Technical brief #1: Insects as food and feed in Kenya – past, current and future perspectives

Contact information:

Professor Monica Ayieko, Jaramogi Oginga Odinga University of Science and Technology (JOOUST), Bondo, Kenya. E-mail: monica_ayieko@yahoo.com

Dr. John Kinyuru, Jomo Kenyatta University of Agriculture & Technology (JKUAT), Nairobi, Kenya. E-mail: jkinyuru@agr.jkuat.ac.ke

Dr. Sunday Ekesi, International Centre for Insect Physiology and Ecology (Icipe), Nairobi, Kenya. E-mail: sekesi@icipe.org

Dr. Nanna Roos, University of Copenhagen, Denmark. E-mail: nro@nexs.ku.dk

#GREEiNSECT

Insects as food and feed in Kenya – past, current and future perspectives

Insects have a long history as a part the diets of several ethnic groups in Kenya. Traditionally, the consumption of insects has mainly taken place in the western provinces of the country and has included primarily grasshoppers, termites, lake flies and crickets.

While these species are harvested and prepared solely for human consumption, attention has shifted in the past years towards insects as animal feed or a supplement to conventional feed ingredients like fishmeal and soymeal. They have also been considered as a means of improving the nutritional composition of traditional feed sources.

The utilisation of insects as food is strongly influenced by the cultural perception of what is acceptable to be eaten in modern times. However, learning and understanding how a traditional practice can contribute to food security and sustainable development in Kenya is of equal importance.

This brief provides an overview of the current state of insects in Kenya. It sheds light on past traditions as well as highlighting their future potential for food and feed.

Traditional utilisation of insects in Kenya

In many parts of Africa, insects as human food are part of traditional diets (Kelemu et. al, 2015). The exact number of edible insect species on the African continent is unknown. An earlier assessment by van Huis et al. (2003) reported 246 species of edible insects from 27 countries. Later, Ramos-Elorduy (2005) found 524 species reported from 34 African countries. The tradition of eating insects is highly heterogeneous. In some countries, a single community has been reported to consume different kinds of insect species, while neighbouring communities refrain from consuming the very same species.

Locust

A recent survey conducted by icipe[1] identified approximately 470 species of edible insects in African communities (Figure 1). The highest diversity of edible insect species is as follows: Moths and flies (Lepidoptera), Grasshoppers (Orthoptera) and Beetles (Coleoptera). The Central African region alone was found to host about 256 edible species making it the most important biodiversity hotspot in Africa. A total of 100 species were found in Eastern Africa, while only 8 species were recorded from Northern Africa (Figure 1). The survey found that 17 main insect species are used for food and feed in Kenya (Table 1)

1 http://www.icipe.org/edibleinsectsurvey/

Common name	Scientific name	Local name (Kiswahili)	Local name (Kikuyu)	Local name (Luo)
Desert locust	*Schistocerca gregaria*	N/A	Gitono/ gitarariki	Bonyo
Longhorn grasshopper	*Ruspolia differens*	Senene	Ndahi	Senene
Grasshopper	*R. Nitidula*	Senene	Ndahi	Senene
Two-spotted cricket	*Gryllus bimaculatus*	Nyenje	Ngiria	Onjiri
House cricket	*Acheta domesticus*	Nyenje	Ngiria	Onjiri
Termite	*Macrotermes bellicosus*	Kumbi kumbi	Nguya	Ng'wen Agoro
Termite	*Macrotermes subhyalinus*	Kumbi kumbi	Nguya	Ng'wen Sisi
Honey bee	*Apis mellifera*	Nyuki	Njuki	Kich
Black ant	*Carebara vidua*	N/A	Thigiriri	Onyoso
Moth	*Bunea alcinoe*	Nondo	Kihuruta	N/A
Black soldier fly (only feed)	*Hermetia illucens*	N/A	Kigunyu/wakaguku	Luang'ni

