Combating Kwashiorkor: Replenishing Tryptophan in Sanambele

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About the Author:

A senior in Montana State Universities Plant Sciences and Plant Pathology Department, Kathryn Gause has been studying horticulture in hopes of one day owning and operating her own vineyard. Born and raised in eastern Maine, Kathryn spent a lot of her young life traveling the world with her parents, to Portugal, Austria, Panama, and England, Kathryn has for a long time known she wants to work with the world to make it a better place for all inhabitants. Kathryn currently works in a plant biotechnology lab creating healthier pasta that resists overcooking. She lives with her 2 dogs, Emma and Jack, and her cat, Piggy.

Abstract:

This paper discusses the seriousness of kwashiorkor, and offers a suggestion to the village of Sanambele, Mali, where a lack of tryptophan is putting the young citizens at risk. It will discuss the factors and thoughts that impact introductions of new crops to a society, referring strictly to Sanambele and why my decision for the introduction of date, sesame or chick peas to the farmers. The accounts considered are local climate and topography, adaptively and growth habit of the crop and differences in cultural practices from the norm in the village.

Introduction:

The United Nations Children's Fund estimates that almost half of the world's child population lives in hunger. No child is safe from hunger, on every continent, in every country and every city. This threat of hunger is much more prevalent in Africa, where years of political unrest, famine and religious prosecution has caused millions of deaths. The World Food Program estimates that 10.9 million children under the age of 5 have died due to hunger or malnutrition. One problem that results from malnutrition is kwashiorkor, a protein deficiency. Kwashiorkor is

a becoming a problem for the children of our sister village, Sanambele in Mali. In this village they children are deficient in tryptophan, an essential amino acid. The purpose of this research is to find an acceptable crop for the farmers of Sanambele to cultivate to help alleviate the problem of kwashiorkor and help reduce the world's child mortality.

Kwashiorkor is a form of malnutrition classified by insufficient protein consumption while the body still receives enough caloric content. Usually the person is consuming too much starch. It has been found that the causes of kwashiorkor are antioxidant and micronutrient deficiencies. Symptoms include edema, irritability, anorexia, ulcerating dermatoses, pedal swelling, thinning hair, loss of teeth, skin depigmentation and an enlarged liver creating the appearance of a pot belly. Kwashiorkor only affects children as they are weaned off their mothers breast milk, which is sufficient is the protein and amino acids. This disorder is also rarely found in the developed countries where families are more able to provide the needed protein to young children. In these developing countries where there is increased aid for citizens like organizations giving out vaccines, the children's bodies fail to produce the antibodies need to resist the disease and will often fall victim to them, like diphtheria and typhoid. Another threat from kwashiorkor is aflotoxin poisoning from eating moldy grains. (Ciliberto 2005 &Williams 1925)

Fig 1. A child suffering from kwashiorkor

The Sanambele village has not always had a problem with protein deficiency. There are 13 amino acids, 9 of which are essential to human life. The amino acids can be thought of as building block in a wall; if just one is missing the wall could fall. This is the current problem in the Sanambele, and many other countries and villages on the continent. In the Sanambele there is a loss of tryptophan building block. In the body it aids in the production of serotonin, auxin and niacin. The people of Sanambele had, in the past, maintained ample tryptophan from eating grasshoppers found in their fields. However in the past decades there has been an increase of insecticide use on the crops around the area to decrease crop loss due to insects. These damaging chemicals have entered the water ways where the grasshoppers lay eggs, and killed off a large number of their population. With no grasshoppers to eat, and no plant forms of the protein, there have been serious deficiencies in the village. As of 2008, 32% of the village's children were at risk of kwashiorkor. There is a way to alleviate this threat on the village by introducing a new crop that is a natural source of the amino acid that they are currently not receiving in their diets.

If they are able to farm a new crop on their land that can provide tryptophan that they are missing, there will be far fewer cases of kwashiorkor in Sanambele (Scott 2008).

