county according to the 2019 National Population and Housing Census (KNBS, 2019). At 1, 033 persons per square km,

the county has the highest population density than any county in the country. Vihiga County has a young population, with 46% of people aged between 15-35 years old. The county is characterized by a beautiful landscape; caves, hills and forests that have the potential to be used for tourism activities.

There are many economic activities taking place in the county which include and are not limited to agriculture, fishing, timber, mining, tea production and cooperative societies. Vihiga County's economy is mainly based on agriculture with about 98% of the land used for farming. It is estimated that 85% of the population in the county depends on agricultural activities for their livelihood but 65% of the population is said to be living in poverty (Ministry of Agriculture, Livestock, Fisheries and Cooperatives, 2017).

Data Collection

The survey was conducted from December 2020 to February 2021, a total of 270 respondents took part in the survey, which was conducted among people aged between 18 and 35 years old. A door to door approach was used to randomly select the respondents. The questionnaire was relayed through a face to face interviews. The questionnaire had both closed and open ended questions. This allowed participants to freely express and present their views on the topic. The questions were articulated in a simple and concise manner to make sure that participants are able to complete the whole questionnaire. Pictures of different edible insects were presented during interviews to assistant respondents to identify the species available in their area. The questions were translated to Swahili for easy understanding and comprehension.

Data Analysis

The data obtained from the questionnaire was coded and entered into The Statistical Package for Social Sciences (SPSS ver.25). Chi-square test of independence was used to determine the relationship between demographic characteristics and knowledge of youth on edible insects. The effect of demographic characteristics and knowledge on the utilization of insects as food and feed was determined by a logistic regression analysis.

Results

Available Edible Insects in Vihiga County

Youth were able to identify edible insects in their local language. This was according to the native sub-tribes in Vihiga County being Banyore, Tiriki and Maragoli. The study discovered seven insects' species were identified by youth to be available in the county, as shown in Table 2. Termites were recorded to be the most abundant and familiar insect in the area. It was indicated that most edible insects; termites, grasshoppers, locust etc., occur during the rainy season of March-May, while cockroaches and mosquitos were noted to be available throughout the year. However, high populations of mosquitos appear during the rainy season when the conditions are favourable.

Demographic Characteristic Influencing Knowledge on Entomophagy

Data indicated that respondents (57.8%) were moderately aware of the consumption of edible insects in their area. A greater percentage (47.0%) showed that they are slightly knowledgeable about the nutritional benefits of edible insects to human beings. Sixty one percent reported that insects can be found in local markets. The respondents also demonstrated considerable knowledge of insect harvesting, preparation and use as livestock feed. It was observed that education level and age have a significant connection to the familiarity of consumption of edible insects, $X^2(6, N=270) = 15.917, p = .014$ and $X^2(15, N=270) = 31.082, p = .009$ respectively. The results also show that there is a significant correlation between awareness on the nutritional value of insects with age and education level, $X^2(6, N=270) = 22.347, p = .001$ and $X^2(15, N=270) = 31.082, p = .009$ respectively. This implies that as age and education level increase knowledge on awareness of consumption and nutritional value of edible insects increased. It was noted that gender is significantly related to the awareness of the use of edible insects as livestock feed, $X^2(1, N=270) = 4.181, p = .041$. Males are more likely to know about the use of edible insects as livestock feed than females.

Table 1. Demographic Characteristics of respondents

Demographic Characteristics	Frequency (N)	Percentage (%)
Age		
18-23	84	31.1
24-28	97	35.9
29-35	89	33.0
Gender		
Male	139	51.5
Female	131	48.5
Marital status		
Single	166	61.5
Married	102	37.8
Divorced	2	0.7
Education level		
Secondary	105	38.9
Tertiary	165	61.1
Employment status		
Full time	15	5.6
Part time	19	7.0
Self employed	67	24.8
Unemployed	107	39.6
Student	62	23.0

Table 2. Edible insects available in Vihiga County

Scientific name	Edible insect	Type	Banyore	Tiriki	Maragoli	Seasonal availability	Harvesting time
Isoptera spp	Termite	Worker termite	Amache	Machee	Amage	April-August	Morning and Evening
		Soldier termite	Chingengeni	Mavalu	Tsindago	March-May	Morning and Evening
		Winged termite	Chiswa	Tsiswaa	Tsiswa	March-May	Early morning and Night
		Queen termite	Omwami	Omwami	Umwami	April-August	Anytime of the day
Gryllus sp	Cricket	Field/Black cricket	Esichilili	Vitsinini	Kisili	June-July	Night
Locusta migratoria	Locust		Chisiche	Tsisichi	Tsisige	March-May	Early morning and Night
Caelifera spp	Grasshopper		Litete	Litakala	Lidede/Lidagala	March-May	Early morning and Night
Scarabaeidae spp	Beetle	Dung Beetle	Lifunyu	Likunyuli	Ling'unyu	May-October	Morning and Evening
Periplaneta fuliginosa	Cockroach	Smoky brown cockroach	Lichilili	Lisilili	Risiri	All year round	Night
Culicidae spp	Mosquito		Isuna	Tsisuna	Isuna	All year round	Early morning and Night