Table 1. Common insect species consumed as food or used as animal feed in Kenya

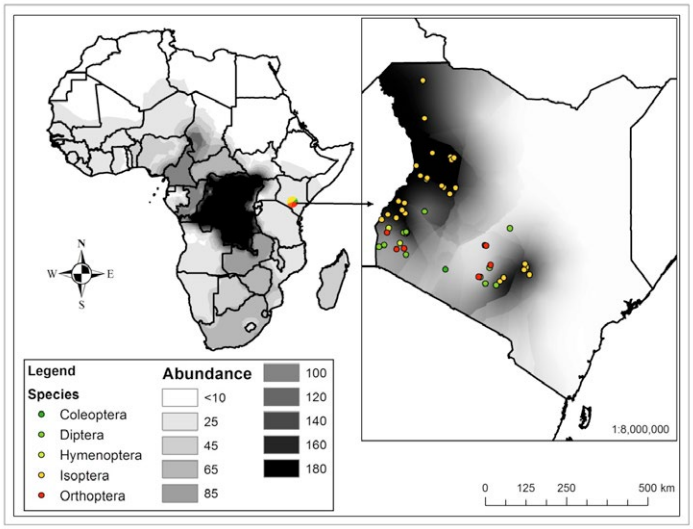


Figure 1. Diversity and abundance of main groups of edible insects in Kenya (Kelemu et al, 2015)

A further systematic inventory of the insects used as food and feed in Kenya and neighbouring countries is needed to define the hotspots of locations where they are consumed and how they have traditionally been utilised. A regional, and ultimately a continental, agenda for their sustainable use to improve food security and enhance livelihoods should be elaborated.

Nutritional contribution of insects

A diverse diet, with a balanced contribution from plant- and animal-source foods, is documented to be the best way of securing nutrient adequacy. In food insecure populations, diets often lack sufficient amounts of animal-source foods like meat, fish, milk and eggs to support good nutrition and health. Micronutrient deficiencies are widespread and create serious public health problems. Vitamin B12 is derived exclusively from animal-source or fermented foods, while critical micronutrients such as vitamin A, iron and zinc exist in more bioavailable forms in animal-source foods compared to plant foods. Animal-source foods also provide a higher proportion of essential amino acids as well as the essential n-3 fatty acids.

The nutritional contribution of the more than 2,000 recorded edible insect species is highly variable between species, and also between morphological stages, for example eggs, larvae, pupae or adults. The protein content varies from 10 to 70 % dry matter (DM). The fat content is equally variable in the edible parts of various insects. For example, palm weevil larvae (*Rhynchophorus phoenicis*) can contain up to 70% fat (DM). Different edible termites from Western Kenya were found to contain about 45% fat and 35% (DM) (Kinyuru et al. 2013), while house cricket contain around 65% protein and 20% fat. Amino acid and fatty acid composition, as well as the micronutrient composition, vary significantly. One assessment of protein quality which took into account amino acid composition and human digestibility found that eri silk larvae (*Samia ricinii*) had protein quality comparable to that of beef. In a dietary context, insects are recognized as valuable animal-source foods that can contribute nutrients scarce in a plant-based diet or nutritionally complement or replace meat.

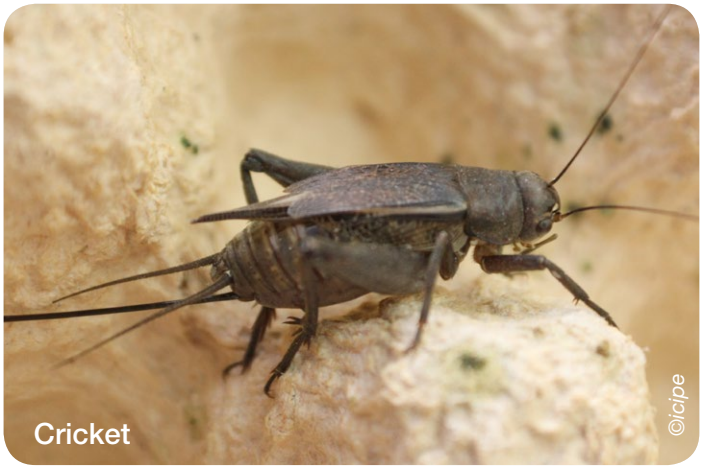
Insects are nutritionally a valuable animal-source food. To achieve the full nutritional benefit provided by insects, the nutritional value of the edible species must be documented in detail.

