

ACHA: A Potential Grain as a Food Fortifier

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ABSTRACT--- *Acha (Fonio), in particular, is sometimes regarded as “the grain of life” due to the fact that it provides food early in the farming season, when other crops are yet to mature for harvest. West Africans have cultivated it across the dry Savannas and it is probably one of the oldest African cereals which have been in existence for thousands of years.*

In Nigeria, Acha (Fonio) products are recommended as choice sources of carbohydrate for diabetic patients. Today, it is the most expensive grain crop in Nigeria, providing resource for poor farmers and alleviating poverty. The possibility of Acha (Fonio) (which is light and easy to digest) been included in many different cereal based recipes, is not farfetched, thus making it an attractive ingredient for health food products usable by those with gluten intolerance, poor health or for baby food.

Acha (Fonio) contains 7% crude protein which is high in Leucine (9.8%) Methionine (5.6%) and Valine (5.5%). The protein in the crop is reported to be unique; in that it has greater methionine content than other cereals. It is reputed to contain almost twice as much methionine as egg protein does.

It is on this premise that the potential of the crop as a food fortifier is been looked into due to its very important possibility of its use not only as survival food, but as a complement for standard diets.

Keywords--- Acha (Fonio), Potential, Standard diet, Fortifier, Whole grain

1. INTRODUCTION

With the world's continued dependence for sustenance on grain crops as reported by (Conklin and Stilwell, 2007) Taylor 2004 reported that this dependence is prevalent in the continent of Africa, however in the developed nations, cereal consumption is more moderate and varies but is still substantial. Cereal grains provide more food energy worldwide than any other type of staple crops. In their natural form (as a whole grain), they are rich source of vitamins, minerals, carbohydrate, fat and oil and protein.

Dendy, (1995), reported that among traditional cereals, Acha (*Digitaria exilis* Stapf) and iburu (*Digitaria Iburua* Stapf) which are also called *Fonio* have received increasing attention in research and development. This has been confirmed from various investigations and reviews, (de Lumen et al., 1993; Irving and Jideani, 1997; Jideani, 1990, 1999; Kwon-Ndung and Misari, 1999; Nzelibe et al., 2000; Morales-Payan et al., 2002; Adoukonou-Sagbadja et al., 2007; Philip and Itodo, 2006; Ayo and Nkama, 2006; Jideani et al., 2000, 2007, 2008; Taylor, 2008; Agu et al., 2008, 2009) on the crop. Such attention is seen in the European Fonio project, a cereal believed to be a healthy and cheap addition to European diets, while at the same time generating income for local producers in Africa (Dury et al., 2007).

Besides other African traditional cereals, Acha (Fonio) grains have played a central role in the emergence and development of traditional agriculture, nutrition and indigenous medicine in the West African savannah (CIRAD, 2006).

2. HISTORY AND CULTIVATION OF ACHA (FONIO)

Acha (Fonio) is a cereal crop of West African origin belonging to the family *Graminaea* with scanty knowledge about its evolution, origin, distribution and genetic diversity even within West Africa itself, this is despite its ancient heritage and

widespread importance as reported by Gibon and Pain, (1985). The crop is grown in various parts of Nigeria, Sierra-Leone, Ghana, Guinea Bissau, Senegal, Togo, Mali, Benin Republic and Cote d'ivoire (Jideani, 1999, Gyang and Wuyep, 2005) goes by various names, such as *fundi*, *findi*, *acha* or “hungry rice”.

According to Vietnameyer et. al. (1996), the crop has been so neglected that it is called the lost crop of Africa, having received but a fraction of the attention accorded to sorghum, pearl millet, and maize. It has received a mere trifle consideration of its importance in the rural economy and its potential for increasing the food supply. Investigations however, has shown that Acha is being gradually rediscovered and considered for improvement as cultivated species (Ibrahim 2001, Morales Payan, et al 2002) with more farmers now engaged in its production and considered for improvement as a cultivated species (Ibrahim, 2001; Morales-Payan et al., 2002).

Of the different varieties of Acha grown, the white Acha (*Digitaria exilis*) is more popular in Nigeria and is more widely grown while the black Acha (*Digitaria iburua*) is rarely cultivated. According to Chukwu and Abdul-kadir, (2008), Acha is probably one of the oldest African cereals which have been cultivated for thousands of years across the dry Savannas of West Africa.

Acha (Fonio) is a very hardy crop and grows well on poor soils, it can even produce seed on soils with Aluminium levels that are toxic to other crops and can be relied on in dry savannah lands, where rains are brief and unreliable. The tiny grains are gluten-free and rich in protein, and consumers outside Africa are beginning to recognize its flavour and nutritional qualities (National Research Council, 1996). Acha (Fonio), is sometimes regarded as the “grain of life” as it provides food early in the farming season, when other crops are yet to mature for harvest (Ibrahim, 2001).