Today in the village the farmers harvest miller, sorghum, dry upland rice, cow peas, peanuts, some garden vegetables, shae nuts for shae butter, cashews and limes. The village of Sanambele, like most of Mali, suffers from recurrent droughts, so a crop tolerance is a must. There are 3 to 4 months from June to September that receive about 45 inches of rainfall yearly. May is typically the driest month. Temperatures range from 60°F to 102°F (16°C to 39°C). The soil of Mali is mostly rich clay deposits that the farmers utilize to make pots and urns, it is labeled as moderately productive by the British Commonwealth Agency. At the present time the farmers of Sanambele grow rice, cow peas, and millet, peanuts, some garden vegetables, shea nuts that are harvested to make shea butter, cashews and limes. All crops are sown, cultivated and harvested by hand. This means that there cannot be and crops that need specialized tools or devices to harvesting. Another concept to consider is the space available to farmers. They currently utilize all possible space even growing in the area that the river floods for part of the year and is dry the other part. Since the village is vegetarian, they cannot rely on meat for tryptophan like we do. (Library of Congress 20050

Hypothesis: There are many crops that the Sanambele farmers could cultivate for the village children to help fight the onset of kwashiorkor by replenishing the missing amino acid tryptophan, including dates, sesame and chickpeas.

Materials and Methods

To complete this research I have looked at literature from countries very similar to Mali where crops were introduced to alleviate a problem similar to kwashiorkor. There was a lot of literature about the suggested crops from the USDA website and country profiles of the Malian soil and landscape. In depth interviews with Kariba and Florence about the site were used to get an idea of the village layout, farmers and citizens. Kariba helped me understand the agriculture sector of northern Africa, the types of crops he works with and how to introduce a new crop to a village.

Index or Data Base	Key Words or Phrase	Results
Google Scholar	Kwashiorkor	22,500
Google Scholar	Kwashiorkor + Tryptophan	1,560
Google Scholar	Tryptophan	745,000
CAB Direct	Tryptophan + Plant	85,200
CAB Direct	Tryptophan + Farming	13,500
CAB Direct	Kwashiorkor + Farming	2,430
CAB Direct	Tryptophan + Dates	7,850
CAB Direct	Dates + Mali	34,700 *wrong kind of date
CAB Direct	Dates + Mali + Tryptophan	396
CAB Direct	Tryptophan + Sesame	2,620
CAB Direct	Sesame + Mali	2,190

CAB Direct	Sesame + Mali+ Tryptophan	47
CAB Direct	Tryptophan + Chick Peas	2,210
CAB Direct	Chick Peas + Mali	908
CAB Direct	Chick Peas + Mali + Tryptophan	38

Table 1. Recourses found on the internet

Results

Now we must investigate the growing habits of each crop to see if they meet the needs of the village without disrupting daily activity. Dates, *Phoenix dactylifera* are one of the oldest cultivated fruits, native to Egypt, but so much variation exists that this is not known for sure. The palms can grow in the hot arid climates and, being a palm, are used to rainy seasons and dry seasons, with the rainy seasons consisting on torrential downpours for days and dry seasons that lasts months without a drop of moisture. The fruit must be dried to provide sufficient levels of tryptophan, which is a commonly used practice in Mali, very similar to processes of tomatoes. The fruit can be given to children as a snack, as it is soft and fleshy young teeth will be able to chew it. The problem with the cultivation of dates in the area is, since it is a tree, the soil may not be able to support the plant. In the area there are small brush trees but nothing of substantial height, suggesting that the soil is not strong enough to support the large tap root of a tree. If that were the case the tree may not grow enough to produce fruit making the efforts wasted. It has already been found that peanuts can grow in the village and the farmers do harvest them but there are storage problems and the peanuts produce harmful aflotoxins that worsen the advances of kwashiorkor. This topic is tackled in another student's paper. (Scott 2006)

Fig 2. A dried date

Date trees can take up to 10 years to fully develop to produce fruit, though the average it 5 years. At full maturity a 20 ft palm can provide up to 100lbs of fruits. Vegetative cuttings will fruit 2 to 4 years earlier that seed plants however most countries have very strict quarantine laws on green tissue to eliminate the spread of preventable disease. The pollen of the palm is wind dispersed, so there will be no need for animals or insects with specialized structures however, the palms are dioecious, so there must be a male and female tree. In this situation only 1 male is needed to pollenate the fruiting females and seedlings can be oriented in a center position for maximum pollination. Once a tree reaches reproductive stages the fruits that are 3 to 7 cm long, roughly the size of a small child's hand, are packed with energy, protein and flavor. For every 100g of fruit there are 33g of protein, of which 0.57g are tryptophan. Harvest is done by hand, but as the tree grows a ladder may be used to reach all fruits, unless a child keens on the idea of climbing the rough flakey bark. This is also a sustainable option because the seeds, once extracted from the fruit can be used to plant a new crop round. . (Walid 2003, Morton 1987 & Beentje 2006)