Food safety and processed foods

Research in Kenya has been undertaken to learn more about the insect species and food products preferred by current consumers. In 2015, Jaramogi Oginga Odinga University of Science and Technology (JOOUST) held a public exhibition that taught about foods made from common edible insects in the Kisumu area such as termites, lake flies and crickets. Visitors were offered biscuits and crackers made with crickets. The purpose was to educate visitors who were not familiar with eating insects and to enable them make informed choices about processed products. The insect products were very well received, whereas the whole roasted crickets were less popular. The event showed that among the population of Western Kenya there was high variation between those who were familiar eating insects and those experiencing them for the first time. In particular, children requested the biscuits even if their parents were not enthusiastic about the products.

In 2015, the cricket biscuit recipe was reformulated and used in a school feeding study as a part of the GREEiNSECT project. Fifty-four children at the Nyakasumbi School in Bondo between the ages of 5 and 10 years participated. The children's acceptance of the cricket biscuit was compared with a similar biscuit made with milk powder instead of cricket powder. Over a four week period, the children were served 100 g of biscuits every school day. The study showed that the cricket and milk biscuits were equally well liked, and that the children in both groups gained weight after the four week intervention (Homann, 2015).

Another GREEiNSECT study investigated Kenyan consumers' willingness to pay for termite-based food products and for breads baked with cricket powder for improved nutritional quality. The study showed that most consumers have positive preferences for such products



Cricket

across more or less all segments of the population, and there is potential for marketing processed foods containing crickets and termites in Kenya (Alemu et al., 2015).

While a previous history of insects in traditional diets exists in Kenya, many people are sceptical about eating whole insects. Consumers may be more willing to eat processed products containing edible insects, such as biscuits and bread.

Legislation and regulation producing, trading and marketing insects

One major barrier to the utilisation of insects as food and feed is the lack of precise and insect-inclusive legislation, standards, labelling and other regulatory instruments governing the production, use and trade of insects along food and feed value chains (Halloran et al, 2015). So far, there has been limited international dialogue regarding international standards like the Codex Alimentarius for the use of insects in food or animal feed. In most of the national standards, including those of the Kenya Bureau of Standards, insects are referred to as impurities that should be avoided in the production of food and feed products. The only attempt at developing international standards for the utilisation of insects as food was brought forth by the Lao People's Democratic Republic for the regional trade of house crickets. However, the proposal was not ratified because the current level of trade was not viewed as sufficient to warrant any action (FAO, 2013). Despite this, the Codex Alimentarius Commission (CAC) did note that developing and adopting a standard could help to increase the level of food safety of insect-based products.

In 2015, the European Food Safety Authority (EFSA) published a scientific opinion on insect production and consumption (EFSA, 2015; Finke et. al, 2015). The report concluded:

- The main risks are food substrates and the handling and storage of farmed insects rather than the insect species themselves.
- Mammalian prions cannot replicate in insects; therefore, insects are not considered to be possible biological vectors and amplifiers of prions unless ruminant or human substrates are used as feed.
- Using feed materials for insects which are currently allowed in the EU, it has been found that the possible occurrence of bacterial and viral hazards are equal or lower to other sources of protein of animal origin and should not pose any additional risk.
- Substrates such as post-consumer food waste and organic side stream manure must be specifically evaluated for safety.
- Chemical accumulation is the main unknown risk factor. Heavy metals have been shown to accumulate in some species of insects. However, little data has been published.