Among the native crop of Africa, it is selected as target for biotechnology because of its exceptional culinary and nutritional properties while in Nigeria, fonio products are currently recommended as choice of carbohydrate for diabetic patients. Today, it is the most expensive grain crop in Nigeria, providing resource for poor farmer and alleviating poverty. The grain when cooked is light and easy to digest and can be included in many different cereal based recipes, making it an attractive ingredient for health food products for those with gluten intolerance, poor health or for baby food (National Research Council, 1996).

3. STRUCTURE OF ACHA GRAIN

Acha (Fonio) grains are extraordinarily tiny with 1,000 grains weighing 0.6 -0.7g. The grain is surrounded by an outer protective covering or the husk (glume) which makes up to 24% of the total weight of the grain, measuring between 1.6 and 1.8 mm long and approximately 0.8 mm wide.

The external structure of caryopsis, is composed of pericarp and a layer of aleurone cells which are the first endosperm tissues. The endosperm of the Acha grains contain the aleurone layer and the starchy endosperm. The bulkiest portion of Acha (Fonio) grains, as in most cereals, is the endosperm which was discovered to measure between 2 and 13µm and an important reserve tissue.



Figure 1. Picture of Fonio Grains with the paddy **Figure 2.** Greatly enlarged Picture of Fonio grains
Figure 3. Picture of dehusked Fonio grains.

4. COMPOSITION OF ACHA (FONIO)

Investigation carried out on the Acha grain reveals that the Acha grain contains 6.5% crude protein which is reported by Temple and Bassa, (1991) where it was further stated that the protein in Acha is high in leucine (9.8%) Methionine (5.6%) and Valine (5.5%).

According to Jideani and Akingbala, (1993). the leucine and methionine found in Acha is greater than that found in other cereals it was also reported to contain almost twice as much methionine as egg protein does (Temple and Bassa, 1991). This implies that Acha is a very good source of protein.

The minerals present in Acha are; Zinc, Manganese, Magnesium and Potassium which are reported to help to build tissues, regulate body fluids or assist in various body functions (Joshi, 2007). Vitamins present in Acha are Thiamin (Vit. B₁), Riboflavin (Vit. B₂), Calcium and Phosphorus, these are essential to normal metabolism; insufficient amounts in the diet may cause deficiency diseases. Fiber, especially those found in Acha, are helpful in the treatment and prevention of constipation, hemorrhoids and diverticulosis.

According to Anderson et al., (2009) the high fiber content of Acha may be useful for people who wish to lose weight as the fiber itself has no calories, yet provides a "full" feeling because of its water-absorbing ability in addition to the fact that it may help reduce the risk of some cancers, especially colon cancer. This idea is based on the information that insoluble fiber increases the rate at which wastes are removed from the body.

A 100 g of Acha (Fonio) grains contains essential Amino acids; Cystine 2.5, Food energy (Kc) 367, Isoleucine 4.0, Protein (g) 9.0, Leucine 10.5, Carbohydrate (g) 75, Lysine 2.5, Fat (g) 1.8, Methionine 4.5, Fiber (g) 3.3, Phenylalanine 5.7, Ash (g) 3.4, Threonine (mg) 3.7, Thiamin (mg) 0.47, Tryptophan (mg) 1.6, Riboflavin (mg) 0.10, Tyrosine (mg) 3.5, Niacin (mg) 1.9, Valine (mg) 5.5, Calcium (mg) 44, Iron (mg) 8.5 and Phosphorus (mg) 177. In gross nutritional composition, fonio differs little from wheat. In one white fonio sample, the husked grain contained 8 percent protein and 1 percent fat. In a sample of black fonio, a protein content of 11.8 percent was recorded. The difference lies in the amino acids it contains. Thus, fonio has important potential not only as survival food, but as a complement for standard diets (National Research Council, 1996).

