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Kenya, Malnutrition

## **How Entomophagy Can Mitigate Micronutrient Deficiencies in Kenya**

Most Americans take for granted the ability to take a short car ride to the store without thinking about how the groceries actually got to the store. While most of the produce in supermarkets is not considered local, because it can be grown on farms thousands of miles away, most of our food is grown domestically in the United States. According to the United States Department of Agriculture (USDA) in 2016, 82.6% of the average American consumer's food spending is for domestically produced products. Why is a country that imports about 75% percent of total petroleum (US Energy Information Administration) and is the highest importer of pharmaceuticals in the world at \$145 billion dollars (Observatory of Economic Complexity), growing our food domestically? The United States is heavily dedicated to the agricultural industry. The USDA says that 52% of the land base is used for agricultural production. How do countries that don't have the economic capabilities to spend billions of dollars on imports, but also don't have billions of acres of usable farmland generate enough food to feed its people?

According to the Global Hunger Index (GHI), Kenya is ranked 86 out of 117 countries in food security with, "serious levels of hunger". Kenya is located on the Eastern coast of Africa, with 536 kilometers of coastline touching the Indian Ocean. Kenya has a largely varying topography with features ranging from vast savannahs to lake lands to mountain highlands to the dramatic Great Rift Valley. According to CountryReports.org only 20% of Kenya's drastically changing land is suitable for cultivation even though agriculture is the most important economic activity. USAID.org reports that 33% of Kenya's GDP comes from their agricultural sector. While Kenya does spend a lot of money on imports, the Observatory of Economic Complexity's (OEC) data also shows that less than 7% of the 23 billion dollars annually spent on imports are on consumable needs. The statistical data strongly aligns from the first-person experiences and observations of Bryan Kiptoo. Kiptoo, a testing manager at Testlio, a software testing company based out of Estonia, lives just outside of Eldoret, Kenya, a town whose main economic value centers around agriculture. Kiptoo says that around him are major plots of land ranging from hundreds to tens of thousands of acres big solely dedicated to agriculture.

In speaking to Kiptoo, I learned how the average person in Kenya gets their food. He says that, not too dissimilar to in America, produce from farms all throughout Kenya get shipped to a centralized market in the capital city. From there, produce gets redistributed to smaller, more local markets, so it is more easily accessible to the people. He said that almost all of their diets are determined by the season due to high market volatility. Kiptoo specifically mentioned mangos. Kiptoo stated that mangos are usually only in season for a short month, and that because of the large influx in mangos, prices in stores drop heavily. When crops are out of

season they become too expensive for most people to buy for day to day use. Kiptoo says the main crop production and consumption comes from wheat and maize, while most of their animal products come from cattle, sheep, goat, chicken, and camel. Kiptoo said there just isn't enough land to support mass farming like there is in America and there isn't opportunity because of the financial situation for those looking for work to start a farm. He said that many farms were passed down family businesses. Kiptoo also shared with me an interesting detail that could influence the dietary habits of different people in Kenya. He said there are 42 different active tribes that are largely influenced by the places they live and the terrain around them. He said many of the tribes living in the desert parts of the North use instead of cattle or goats for dairy products, because of the topography.

Kenya's poor financial, spatial, and resource availability are the main reasons for their food insecurity. Lack of production and the government's ability to support importing food supplies, leads to food insecurity in Kenya, but how does food insecurity directly relate to Kenya's health. The lack of production takes a toll on the health of Kenyan people, mainly in children. According to researchers of the Department of Human Nutrition Sciences at Jomo Kenyatta University of Agriculture and Technology, more than 50% of mortality rates in children in Kenya come from micronutrient deficiencies. The insufficient amounts of vitamins and minerals are a result of improper diets of people in Kenya. Kiptoo immediately pointed out the poor nutrition of children in Kenya, stating that many children were missing out on proper food and that the government had started supplying schools with food dense in the nutrients they were missing out on such as milk. In the same study they outlined six major deficiencies in micronutrients, those being: vitamin A, iodine, zinc, iron, B12, and folate. These deficits are because of the lack of meat intake in Kenya. Kiptoo, who is of higher socioeconomic status than the average person in Kenya says he only consumes animal meat every 10-15 meals. While having a form of animal meat or high protein substitute in every meal is common in America, it is just not possible for those with less livestock production. The study also outlined how it wasn't just the micronutrient deficiencies, but the lack of knowledge around them. Kiptoo, while being able to point out there was a deficiency in the diets of children in Kenya, was not aware of why or what specifically was insufficient in their diets.