In Kenya, there are a number of agencies at the national level that regulate food safety issues and consumer protection. They operate under the Ministries of: 1) Trade, 2) Industrialisation, 3) Public Health and Sanitation, and 4) Livestock, Fisheries Development, and Agriculture. Nonetheless, a defined food safety policy is still lacking as a part of the wider National Food and Nutrition Policy.

Consultations with the Kenya Bureau of Standards (KEBS), as well as other relevant agencies, are currently underway in order to establish a technical committee to draft standards governing the application of insects as food and feed. In addition to the establishment of standards through KEBS, the Kenya Wildlife Services also requires permits for large-scale farming of insects such as crickets. These permits are required in order to conform to wildlife domestication regulation processes and match regulations on transporting livestock. This is required when moving animals from one zone to another and also includes an approved method of transportation.

The Kenya National Guidelines on Nutrition and HIV/AIDS also recognizes insects as a part of traditional food culture. The guidelines mention "edible insects such as termites" among other common sources of animal proteins in Kenya such as milk, meat and fish (Republic of Kenya 2006; p. 11). It recommends that food security in HIV-affected households could be addressed by promoting indigenous foods such as termites.

To establish a strong legislative and regulative framework for production and trade of insects for food and feed in Kenya and other African countries, all the stakeholders involved in the legislative process must continue to exchange and consolidate information.

Sources of insect for food and feed

Insects gathered from the wild

Most edible insects in Kenya are harvested directly from nature by traps or hand gathering. However, harvesting insects has the potential to become a threat to both the target species and to the environment. Given the diversity of insect species and the complexity of the environment in which they inhabit, many opportunities exist to improve sustainable harvesting through better understanding of their biology, ecology, and ecosystem functions.

Traditional harvesting of insects from the wild needs to be assessed species by species for sustainability and safety. Future legislation will be needed to regulate the harvest for sustainability and consumer safety. This would include: 1) regulates and permits sustainable harvesting, 2) stipulates flexible maximum quantities for each species, 3) specifies areas for harvesting including possible closed seasons for harvest depending on the ecology of the insect, and 4) regulates the amount sold and number of anticipated harvesters.

Insects produced in farming systems

In order to utilise insects on a grand-scale, production will depend on the ability to establish cost-effective rearing methods. Bees and silkworms have a long history of domestication and several species are reared for the purposes of biological control and the technology can be applicable for other species. Rearing of crickets for human consumption has developed over the past 15 years in Thailand where more than 20,000 farmers produce for domestic and regional markets. Cricket farming systems inspired by Thailand are currently being introduced in Kenya. For animal feed, industrial-scale enterprises are at various stages of development for rearing insects in large quantities, in particular black soldier flies and house flies.

Critical elements for successful large-scale rearing operations include stable rearing conditions and diet formulas for the farmed insect species. Feed and rearing conditions will influence growth, survival, fecundity, fertility and mating ability of the insects (Ekesi & Mohamed, 2011).

Preserving the genetic variability of the insect colony is important for long-term success. Insect farming is therefore a matter of careful rearing, diligent monitoring of quality control parameters and periodic strain restoration or replacement. Disease diagnosing and treatment guidelines in insect colonies need to be developed. Investment in research and development in all aspects of the domestication and mass-production of target insect species is needed.

Cost-efficient production systems for scaled-up insect farming are still under development. Best practice guides and clear standards are important in order to protect consumers and the environment.

