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The Power of Protein

Figure 1. Cattle in Sanambele (Dunkel, 2009)

How incorporating animal proteins, specifically beef, into the diets of the Sanambele people may answer the kwashiorkor issue and other nutrition-based deficiencies using some traditional ways of the Northern Cheyenne people.

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About the Author

Kelsi Gambill is from Forsyth, Montana. A senior at Montana State University-Bozeman, Kelsi will graduate with a Bachelor's Degree in Agriculture Education-Relations option in May of 2011. Kelsi received an Associate of Science degree in Agriculture Communications in 2009 from Northwest College in Powell, Wyoming. Kelsi's aspirations are to become a national agriculture advocate for the agriculture industry; sharing the story of farmers and ranchers, educating consumers and interacting with producers as an industry spokesperson. This research and the experiences from the Health, Agriculture, and Poverty class will be beneficial to Kelsi's career in connecting with people from other cultures that have various backgrounds more easily.

As a Montana native, Kelsi's varied experiences have shaped her passion for agriculture, especially the livestock industry. Some of these experiences include being active in many agriculture-based organizations which began in childhood and have continued through today; raising livestock through 4-H, and being involved in her parents' meat processing business, C& K Meats. From the age of nine, Kelsi has raised livestock in 4-H. She always knew that the market lambs, pigs, and steers she was raising and showing would be consumed by someone after the county fair. Her interest in nutrition, protein, and livestock comes from these experiences and has shaped her vast knowledge of animal-based food production from gate to plate.

Abstract

Kwashiorkor is a form of malnutrition affecting the children of Sanambele, Mali. It is a result of deficient amounts of essential amino acids. The role of amino acids and their function can be explained using the rain barrel concept and relating it to a gigine; grain storage facility in Sanambele.

Livestock are prized possessions and cattle are a source of financial wealth and social status. Cattle are only consumed at times of celebration in the village. Obtaining the essential amino acids can occur through increasing the amounts of meat consumed on a regular basis. Forming a cattle herd that belongs to the children will bridge the gap between beef consumption and cattle as a currency. This will help people to view beef consumption as a way to become healthy.

Borrowing traditions of the Northern Cheyenne to make a dried beef product will improve the amino acid profile of the diet being consumed by children and adults in Sanambele. The climate of Sanambele is very conducive to creating a dried beef product, with hurdle technology creating a safe, shelf-stable food. Dried beef will be treated like grain and pounded into small pieces before adding to the sauces for human consumption.

Introduction

Demographics and Environment

Sanambele is a village in Mali, Africa. It is believed that the village is growing as there are approximately 1,200 people in the village as of 2009. Eleven years ago, around 700 people lived in the village (Dunkel, 2011). The village is built in a circular fashion and fields where the crops are grown are a perimeter around the outside (See figure 2 map of Sanambele).

The Sanambele people are Muslim which has been superimposed on animism, the attribution of spirits to non-human things. More than 80 percent of the Sanambele people have Muslim beliefs. They have a rich oral culture as wisdom and information is passed from generation to generation through stories and conversing with each other.

Each person in the village has their own tasks and responsibilities that they are born into, as in a caste system. Women are specialized in cooking, taking care of the children, and other tasks of the home while men are the caretakers of the crops, gardens, and livestock animals. Children of Sanambele attend school but many do not go on to higher education.

The Sanambelean people live in brick huts made of clay bricks that have either metal or thatched roofs. The soil in Sanambele is very clayey and red in color. It is the only available building material and the wet clay is gathered from the riverbed to make bricks. Some of the grasses that grow in Sanambele are used for weaving.

The rainy season begins in late June and ends in September. There is no rainfall from October through May. The coolest time of the year is January while the hottest is May. At night the lowest temperature is 80 degrees Fahrenheit. During the heat of the day, temperatures of 120 degrees are common. In March, there is four hours of 120 degree heat and it increases to five hours in May. Sun-up and sun-down occurs consistently at 6 a.m. and 6 p.m.

By March, the river may be muddy or a small patch of gray water. Large amounts of clay are suspended in the water. Cattle and other livestock have free access the river. When the river becomes dry or unsuitable to drink, water is drawn by hand and poured into large clay troughs for the cattle and other livestock. The wells have water year-round, although occasionally a well is contaminated due to animal's falling into it.

Current diet

Grain crops of sorghum, cowpeas, millet, and maize are widely grown in Sanambele. Ngomi and noni are fermented grains served at breakfast. Due to the extreme heat of Sanambele's environment and simple living conditions, the only form of food preservation is drying. There is no refrigeration in Sanambele. Stalks of these grains used to be used for roofing material but now can be consumed by livestock because most roofs are now metal. Commonly used seasonings include cumin and cayenne, which attribute to the sauces being very spicy. Other foods used for flavor include onion, shallot, salt, bouillon, sumbala (which comes from the narray tree), and hibiscus. Leaves of peanut, cowpea, hibiscus, amarantis, and datu (which comes from hibiscus) are commonly used and consumed as they are a good source of fiber and aid in digestion.

Kwashiorkor is a protein deficiency which has many symptoms and signs which include: a distended belly, edema, irritability, hair loss, ulcerating dermatitis, pedal swelling, and tooth loss. Additionally, brain development is affected as well as skin becoming discolored and liver enlargement (PSPP 465 discussion, 2011). As of 2008, approximately 23 percent of the population of Sanambele was affected by kwashiorkor. The average number of people affected by kwashiorkor is 34 percent nationwide in Mali (O'Brien, 2009). This protein deficiency is not due to a lack of food. Rather, it is due to a deficiency in the quality of food. It has been

determined that tryptophan, an essential amino acid, is missing from the diet of the Sanambele people. Trace minerals in the soil are important as some trace minerals are necessary for amino acid production. Minerals are the co-factors for proteins and are needed for enzyme reactions in the human body. The grains consumed by the Sanambele people have proteins and amino acids; however they are not a complete source of all eight essential amino acids.