Sesame, *Sesamum indicum,* is native to Sub Saharan Africa, where is has adapted to many climates and from where the seeds have migrated and can be cultivated in the Middle East and Asia. The annual shows small yellow, white or purple flowers, and grows to about 2.5 ft tall. Primarily grown for their oil rich seeds, the flowers are pretty but not ornamental. Like the

flowers the seeds come in differing colors from pale yellow to black, each of which is praised in different regions. The seeds themselves are formed in pods, containing over 100 seeds each. The seeds are rich in elemental nutrients as well as vitamins, so while they are healthy in moderation there is also the threat of allergies. It have been found that these nutrients are better absorbed in the body is ground into a paste or powder. For every 100g or sesame there are 17g of protein and o.37g of tryptophan. There are many ancient stories that involve consuming sesame seeds or paste to preserve beauty or for strength, this is probably due to their high levels of antioxidants. The bush that only grows to a maximum of 3 feet and about 1 circular foot round is very resistant to disease and pathogen but is however susceptible to the larvae of the turnip moth, that will eat the seeds within the pod. The flowers are perfect and can self-pollenate but they are an annual crop, so a small portion of the crop must be saved to plant the next year's batch. (Bedigian 2000, Bedigian 2003& Bedigian 2006)

Fig 3. The flower and leaves of a sesame plant

The final crop option for the farmers in chickpeas, *Cicer arietinum,* is in the legume family. This is a desirable crop because not only is it high in protein but all civilizations need some sort of legume to provide protein and other nutrients that starches and sugars cannot supply, and legumes have

the unique property of being able to fix nitrogen in the soil and make it available to other plants, this is so important to cropping systems in countries where fertilizers are impractical. Currently in Sanambele they farm cowpeas, another legume grown in most arid regions because of its durability, however, even though it is nutritious it is lacking in some of the vital proteins needed for development in villages Sanambele. Cowpeas are also a simple cropping system, there is no need for selection of seeds or breeding since they are such an old crop, they are fairly genetically uniform. (Singh 2003)

Fig 4. Cowpeas, the current staple in Sanambele

The benefits of switching, at least partially, to chickpeas, which are very high in proteins, are great. Another one of the earliest domesticated crops, chickpeas are native to Turkey but in the thousands of years since domestication they have been moved and cultivated all over the world, including Greece, France, and Morocco. The plant grows about 3 ft tall and produces a type of pulse, a pod with 2 or 3 peas incased in it. One of the many beneficial things about the chickpeas in their versatility, they can be eaten cooked or raw, can be ground into a flour or paste, soaked and dried, and can even be fermented into an alcoholic drink. Many vegetarian cultures consume chickpeas as a protein source. There are 23g of protein and 0.3g of tryptophan per 100g of material. The peas are also very high in fiber and are a healthy source of carbohydrates. (Mansfeld & Zohary et al 2000)

Fig 5. A bowl of freshly harvested chickpeas

Conclusion:

In conclusion, these are the best options of crops to replace the lost tryptophan. Now they must be presented to the Elders of the village of Sanambele so they can make a decision on which best suits the needs and wants of the village. They are all adapted to the hot dry months, or the wet conditions. I have suggested growing strategies that will fit the villages' current practices and not required them to change their tried and true methods. This way as students at MSU we are fulfilling our promise to adhere to the holistic process and methods. When presenting to the village we have to conceptually show them what we have been researching and learning. It would be best if we were able to bring a sample of each crop and produce, however some quarantine laws may not permit this, so pictures are an easy, and space effective way to show the Elders. We can show them each crop, how its farmed, ways in which they differ and are similar to the current crops, and maybe in some of their travels they have seen, tried or heard stories about some of these crops. When and if the Elders make their selection it is then our turn to come through with our promise to help. We can provide seeds or cuttings and teach them or have an

extension officer in the area, or expert show the farmers have to sow, cultivate, harvest and prepare the crop. Then it is all theirs to manipulate or change how they wish.

Fig 7. The happy farmers of Sanambele

Recommendations

- Keep the holistic process in mind when helping the village
- In the meeting with the Elders be respectful and observe cultural practices
- Show each crop, product, and process to the end goal
- Give realistic timelines to the completion of the project: dates will take longer than sesame
- Recommend options of pest control
- Keep in mind cultural practices when integrating cropping systems
- Make sure the new crop is truly the best option for the village
- As there are many other students in the class working on projects focused on other issues in the village, take into consideration there work because many of them tie together.
- Offer future support if something should come up with the crop

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