Cultural barriers and challenges

Anecdote of the mole cricket in Luo culture – an edible insect feared by Luos but loved in the Coastal areas: (*By Prof. Monica Ayieko*)

The old adage 'one person's meat is another person's poison' is true in many ways. You may wonder why certain foods are consumed in one community yet regarded as inedible or even poisonous in another! When I was growing up, I was told that certain cricket species were not safe for human consumption. In fact, children were forbidden from collecting or playing with such insects. We were not allowed to eat the black field crickets (*Gryllus bimaculatus*) because they were said to be only eaten by witches. We were also instructed not to touch soldier crickets (*Jerusalem cricket*) because they were poisonous and could bite and even kill a human being. I never saw or even heard of anyone talking about eating such species of crickets. When my mother introduced us to crickets as food and she read from the bible which insects were condoned for human consumption, she did not observe that the scripture said "…crickets with all its kind…" and neither did we question her! Later on in life, I learned that black crickets are safe for human consumption. To my surprise, I also learned that the soldier crickets are a delicacy in the coastal region in Kenya because they are hard to find and collecting them from their hideouts is a challenge. They burrow in the ground and can move very fast. By the same token, the short tailed crickets (*Brachytrupes sp*), also called 'The god of crickets', are a delicacy amongst the Luo community in Kenya. Eating them is also believed to increase one's vocal capacity to sing!

Insects for animal feed

The increasing consumption of animal products demands enormous resources. Feed ingredients will become an even greater challenge due to a limited availability of natural resources, ongoing climatic changes and food-feed-fuel competition. The most widely used and protein-rich feed resources are soymeal and fishmeal which demand enormous resources in terms of land, energy and water, among others.

Insect meals, made from insect larvae or whole insects, are also rich in protein (42-63% on a dry matter basis). The essential amino acid composition of their proteins is good and protein digestibility is high (Makkar et al., 2014). Insect larvae grow and reproduce easily, and convert the substrates on which they are reared to insect mass with high efficiency because they are cold blooded. Insects can feed on waste biomass, for example vegetable and fruit wastes, and can transform this into high value protein, in turn potentially replacing soymeal or fishmeal in livestock and aquaculture feeds. Insect meals from black soldier fly, house fly, mealworms, locusts, grasshoppers, crickets and silkworm have been studied for their nutritional qualities and as a component in the diets of pigs, poultry (both broilers and laying hens), ruminants and fish.

Animal feeding studies across insect species and production animals have shown that palatability of insects is good and they can replace 25-100% of soymeal or fishmeal depending on the animal species. Insects can also be fractionated into protein concentrates and some insects can accumulate high levels of lipids (up to 36% oil depending on the substrate composition on which they are reared). The extracted oil can be used for various applications including biodiesel production (Makkar et al., 2014).

The international feed manufacturing industry has shown commercial interest in insect meals for use in animal feeds. The industry is of the opinion that insect meal of uniform quality with availability in sufficient quantity throughout the year can accelerate its use as a part of manufactured feed for various animal species.

For large-scale use of insect meals in animal feed, a number of technical and regulatory constrains need to be addressed. Some actions required to overcome these constraints are:

- Define the quality of substrates used for to feed the insects, including sanitation procedures for safe use of bio-wastes and managing diseases, heavy metals and pesticides;
- Optimize quality of insect-based feed products (processed insects or isolated insect proteins) for livestock and aquaculture;
- Monitor and evaluate safety from a human health point of view;
- Conduct life cycle assessments on the environmental impact of using insects as animal feed

This brief was issued by the GREEiNSECT project (www.greeinsect.ku.dk) supported by DANIDA, The Ministry of Foreign Affairs, Denmark. The brief was written by Christopher Münke-Svendsen (CMS Consulting, Copenhagen, Denmark), Sunday Ekesi (ICIPE, Kenya), Monica Ayieko (JOOUST, Kenya), John Kinyuru (JKUAT, Kenya), Afton Halloran, (UC, Copenhagen), Harinder Makkar (FAO, Rome), Nanna Roos (UC, Denmark). Design and layout by Brian Mwashi (ICIPE). Special thanks to comments from Mohammed Alemu and Anja Homann (UC, Denmark).