Kwashiorkor most commonly affects children at two to three years old as this is the age when they are weaned off of breast milk. Breast milk is very important because it is a nutritionally complete food source and also provides the antibodies which help the immune system to develop. Milk from animals becomes important after weaning and goat's milk is the best form of animal milk because it is closest to breast milk. Goat milk has high levels of tryptophan but it is not recommended as a way to solve kwashiorkor due to the changes needed to improve milking. Some of the necessary changes include genetic improvement to incorporate better milking characteristics into the female goats, such as larger teat size and increased milk production.

Livestock & Agriculture

The livestock in Sanambele include chickens, sheep, goats, cattle, donkeys and oxen. These animals consume forage, primarily grasses. They drink water from the river during the rainy season. When the river and other natural water sources dry up, the livestock animals are given water in clay troughs that has been drawn from wells. The chickens live freely in the village. The sheep are goat-like and hardy, being primarily of the Sahel breed with some similarities to Nubian goats. Goats are crossbred, a mixture of Nubian, Togenburks, and Sahel. The cattle in Sanambele are of Brahman descent and weigh around 600 pounds. Donkeys and

oxen are used for labor with the donkeys being used to carry heavy loads and the oxen being used to plow the fields and other heavy work.

Hypothesis

Kwashiorkor and other nutrient deficiencies related to protein can be eliminated or greatly diminished through consumption of animal proteins, specifically beef. Protein advancement in the diets of the Sanambele people can occur through increasing amounts of meat and eating meat regularly which can be done by preserving meat for consumption.

Materials and Methods

Information for this research paper was gathered from many sources including visits, personal interviews, video conferencing, student research papers, peer-reviewed journal articles, and class discussions.

During our class visit to the Northern Cheyenne Reservation, we were able to gain first-hand knowledge about current issues and conditions on the reservation from people who live there. They included students at Chief Dull Knife College, elders of the Northern Cheyenne Tribe, and influential ladies who had traveled to Sanambele. It was during this discussion that I learned about the traditional Northern Cheyenne way of drying meat, mostly game animals. This information came mostly from Wade Longie, his aunt, and Fred Blackwolf Junior.

Dr. Florence Dunkel was an important source of information, knowledge and wisdom, providing not only information but direction and guidance. Researchers and professors at Montana State University that were interviewed, provided information and direction include Dr. Jane Ann Boles, Marty Frick, and Mary (Mo) Harbac. Interviews and time spent with Keriba Coulibaly provided first hand information about Sanambele and Mali. A majority of the information used for this research paper came from the knowledge of the before-mentioned people, as their knowledge and expertise provided more than a baseline of information.

Index	**Keyword**	**Results**
EBSCOhost	Cattle+ Mali	37
Agricola	Beef+health benefits	31
Agricola	Beef+Mali	1
Agricola	Meat preservation	286
Agricola	Agriculture+Mali	120

Table 1 Search Terms and Results

Results

Livestock and Livestock Management

Management practices for cattle include calving and branding as most calves are born between June and November to December. In Mali, there are people who are big farmers but not skilled in animal husbandry. One ethnic group, the Sidi-Ba, is specialized in animal care and husbandry. In Bambara, the livestock animals are cared for by a specialized keeper who takes them to feed and water (Coulibaly, 2011). This is a shared job and currently, a cow keeper will manage the cows and cattle. Flies are a nuisance to humans and livestock in Sanambele. The muscoid fly is the common fly that is troublesome.

Water is abundant in the rainy season and it fills all of the small rivers in and around Sanambele. The months of March, April, and May are the difficult months to feed livestock animals as it is a dry period in Sanambele and the vegetation becomes scarce. In June, the rains start and grasses grow again. The grasses and forages are managed to keep some aside for livestock consumption during the dry period. This is to ensure milk production and maintenance of the livestock animals. Some villagers send their cattle to Seacastle for the dry months. There is competition for feed.

Cattle forage on the fallow of crops during the daytime. They also consume native forage such as grasses. There are many types of grasses that grow and are consumed by the cattle. They do avoid certain types of grass before harvest and also avoid tree leaves. The native cattle avoid the poisonous trees but the cattle that are imported from northern Mali do not know the difference between the poisonous trees and non-poisonous ones. Therefore, the imported cattle can become sick or die from consumption of the poisonous trees.

They are gathered and brought into the village at night where they stay in pens. The cattle are protected by guard dogs. Many people in the village keep their cows together and a cow keeper or group of young boys tends the herd. The Brahman cattle in Sanambele produce at most 15 liters of milk daily if they are well fed.

Cattle are viewed as a financial investment and source of social status. If a villager wants to raise livestock, he must start by raising chickens. After successfully raising chickens, he can use a number of them to buy goats. A similar progression occurs from goats to cattle. Ownership of cattle is much esteemed and shows great financial stability. The cattle and other livestock animals are seen as a person's income and may be sold if a person falls on economic troubles.

Traditionally, the cattle are only consumed in times of celebration or mourning. A couple head of cattle will be harvested when a wedding occurs so that there will be enough meat for all of the guests because lots of people attend the wedding. Beef is also consumed at a funeral. A sacrifice of a cow is offered at the beginning of the rainy season.