Table 3. Socio-demographic characteristics influencing knowledge

Variables	Value	df	P-value
Familiarity to the consumption of edible insects			
Age (Years)	15.917	6	.014*
Education level	31.082	15	.009*
Awareness on the nutritional value			
Age (Years)	22.347	6	.001*
Education level	31.082	15	.009*
Awareness on the use of edible insects as feed			
Gender (Male)	4.181	1	.041*

Note: * implies statistical significance at 5% level

Use of Edible Insects as Food and Feed

A large number of respondents indicated that they consumed insects, while a small percentage showed that they used edible insects as feed for livestock. Termites were the main consumed insects in the area. Consumption of edible insects is still acknowledged and considered important by youth though the consumption rate is low. Insects consumed or used as feed were either harvested from the wild or bought from local markets.

Factors Affecting the Consumption of Edible Insects

Table 5 shows logistic regression results for consumption of edible insects, demographic characteristics, and knowledge. Gender, Marital status, employment and familiarity to the consumption of edible insects have no statistically significant association with the

consuming edible insects. The age of respondents is significant and negatively correlated with the consumption of edible insects. This shows that as age increases a respondent is 0.376 more likely not to consume insects. The coefficient of education level is statistically significant and negatively associated to the consumption of edible insects. The odds ratio of 0.517 for education level insinuates that an increase in education of youth is 0.517 times likely not to consume edible insects. Furthermore, the availability of edible insects and awareness on the nutritional benefits could not motivate respondents to consume insects. The coefficients of harvesting and preparation knowledge determine the consumption of edible insects but negatively. This implies that knowing how to harvest and prepare insects does not encourage youth to consume them.

Table 4. Utilization of insects by youth

Variable	Yes	No	Total
Consumption	74.4	25.6	100
Livestock feed	23.7	76.3	100

Table 5. Factors influencing the consumption of insects

	Coefficient	Standard error	Significance	Odds ratio
Gender	.401	.399	.314	1.494
Age	-.978	.370	.008*	.376
Marital status	.270	.477	.572	1.309
Education level	-.659	.182	.000*	.517
Employment	-.135	.224	.548	.874
Familiarity on consumption of insects	.618	.330	.061	1.855
Availability in local markets	-1.516	.408	.000*	.220
Awareness on nutritional benefits	-1.518	.345	.000*	.219
Harvesting knowledge	-2.281	.615	.000*	.102
Preparation knowledge	-1.533	.427	.000*	.216

Note: * implies statistical significance at 5% level

Table 6. Factors influencing the use of insects as feed

	Coefficient	Standard error	Significance	Odds ratio
Gender	.372	.427	.383	1.364
Age	.161	.361	.655	1.649
Marital status	.500	.510	.327	1.009
Education level	-.313	.169	.063	.704
Employment	.010	.236	.965	1.003
Availability in local markets	.932	.483	.054*	2.275
Nutritional benefits	.028	.271	.917	1.306
Harvesting knowledge	-2.815	.470	.000*	.056
Knowledge on use as livestock feed	-4.586	1.048	.000*	.005

Note: * implies statistical significance at 5% level

Determinants of Edible Insects Use as Feed

According to the findings there is no statistically significant association between the use of edible insects as livestock feed with the demographic characteristics of respondents and knowledge on nutritional benefits. The availability of insects has a positive relationship with the use of insects as feed. A participant is 2.275 times more likely to use insects as feed as the availability of insects in local markets increase. Harvesting and the use of insects as feed are negatively associated with the use of edible insects as feed. The respondent's likelihood of using insects as feed decrease with the increase in awareness on the use of edible insects as feed and harvesting knowledge.

Discussion

The utilization of edible insects as food and feed is not a new concept; it is a practice that has been part of the tradition to many communities around the world. They have been primarily used as supplementary food in most African countries (Defoliart, 1995). In this study seven species were found to be available in the area. The natural presence and abundance of edible insects is ascribed to the diversification in the quantity of insects consumed in different countries. Emergence of most edible insects is affected by precipitation hence their abundance during rainy seasons (Ayieko et al., 2010b). Insects and their consumption preferences differ from one area to another that is why in most communities, people do not use all the

available edible insects (Fischer and Steenbekkers, 2018). According to Chan (2014) familiarity with entomophagy increases consumer readiness to adopt insects as food.

The mostly consumed insects in Southern Africa are termites and mophane worms (Kelemu et al., 2015), edible stink bugs in Zimbabwe (Kunatsa et al., 2020), palm weevil in Ghana (Parker et al 2020), palm weevil, moth caterpillar, rhinoceros beetle in Nigeria (Idowu et al., 2019), and grasshopper, locusts and crickets are common in Japan and Thailand (Feng et al., 2018). The study found that termites were the most abundant and mainly used as food and feed among the youth.