GREEiNSECT

UNIVERSITY OF COPENHAGEN

icipe
African Insect Science for Food and Health

FAO
FIAT PANIS

Jaramogi Oginga Odinga University of Science and Technology

JKUAT
Jomo Kenyatta University of Agriculture and Technology

DANIDA

Key References

Alemu, M.A., Olsen, S.B., Vedel, S.E., Pambo, K.O, Owino, V.O. (2015). Consumer acceptance and willingness to pay for edible insects as food in Kenya: The case of white winged termites. IFRO working paper 2015/10. University of Copenhagen, Denmark.

EFSA (2015). Risk profile related to production and consumption of insects as food and feed. EFSA Journal 2015;13(10):4257. http://www.efsa.europa.eu/en/efsajournal/pub/4257

Ekesi, S. and Mohamed, S.A. (2011). Mass Rearing and Quality Control Parameters for Tephritid Fruit Flies of Economic Importance in Africa, Wide Spectra of Quality Control, Dr. Isin Akyar (Ed.), ISBN: 978-953-307-683-6
FAO (2013) Edible insects. Future prospects for food and feed security. FAO Forestry Paper 171. FAO, Rome, Italy.

Finke M.D., Rojo,S. Roos, N., Huis, A.v., Yen, A.L. (2015). The European Food Safety Authority scientific opinion on a risk profile related to production and consumption of insects as food and feed. Journal of Insects as Food and Feed, 2015; 1(4): 245-247

Halloran, A., Vantomme, P., Hanboonsong, Y., Ekesi, S. (2015). Regulating edible insects: the challenge of addressing food security, nature conservation, and the erosion of traditional food culture. Food Security. 7 (3) , pp 739-746

Homann, A. M. (2015). Acceptability of cricket-based biscuits and assessment of gut microbiota composition in schoolchildren. A study in Bondo, Kenya MSc thesis in Human Nutrition, Univ Copenhagen, 2015

Kelemu, S., Niassy, B., Torto, B., Fiaboe, K., Affognon, H., Tonnang, H., Maniania, N.K., Ekesi, S. (2015). African edible insects for food and feed: inventory, diversity, commonalities and contribution to food security. Journal for Insects as Food and Feed 1(2), pp. 103-119.

Kinyuru, J.N., Konyole, S.O., Roos, N., Onyango, C.A., Owino, V.O., Owuor, B.O., Estambale, B.B., Friis, H., Aagaard-Hansen, J., Kenji, G.M., Glaston, M. (2013) Nutrient composition of four species of winged termites consumed in western Kenya. Journal of Food Composition and Analysis, 30(2): 120-124.

Makkar, H.P.S., Tran, G. Heuzé, V., Ankers, P. (2014). State-of-the-art on use of insects as animal feed. Animal Feed Science and Technology 197, 1–33.

Ramos-Elorduy, J. (2005). Insects: a hopeful food source. In M.G. Paoletti, ed. Ecological implications of minilivestock, pp. 263-291. Science Pub., Enfield NH, USA.

Republic of Kenya (2006). Kenyan national guidelines on Nutrition and HIV/AIDS. Republic of Kenya, Nairobi: Ministry of Health.

Van Huis, A. (2003). Insects as food in Sub-Saharan Africa. Insect Scientific. Application. Vol. 23, No. 3, pp. 163-185.

International Conference on Legislation and Policy on the Use of Insect as Food and Feed in East Africa

March 2 – 3, 2016
The Vic Hotel, Kisumu, Kenya

icipe
African Insect Science for Food and Health

NWO
Netherlands Organisation for Scientific Research

FAO
FIAT PANIS

IDRC
International Development Research Centre

CRDI
Centre de recherches pour le développement international

DANIDA

GREEN INSECT

giz

On behalf of
Federal Ministry for Economic Cooperation and Development

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Makerere University

JOMO KENYATTA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY
TECHNOLOGY FOR DEVELOPMENT

UNIVERSITY OF COPENHAGEN

Jaramogi Oginga Odinga University of Science and Technology

Australian Government
Australian Centre for International Agricultural Research