Typical activities around a wedding are harvesting a beef on the first day that all of the guests arrive. On this day, everyone eats a large amount of meat. Over the next three days, the guests stay and continue to consume the beef. Sometimes, another beef animal is harvested and consumed. During these three days, the people dance and celebrate.

The goats in Sanambele are smaller in stature than goats in the United States. They have small udders and very small teats which make them less desirable for obtaining milk for human consumption. One goat is consumed by each grand-family each tabaski holiday, which falls at the end of Ramadan. Goats reproduce quickly and have good milk from a nutrient basis.

Answers to Kwashiorkor

Kwashiorkor is a disease caused by malnutrition due to inappropriate amounts of essential amino acids in the diet. It is caused by a lack of quality of food not quantity of food. The people of Sanambele eat a limited amount of animal-based protein, or meat. Amino acids are the building blocks of protein. The lack of protein consumption directly correlates with the deficient amino acid in the Sanambele people's diet. They are missing tryptophan, which is not found in plants or plant parts consumed by humans.

Shortage of an amino acid will limit growth and can result in kwashiorkor in children. In the rain barrel concept, each amino acid is like the stave of a barrel (figure 14). The barrel can only be filled to the level of the shortest stave (Goodband, 2010). Relating this to life in Sanambele, a rain barrel is similar to the grain storage facilities, the gigine's (figure 6). If the amino acids form the walls of the gigine, and there is an opening or short piece in the wall, then the gigine can only hold grain up to that point; just as a person can only grow to a certain height and weight without sufficient amounts of all essential amino acids.

Janell Beartusk shared the concept of amino acids through the brick wall illustration in her visit to Sanambele in September, 2009. Using illustrations of the rain barrel and gigine models via participatory activities can further aid in explaining the role and importance of amino acids in the human diet. Exposure to this information will create new knowledge about health and diet for the Sanambele people. Without education about the role of amino acids and importance of animal protein consumption, it will be difficult to improve the Sanambele people's diet by increasing their amino acid profile through meat consumption.

By allowing and providing one cup of milk daily per child, kwashiorkor can be greatly reduced. Eggs are not a food item that is consumed by the Sanambele people. Overcoming this

cultural change would take time. It would also require the chickens to be raised in some sort of pen so that the eggs could be gathered.

Benefits of Animal Protein (Meat)

Animal proteins are good sources of many key vitamins and minerals as well as being complete sources of essential amino acids. There are twenty amino acids that the human body needs for growth and body function. Of these amino acids, the body can make ten. The other amino acids, known as essential amino acids, must be consumed from food as the human body cannot synthesize them. These amino acids are arginine, histidine, isoleucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine. Arginine is only for proper growth and development in children; it is not required after adulthood is reached. Amino acids are not stored in the body, unlike fats and starches; therefore they must be obtained from diet daily.

Animal food sources provide high levels of protein as well as certain 'key' nutrients that are not widely available from plant sources (Yaktine, Nesheim, & James, 2001). Some of these key nutrients include Vitamin B6, Vitamin B12, zinc, and iron as shown in table 2. Other key nutrients in beef include selenium, thiamin, riboflavin, niacin, and pantothenic acid (USDA, table 4). Animal food sources, such as beef, contain high levels of protein and relatively low levels of fat as illustrated in table 3.

Meat Preservation

Hurdle technology would be employed in making dried beef, utilizing the traditional ways of the Northern Cheyenne people of Lame Deer, Montana. The Northern Cheyenne use this traditional way for drying game, such as deer and antelope. The drying occurs in the fall, during the hunting season. Often, the meat is dried indoors for several days at 80 degrees Fahrenheit (Longie and Blackwolf Jr., 2011).

To make dried beef, a drying rack must first be constructed. The drying rack is simple and would be easy to construct, using large sticks to make the frame with clay bricks at the base for stabilization (see figures 11 and 12). A model, such as that of figure 12, would be beneficial in explaining the drying process and how to build the drying rack to the people of Sanambele.

To create the dried beef, a beef animal must be harvested first. Then the muscles of the beef would be separated and cut in long strips (Longie and Blackwolf Jr., 2011). The strips of meat must be no thicker than one-fourth of an inch in order to create a safe, shelf-stable product. The consistency of the thickness of the strips will create an evenly dried product. Drape the strips of meat over the drying rack. When the top side of the meat strips become dry to the touch, turn it over to dry the underside (Longie and Blackwolf Jr., 2011). This will ensure that the meat is dried completely as it needs to dry until it becomes brittle to ensure it is safe to eat (Boles, 2011).

The dried beef should be made during the dry season, from March through May. The 120 degree Fahrenheit temperatures that occur in the dry season for between four and five hours, with lows of 80 degrees (at night) will speed the drying process and allow more dried beef product to be made. This process of drying beef can occur more easily in the hot, arid climate of Sanambele, Mali because it is the same process used by the Northern Cheyenne people in much cooler temperatures of Montana. It is not recommended to make dried beef during the rainy season because the lower temperatures, moisture, and humidity will prevent the meat from drying properly and may result in a product that is not safe for consumption or shelf-stable.

To prevent contamination from insects, such as flies, the drying rack and meat should be loosely covered with a gauze type fabric, similar to mosquito netting, until the meat feels dry to

the touch. A gauze-type fabric is necessary because there needs to be unrestricted airflow across and around the meat strips for them to dry.