How can we solve this? Getting more micronutrients to the people in Kenya has to come from a change in their diets. While outside aid has been given to Kenya, financially this only patches the issue for a short period of time. My solution aims to restructure the agricultural industry in Kenya which could come with some collateral benefits outside of food security. Entomophagy. Entomophagy is the human consumption of insects. Not only are insects easy to keep, produce, and are high in micronutrients, but the farming of insects can open new jobs to people in Kenya. The farming of insects, while present, is very small scale. Kiptoo, who likes to travel, has seen most of Kenya, while knowing about insect farms has never seen one himself or seen them sold at markets. Crickets, more specifically *A. domesticus*, comprise most if not all of entomophagy in Kenya.

Nutritionally, crickets are very high in the micronutrients that were found insufficiently supplied in the diets of children in the aforementioned study. A study done on the benefits of orthoptera (genus of edible insects), by thirteen researchers across the world, found the nutritional value

on eight different insects of the orthoptera class and compared it to more traditional livestock nutritional values. *A. domesticus* has a significantly higher zinc value at 22 mg of zinc per 100 g (.28% and .78% of recommended daily value for adults and children respectively per mg) of cricket meat while values for beef chicken and pork range from 0.7-6.9 mg per 100 g. They are also higher in iron than chicken, beef, and most species of pork at 8.75 mg per 100 g (.075% and .032% of daily values per mg). *A. domesticus* also has significantly high values of vitamins. The crickets can have up to 67 mg per 100 g of vitamin A (.44% and 1.2% per mg) and around .01 mg per g (.41% and .25% per mg) of vitamin B12. If you're thinking that the percentages for daily intake are low, those values are per 100 mg only. An average 8 oz steak has over 200,000 mg of weight in it, which is significantly more than the daily intake in all of these micronutrient categories. The real question of nutrition falls less in what the product contains nutrient wise, but more of its bioavailability, or how much of the nutrients can be used by the body. Unfortunately, there isn't a plethora of research on the bioavailability of crickets *in vivo*, but there is a small amount *in vitro*. Crickets have comparable bioavailability in all categories to that of beef and other insects but were slightly lower when synthesized in Caco-2 cells than that of beef sirloin (European research study).

Economically and environmentally crickets are a much more efficient source of food than that of any other livestock now being used in Kenya. The main issue with livestock farming is resource availability to small farmers. It takes 444 square meters of land and 22,000 liters of water to produce 1 kg of cow meat, while crickets require only 33.33 square meters of land and a mere 1 liter of water for the same amount of meat. Furthermore 80% of a cricket is digestible while only 40% of a cow is digestible for humans. (ASAP Science) It is significantly easier, less laboring, and cheaper to farm crickets than any other form of livestock. The farming of insects could also lead to more economic opportunities for those in Kenya. When asked, Kiptoo said that he has seen a significant amount of people in Kenya, who want to become farmers or have their own farm, but it is too expensive to start on their own. A cheaper and easier alternative to livestock such as crickets, opens those who couldn't afford it an opportunity to have their own sustainable income. Not only could those who farm crickets in Kenya become partially self-sufficient, making food for themselves, but they could also sell surpluses to provide for the rest of their needs.

Socially, there might be some friction getting general communities to accept entomophagy as normal, but it is not uncommon in a lot of places around the world. Kiptoo, after being presented with my solution, wasn't completely sound with the idea of consuming insects, but he was open to the idea because of the benefits. He had consumed roasted crickets before and he said "no, they're nothing to be afraid of". The consumption of different insects is seen as a regular practice in many countries around the world from Brazil to Zambia to Japan. Entomophagy is historically a staple practice in communities especially in Africa. Chinua Achebe, in the historical fiction work, *Things Fall Apart*, uses an extended metaphor connecting a swarm of locusts to the colonization of the white man in Umuofia (a fictional city in Nigeria). Locusts are known to swarm once every 13-17 years depending on the species. In the book they are revered by the village of Umuofia, the book says, "Everyone was now about, talking excitedly and praying that the locusts should camp in Umuofia for the night. For although locusts had not visited Umuofia for many years, everybody knew by instinct that they were very good to eat". In the book they

were prepared by simply roasting them with seasonings. Even hundreds of years ago, before the science of nutrition, the people of Nigeria knew that insects were good to eat because of their abundance and nutritional value.

We can also help increase food security in Kenya through the education of the people and food researchers who work there. If many of the Kenyan population aren't aware of what they are missing in their diets then how are they supposed to fix it, even with plenty of resources available. High level organizations that have the resources to educate people should be there helping their food security crises. Entomophagy and education can greatly improve the food security in countries such as Kenya by providing a source of micronutrients that are normally deficient at a much cheaper financial and environmental cost.

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