We found that the socio demographic characteristics; age, educational level, and gender have significant association with entomophagy knowledge indicators. Higher education improves an individual's awareness and learning capabilities, hence increasing access to nutritional information of new food products (Ayuya et al, 2015). Comparably, Ghosh et al (2020) found that knowledge on edible insects consumption increased with age. In addition the study by Heanult-Ethier et al (2020) demonstrated that males are more likely to be informed about the use of insects as food and feed more than females. The most conventional method of collecting insects is from the wild. A wider array of species can be gathered at different developmental phases. Each species' harvesting is distinct and is based on its developmental stage (Mutungi et al., 2019). The present research indicated that early morning and evening were appropriate to harvest most edible insects. This was because insects such as grasshoppers, locusts and

crickets are usually not active during those times making it easier to catch those (Sere et al., 2018). Hand picking and simple traps were reported to be mostly used to collect insects. The findings were also reported by (Charkravorty et al., 2019; Meutchieye et al., 2016; Durst and Hanboonsong, 2014). They found that the local people harvested insects through hand picking and traps such as light traps, net traps and water traps etc. According to Chakravorty (2014) the knowledge and skills on harvesting insects is passed from generation to generation. Women are usually responsible for collecting and preparing insects (Mandiretsera et al., 2018). Contrastingly, our findings reported that in terms of youth, males were more involved in harvesting and processing of insects. The current study revealed that the younger generation follow the traditional way of consuming insects; uncooked, fried, roasted and sun-dried. Meyer-Rochow et al (2021) and Netshifhefhe et al (2018) reported the same results regarding the preparation of insects. The methods used in insects processing and preparation vary from species to species and from culture to culture. Processing makes the insect more palatable and digestible. Certain cooking techniques extend the shelf life of food items, enabling vendors to sell during off-peak times (Melgar-Lalane et al., 2019).

Availability, culture, taste, knowledge of usefulness are among the factors that influence the use of insects as food and feed (Raheem et al., 2019). Our findings reported that socio demographic characteristics; age and educational have a negative influence on the consumption of insects. This finding is in contrast with the study carried out by Liu et al (2020) which was investigating factors that influence Chinese consumers to consume edible insects. They found out that age positively affects the consumption of edible insects. According to Megido et al (2016) age is related to awareness and experience about the benefits of entomophagy, all of which improve acceptance. Similarly, Education and the eating of edible insects have a negative correlation, according to Manditsera et al (2018). A probable explanation is that young and educated individuals are profoundly enticed by Western culture, as a result of which they adopt diets and avoid eating traditional foods such as edible insects.

The current study findings show that the utilization of insects is still practiced in Kenya. Despite being considered important, there is evidence of decline. The findings indicated that only 4.5% of the respondents consumed insects frequently and 23.7% of the respondents showed that they used insects as feed. Therefore, it is would be appropriate that youth are educated about the importance of entomophagy to improve the acceptance/usage. The study's findings revealed that respondents had a bit of knowledge on nutritional benefits, harvesting, availability and preparation but they were less likely to consume insects or use them as feed. Correspondingly, same results were reported by Sogari et al (2019) in a study to learn more about young Australian consumers' knowledge and attitudes. . Despite knowing about the uses and advantages of edible insects, it was found that the respondents had no intention of consuming them. On the contrary, Chia et al (2020) reported that awareness of the use of insects as feed positively influenced the use of insects. Moreover, Hlongwane et al. (2021) that found availability of insects is a primary factor that influences eating of edible insects. Insect usage is declining, and habitat degradation is the

cause. Due to the deterioration of the ecosystem brought on by the shifts in land use and urbanization, natural environment has been lost (Wagner et al, 2021). The other factor is climate change have increased temperatures and reduced precipitation. This has increased drought periods resulting in reduction of insect availability. Awobusuyi et al (2020) described that insects availability, preference as well as acceptance influence their use. In any event, the diversity of consumption is dependent on the knowledge and culture of the population. If the benefits of an edible species are unknown, even though it may be abundant there, locals may choose not to eat it.

Conclusion

Low income earners and rural poor people cannot purchase animal meat and products, which are great sources of protein, minerals, and vitamins. As a result, many people living in sub-Saharan African nations have been consuming edible insects, which are an affordable source of protein, to help with the issues of protein and micronutrient deficiencies. Entomophagy is still an integral part of Vihiga County. However, consumption of insects has significantly decreased, particularly among young people. This may be due to adoption of western culture, negative attitudes towards insects, lack of knowledge and availability of insects in local markets. It is noticeable that indigenous knowledge on entomophagy is slowly disappearing with the shift in eating habits and changes in the socio-economic environments. Therefore, it is important that a holistic approach is developed to incorporate the future generation in achieving the goal of promoting entomophagy to deal with issues of food and nutrition security.

Young people are considered to be early adopters of technology. In addition, their food culture is usually not as solid as it is with the older generation. Thus, it would be easy to change the perspective of youth than people who already have established their diet habits and norms. As such, it is imperative that indigenous knowledge is preserved and educational interventions are done to raise awareness on the benefits of entomophagy in order to improve the utilization of insects among the youth.

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Conflict of Interest

The authors declare no conflict of interest

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