The dried beef should be stored so that air can circulate around it to prevent microbial growth and spoilage. Airflow will be important to prevent mold and any other possible microbial growth as well as keeping the product dry (Boles, 2011). During the rainy season, it could be kept dry and free of moisture by storing in the clay pots similar to those that the grains are stored in. A beef animal that weighs 700 pounds live will have a dressing percentage of 50, yielding a 350 pound carcass. 45 percent of the carcass weight (approximately 160 pounds) will be available as meat for drying. From this, approximately 60 pounds of dried beef product will result (Boles, 2011).

As the dried beef will be hard and brittle, it will require softening before being consumed (Boles, 2011). Softening could occur through boiling in water or broth. Another option would be shredding the dried beef into small pieces, using a process similar to the way the grain is ground. The small pieces of beef can then be added to the sauces or incorporated into other foods consumed by the Sanambele people.

Hurdle technology is used in industrialized as well as in developing countries for the gentle but effective preservation of foods. "The microbial safety and stability as well as the sensory and nutritional quality of most foods is based on an application of combined preservative factors, called hurdles" (Leistner, 1995a). "The most important hurdles use in food preservation are temperature (high or low), water activity, acidity, redox potential, preservatives, and competitive microorganisms" (Leistner, 2000). Utilizing hurdle technology will create a shelf-stable and safe dried beef product.

This technology, hurdle technology, creates foods that remain safe, stable, and tasty, especially if under conditions that are without refrigeration (Leistner, 2000). Hurdle technology is viable to create a safe food product because it puts microorganisms in a stressful environment. Under this environment the microorganisms die, live for shorter periods of time, or their growth is inhibited (Leistner, 2000). Each food is affected by different microorganisms and requires different sets of hurdles to overcome the microorganism activity. "In any case, the hurdles must keep the 'normal' population of microorganisms in the product under control" (Leistner, 2000).

There are three ways to overcome microorganism activity by utilizing hurdle technology. They are homeostasis, metabolic exhaustion, and stress reactions. Homeostasis is the natural state in which organisms strive to remain uniform and stable. Through disturbing the microorganisms' natural homeostasis via heat and other hurdle technologies, the microorganisms are permanently or temporarily disabled and not able to affect the food product. Metabolic exhaustion occurs when microorganisms spend all of their energy in attempts to metabolize and repair their homeostasis in the hostile environment made by the hurdle technology. Through the expending of this energy, the microorganisms become metabolically exhausted and die, resulting in autosterilization of the food (Leistner, 1995b).

This autosterilization, from metabolic exhaustion, further makes the food product safer because it is more microbiologically stable, especially at ambient temperatures, like those of Sanambele, Mali. The disturbance of the homeostasis of microorganisms is the key phenomenon of food preservation (Leistner, 2000). Metabolic exhaustion may foster further food preservation as it disturbs the microorganisms present in the hurdle technology used on the food.

Discussion

Forming a children's herd of cattle to make the children health and prevent kwashiorkor will bridge the gap between beef consumption and cattle as currency. It will help the people of Sanambele to view beef consumption as a way to become healthy. Cattle could be obtained by the children through non-profit organizations like Heifer International or the Zebu Overseas Board. The children could also obtain micro-loans through the village bank (Wedlake, 2011). By having the children own the cattle as a community herd, it allows the cattle to be readily consumed as they would become seen as a food source and not as currency or financial status.

Cattle in Sanambele could be fed a ground mixture of maize, bran, straw and salt as a dietary supplement with many benefits. When feeding straw, the need for great amounts of other foodstuffs decreases, thus making it a more cost effective ration. The straw increases the consumption of the mixture because the salt enhances the flavor of the feedstuff and aids in mineral absorption (Goodband, 2010). However, the cattle would require more water when they are fed this salted straw mixture.

There are numerous applications for this feed mixture as it can be fed to maintain the weight of the cattle, aid in reproduction, and prepare chosen beef animals for harvest. This feed mixture could be fed during the dry season, when there are no rains because it would help ensure that they are getting proper nutrition for maintenance of their body weight and condition.

A feed mixture could also be fed to the cattle chosen for human consumption to improve the human diet of the Sanambele people and eventually maintain healthy levels of protein. Feeding grain and other feedstuffs to cattle will help them to gain weight, put on muscle and fat, and ultimately marbling. The meat will have better flavor and texture due to the marbling and

the cattle's consumption of grains. The meat from cattle in Sanambele would be very lean because the cattle are grass-fed.

Another benefit of feeding this feed to the cattle would be improved herd health because they would maintain their weight through consumption of the additional feed. Having a constant weight in cattle and other livestock is important for performance, both in growth into an adult animal and for reproduction. Maintenance of cattle weight is related directly to the energy they receive from the feedstuffs consumed and the energy needed for maintenance and growth. By feeding cattle an additional feedstuff to the forage already consumed, they will maintain their weight better and thus more energy can be put into growth, reproduction, or fat storage.

The Ivory Coast is the closest port to Mali. Livestock animals are sold on a live basis, not by meat. There is room for expansion into new markets if a plan could be made to sell the meat of these livestock animals.

Cow milk could be another answer to the protein deficiency problem in Sanambele. However, there are numerous hurdles and problems related to milk production and current conditions. It is very extensive and takes lots of time to improve genetics in cattle. Sanambelean cows would need to be genetically improved to reach sufficient levels of milk production so that all children and people in the village could consume adequate amounts of milk. The principle that cattle are a source of one's finances contributes to the idea of quantity, not quality which makes it increasingly difficult to make management decisions which improve the cattle herd. There is not a dairy in Sanambele and there are few dairies in Mali. Therefore, it is difficult to process the milk. Without immediately consuming the milk or processing to turn the milk into a shelf stable product it will spoil and be wasted. The government is trying to help dairy development (Coulibaly, 2011).

Goat milk production could also be expanded but there are numerous hurdles to overcome before this becomes feasible. The number of dairies would have to increase so that there would be a way to process the milk into cheese or other shelf-stable foods. Cheese is an accepted food as well as yogurt. Milk is an accepted food as well as milk-based products; the problem comes with how to process it. Currently, powdered milk and cheese are imported into Mali and Sanambele.

Due to the obstacles of dairy production, in both cattle and goats, consumption of beef becomes a more viable answer. Making a dried beef product has relatively few inputs and results in a safe, shelf-stable meat product that will improve the amino acid profile of the Sanambele people. The only major obstacles would be obtaining cattle to start a children's herd, maintaining numbers of cattle in the herd to ensure enough numbers of cattle to feed the village, and lastly, overcoming the belief that cattle are only a currency as they are reserved for weddings and funerals.

Ultimately, it becomes a question of management and investment, whether it is drying meat for improving the amino acid profile and providing a steady protein supply, improving the characteristics of the different livestock species, or any other decisions related to livestock and the diets of the Sanambele people. In the end, the people of Sanambele have to decide what action, if any, to take. Education and discussion will are very important aspects in this process. As Montana State University students and 'outsiders' to the Sanambele village, we must be careful to present this information and then let the people decide what action to take. People have to see it to believe it-an often used Extension Service approach employed via demonstration (Chambers, 1989).

Conclusion & Recommendations

Conclusion

Consumption of meat, specifically beef, is an excellent way to obtain proteins and essential amino acids as well as many other vitamins and minerals. This can decrease the prevalence of kwashiorkor in the children of Sanambele. However, there are a couple of major hurdles to consuming cattle in Sanambele. The first is that cattle are seen as a source of finance.

To overcome this, creation of a children's cattle herd becomes needed and feasible, yet it creates another hurdle-how to obtain the animals and build up a cattle herd. To consume meat on a regular basis, it needs to be made into a safe, shelf-stable food product. This can be achieved through making a dried beef product using the traditional ways of the Northern Cheyenne.

Recommendations

- Further education on role of amino acids.
- Establish a children's cattle herd.
- Continue to graze cattle on available forage. Supplement cattle diet with a mixture of grains and straw for the cattle that will be consumed so that the animals are in good conditions before they are harvested (if financially feasible).
- Education of Sanambele people on meat preservation, exposing them to a new form of meat; including how to make the product and how to incorporate into the foods that are already part of their diet.
- Education on importance of protein and the value of animal protein
- Overcome the gap between beef consumption and beef as currency through education

- Create drying racks for meat preservation so that consumption of dried beef on a regular basis can occur which will help improve the current nutrient deficiencies (lack of essential amino acids).
- Explore and improve animal husbandry practices to improve the livestock in Sanambele so that more beneficial traits can be introduced and incorporated into the animals. This will aid in production of meat and milk, as well as other food products; thus improving food sources for the people.
- Further exploration of livestock and the animal-based food products by PSPP 465 students to further this research and continue to find answers for these issues.

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Illustrations

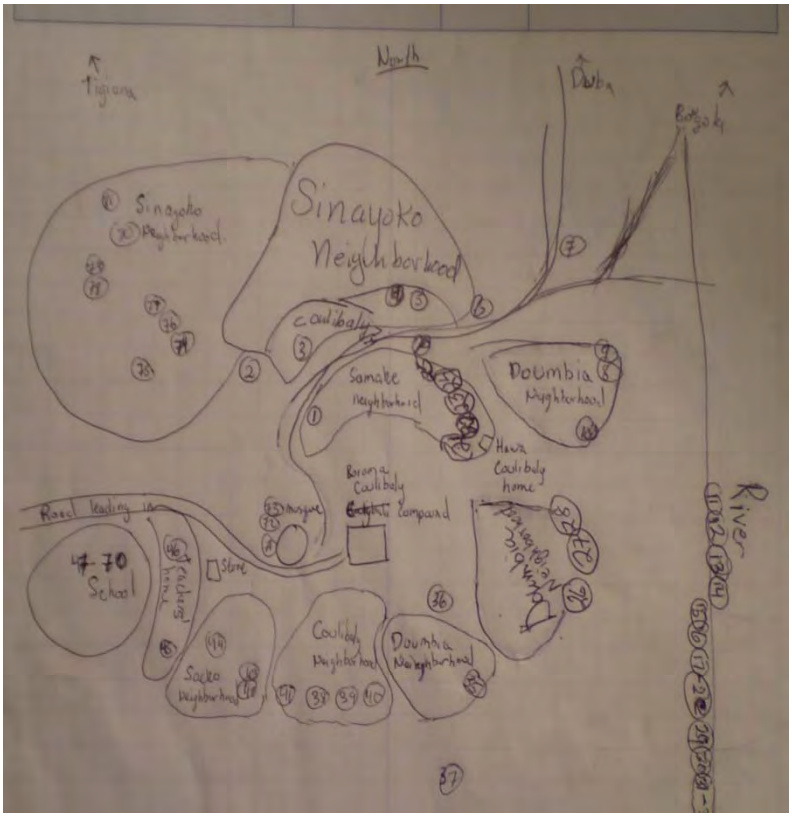


Figure 2. Map of Sanambele Village. (Long, 2010).

Figure 3. Young child with kwashiorkor. (Dunkel, 2009).

Figure 4. Young girl affected by kwashiorkor. Note the reddish-colored hair. (Dunkel, 2009).

Figure 5. Sanambele village buildings. Note that they are made of clay bricks with thatched roofs. (Dunkel, 2009).

Figure 6. Gigine, a Sanambelean grain storage facility. (Dunkel, 2009).

Figure 7. Clay pot made in Sanambele. (Dunkel, 2009).

Figure 8. Clay pot used for grain storage. (Dunkel, 2009).

Figure 9. Cattle sheltered from the sun. (Dunkel, 2009).

Figure 10. Brahman descent cattle in Sanambele. (Dunkel, 2009).

Figure 11. Meat drying rack.

Figure 12. Model showing how meat drying would occur. (Dunkel, 2011).

Figure 13. Dried beef. (Google Images, 2011).

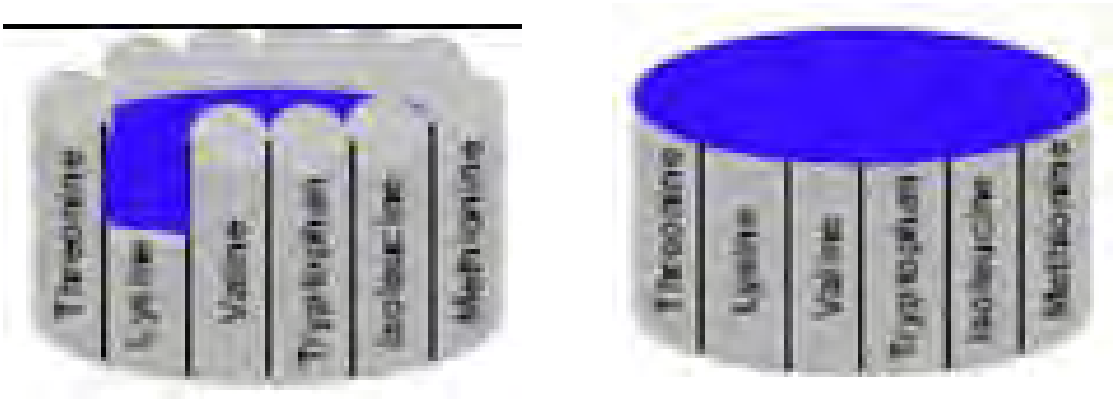


Figure 14. Rain barrel illustration of amino acid shortage. (Goodband, 2010).

Tables

Index	Keyword	Results
EBSCOhost	Cattle+ Mali	37
Agricola	Beef+health benefits	31
Agricola	Beef+Mali	1
Agricola	Meat preservation	286
Agricola	Agriculture+Mali	120

Table 1. Search Terms and Results. (Gambill, 2011).

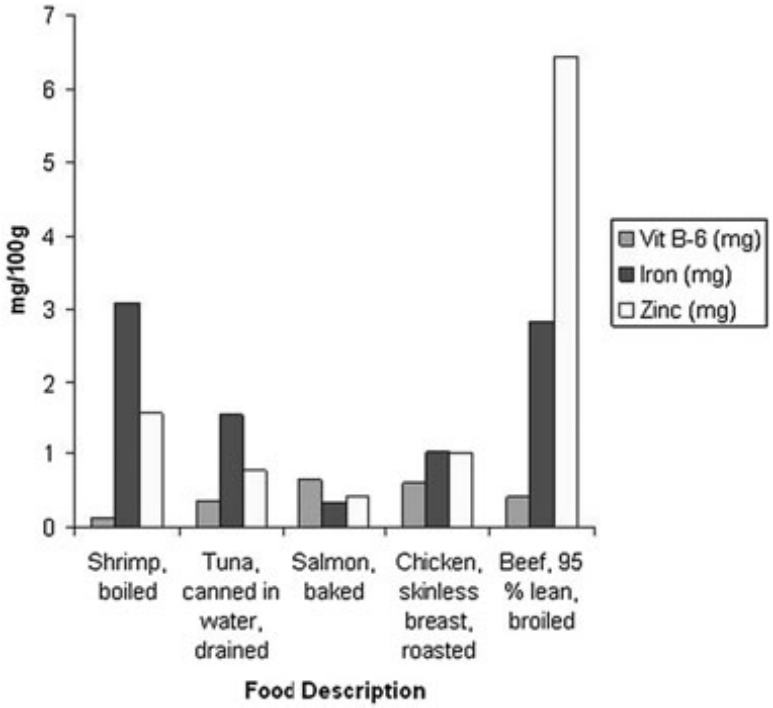


Table 2 Comparison of Vitamin B6, iron, and zinc content of selected animal foods. (USDA, 2007).

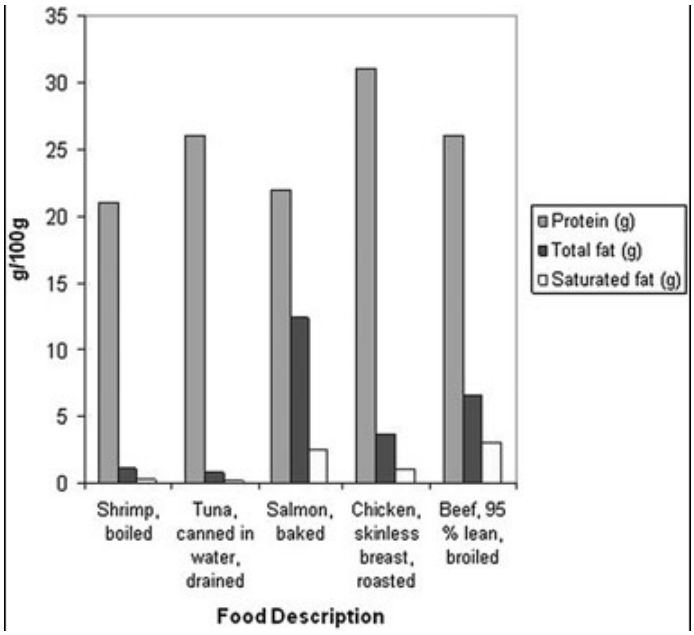
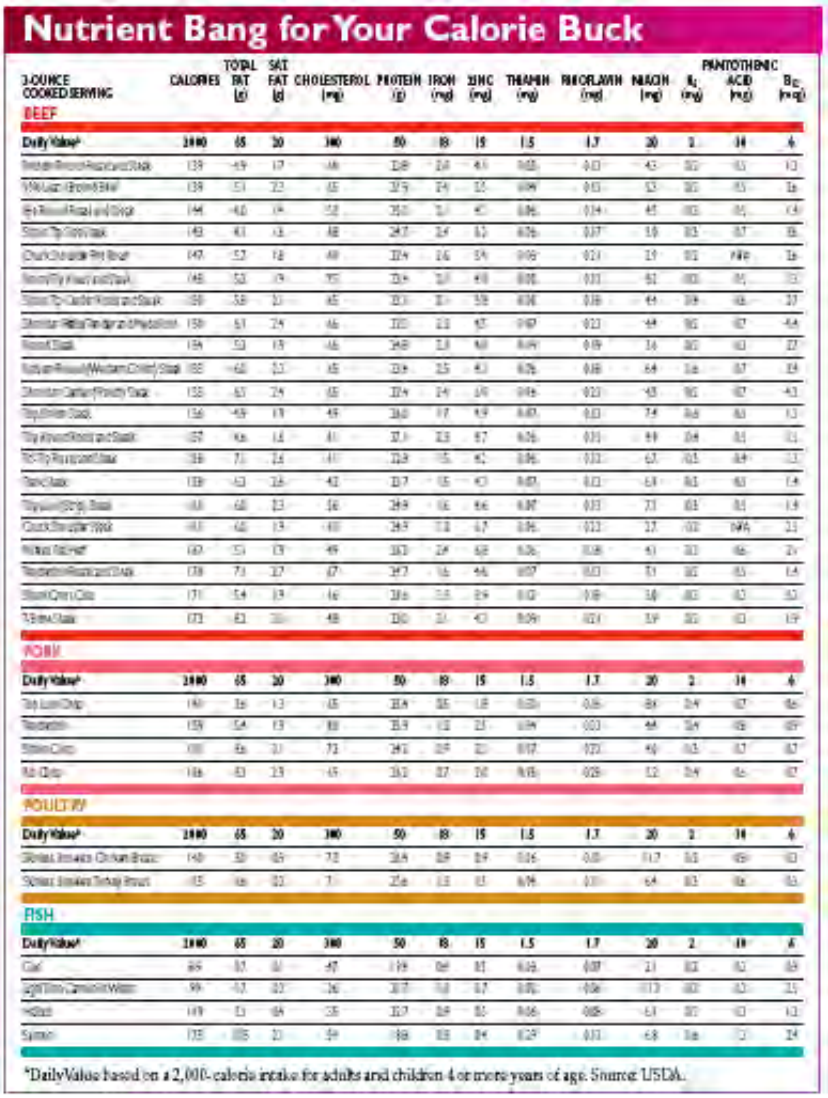


Table 3 Comparison of protein and fat levels of animal foods. (USDA, 2007).



Nutrient Bang for Your Calorie Buck

3-OUNCE COOKED SERVING	CALORIES	TOTAL FAT (g)	SAT FAT (g)	CHOLESTEROL (mg)	PROTEIN (g)	IRON (mg)	ZINC (mg)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	B_6 (mg)	PANTOTHENIC ACID (mg)	B_{12} (mcg)
BEEF													
Daily Value*	**2000**	**65**	**20**	**300**	**50**	**18**	**15**	**1.5**	**1.7**	**20**	**2**	**10**	**6**
[illegible]	139	4.9	1.7	66	23.8	2.4	4.1	0.05	0.13	4.5	0.2	0.5	1.3
[illegible]	138	5.1	2.2	65	22.9	2.4	3.5	0.04	0.13	5.3	0.1	0.5	1.6
[illegible]	144	4.0	1.4	72	25.0	2.1	4.2	0.06	0.14	4.5	0.2	0.5	1.4
[illegible]	143	4.1	1.5	68	24.7	2.4	4.2	0.06	0.17	5.9	0.3	0.7	1.6
[illegible]	147	5.2	1.8	69	22.4	2.6	3.4	0.09	0.13	2.9	0.2	0.8	1.6
[illegible]	148	5.2	1.9	70	23.4	2.1	4.0	0.05	0.13	4.2	0.2	0.5	1.5
[illegible]	150	5.8	2.1	65	23.3	2.1	3.8	0.08	0.16	4.4	0.4	0.6	2.7
[illegible]	159	6.1	2.4	66	23.5	2.3	4.7	0.07	0.13	4.4	0.2	0.7	4.6
[illegible]	154	5.3	1.9	66	24.8	2.3	4.0	0.09	0.19	3.6	0.2	0.3	2.7
[illegible]	155	4.8	2.1	65	23.4	2.5	4.3	0.06	0.18	6.4	0.4	0.7	2.4
[illegible]	153	6.1	2.4	65	22.4	2.4	3.9	0.06	0.13	4.3	0.2	0.7	4.3
[illegible]	156	4.9	1.9	69	24.0	1.7	4.9	0.07	0.13	7.4	0.6	0.3	1.3
[illegible]	157	4.6	1.8	81	27.1	2.3	4.7	0.06	0.15	4.9	0.4	0.5	1.1
[illegible]	159	7.1	2.6	61	22.9	1.5	4.2	0.06	0.12	6.7	0.3	0.4	1.3
[illegible]	159	6.3	2.6	62	23.7	1.5	4.3	0.07	0.13	6.3	0.3	0.3	1.4
[illegible]	163	6.8	2.3	76	24.9	1.6	4.6	0.07	0.13	7.1	0.3	0.5	1.9
[illegible]	163	6.8	2.9	63	24.9	2.2	4.7	0.06	0.12	2.7	0.2	N/A	2.5
[illegible]	163	5.5	1.9	69	26.3	2.4	4.8	0.06	0.18	4.1	0.3	0.6	2.1
[illegible]	170	7.1	2.7	67	24.7	1.6	4.6	0.07	0.13	7.1	0.2	0.5	1.4
[illegible]	171	5.4	1.9	66	28.6	2.5	5.9	0.12	0.18	5.8	0.3	0.7	3.2
[illegible]	173	8.2	3.0	68	23.0	2.1	4.3	0.09	0.13	5.9	0.2	0.3	1.9
PORK													
Daily Value*	**2000**	**65**	**20**	**300**	**50**	**18**	**15**	**1.5**	**1.7**	**20**	**2**	**10**	**6**
[illegible]	140	3.6	1.3	65	25.4	0.5	1.8	0.55	0.16	8.0	0.4	0.7	0.6
[illegible]	159	5.4	1.9	80	25.9	1.0	2.5	0.84	0.23	4.4	0.4	0.5	0.9
[illegible]	181	9.6	3.1	73	24.2	0.9	2.2	0.57	0.22	4.0	0.3	0.7	0.7
[illegible]	186	8.3	2.9	69	26.2	0.7	2.0	0.95	0.28	5.2	0.4	0.6	0.7
POULTRY													
Daily Value*	**2000**	**65**	**20**	**300**	**50**	**18**	**15**	**1.5**	**1.7**	**20**	**2**	**10**	**6**
[illegible]	140	3.0	0.9	73	26.4	0.8	0.9	0.16	0.10	11.7	0.5	0.5	0.3
[illegible]	135	4.4	2.1	71	25.6	1.3	1.1	0.79	0.11	6.4	0.3	0.6	0.3
FISH													
Daily Value*	**2000**	**65**	**20**	**300**	**50**	**18**	**15**	**1.5**	**1.7**	**20**	**2**	**10**	**6**
[illegible]	89	0.7	0.1	47	19.9	0.4	0.5	0.05	0.07	2.1	0.2	0.2	0.9
[illegible]	99	1.2	0.2	26	20.7	1.0	0.7	0.05	0.06	11.3	0.2	0.2	2.5
[illegible]	149	5.1	0.4	55	23.7	0.9	0.5	0.06	0.05	6.1	0.1	0.3	1.3
[illegible]	155	10.5	2.1	59	19.8	0.3	0.4	0.29	0.11	6.8	0.6	0.3	2.4

*Daily Values based on a 2,000-calorie intake for adults and children 4 or more years of age. Source: USDA.

Table 4 Nutrient comparison for animal food sources. (USDA).

Participatory Activity
Preserving animal protein sources (meat) in Sanambele

Objective: The objective of this activity is to expose the Sanambele people to a way of preserving meat in order to have a steady supply of protein in their diet.

Materials Needed: -Diagram of meat drying rack

-OR Model of meat drying rack (more preferable)

-Pictures of cutting beef into strips for drying

-Pictures of beef harvest and cutting (to show harvest and preservation/meat drying processes)

Introduction: Develop a dialogue to gather information and build repoir with the Sanambele. Sample questions to ask include: how they harvest cattle? How often are cattle harvested? What steps are taken for the harvest to occur? How is the meat cooked? What is done with the blood, offal, hide, and other parts of the cattle? How is the meat consumed? Is any preservation done? During this question and information gathering session, share dried meat with the Sanambele people so that they can taste it and explore the end product of the process that will be shown to them.

Steps: Show pictures and explain process of how beef is harvested and cut into strips to make dried beef. Use pictures as an illustration for the people to follow while the processes are explained. This drying process is a traditional form of meat preservation used by the Northern Cheyenne people on game meat.

1. After harvest and removal of the hide, and other inedible parts of the animal, the muscle can be cut into meat.

2. Separate the muscles by cutting them away from the rest of the muscle, following the natural seams made where the muscles connect.

3. Cut the meat into long, thin strips (less than ¼" thick).

4. Drape over the drying rack. Dry during the daytime (utilize the 5 hours of 120 degree heat as much as possible).

5. Turn strips over when the meat strips appear dry to ensure that all of the meat gets dried completely.

6. Cover and store once both sides are dry.

Follow-up Activities: Tour village to see what the cattle look like, what they are consuming, etc.

Observe harvest of cattle in the way of the Sanambelean people. Compare ways that harvest is done, Sanambele vs. U.S. Construct a drying rack and dry some of the beef after harvest.