Table 1. Proximate Composition of Acha (Fonio)

| Main Components | | Essential Amino Acids | |
|------------------|------|-----------------------|------|
| Moisture | 10 | Cystine | 2.5 |
| Food energy (Kc) | 367 | Isoleucine | 4.0 |
| Protein (g) | 9.0 | Leucine | 10.5 |
| Carbohydrate (g) | 75 | Lysine | 2.5 |
| Fat (g) | 1.8 | Methionine | 4.5 |
| Fiber (g) | 3.3 | Phenylalanine | 5.7 |
| Ash (g) | 3.4 | Threonine | 3.7 |
| Thiamin (mg) | 0.47 | Tryptophan | 1.6 |
| Riboflavin (mg) | 0.10 | Tyrosine | 3.5 |
| Niacin (mg) | 1.9 | Valine | 5.5 |
| Calcium (mg) | 44 | | |
| Iron (mg) | 8.5 | | |
| Phosphorus (mg) | 177 | | |

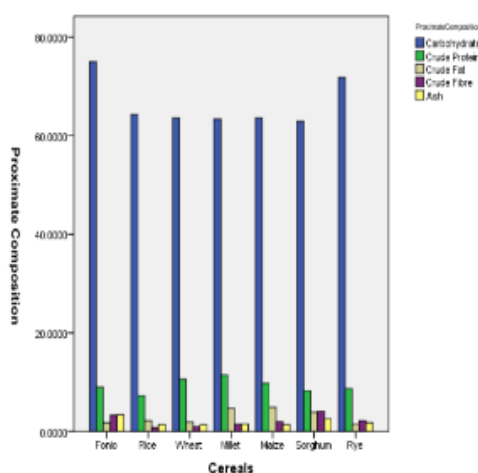


Figure 4. Proximate composition of some Cereals (Source [The National Academies | 500 Fifth St. N.W. | Washington, D.C. 2001])

5. USES OF ACHA

Acha grain is consumed and used in a variety of ways. The list of the usage of Acha (Fonio) for human and industrial usage is unending. In West Africa Acha (Fonio) is considered to be the tastiest of all cereals. Serving fonio as a dish at festivals or important ceremonies is always a good choice because of its fine and delicate taste. As a popular proverb says “Fonio never embarrasses the cook”. Fonio is also known for its nutritional properties. It can also be used in the Beverage industry and for livestock feeding.

As a Delicacy: Acha can be made into a numbers of dishes such as porridge and couscous. It is cooked in various forms with fish, meat, legumes or vegetables. In West Africa, it is mainly grown and cooked by women, as a special food for treats at weddings, and other ceremonies.

As a Baking flour: It is mixed with other flours to make bread and other pastries thus serving as a fortifier for these pastries. The grains could be used for cookies, crackers, and popcorn. Whole meal Acha and iburu flours can be used in the preparation of a number of biscuits and snacks that could be useful for individuals with gluten intolerance (Ayo and Nkama, 2003).

As a Weaning Food: Whole Acha grains are used for quick cooking non-conventional food products. It can be used as weaning food and it is recommended for diabetic patients by doctors (Jideani, 1990) because of its low bulk density.

Used for Brewing: It is used as a brewer’s grain for beer brewing. Acha grains can be ground into flour and used to prepare local beverages. Northern Togo, the Lambas brew a famous beer (*tchapalo*) from white fonio.

As a Primary Cereal: It can be used as breakfast cereal. It is one of the primary cereals in Sudan and Ethiopia. Fonio is light and easy to digest and can be included in many different cereal based recipes, making it an attractive ingredient for health food products for those with gluten intolerance, in poor health or for baby food (National Research Council, 1996).

As Animal feed: The grains are used to prepare food for domestic animals. Fonio grain is digested efficiently by cattle, sheep, goats, donkeys, and other ruminant livestock. It is a valuable feed for monogastric animals, notably pigs and poultry, because of its high methionine content (Adoukonou-Sagbadja, 2010). The straw and chaff are also fed to animals. Acha and iburu have great potential in their use as ingredients in product formulation because they contain vitamins, minerals and fibre.

As a Traditional Cousine: In the Hausa region of Nigeria and Benin Republic, people prepare a couscous (*wusu-wusu*) out of both types of fonio. In southern Togo, the Akposso and Akebou people prepare fonio with beans in a dish that is reserved for special occasions. The tiny grains are gluten-free and rich in protein.

As a Multipurpose Crop: The husk is a source of domestic fuel for cooking. The straw is commonly chopped and mixed with clay for building houses or walls. It is also burned to provide heat for cooking or ash for potash.

6. POTENTIAL OF ACHA (FONIO) AS A FOOD FORTIFIER

Fortification is the process of adding micronutrients (essential trace elements and vitamins) to food so as to eliminate its deficiency. Food fortification as defined by the World Health Organization (WHO) and the Food and Agricultural Organization of the United Nations (FAO), refers to "the practice of deliberately increasing the content of an essential micronutrient, ie. vitamins and minerals (including trace elements) in a food irrespective of whether the nutrients were originally in the food before processing or not, so as to improve the nutritional quality of the food supply and to provide a public health benefit with minimal risk to health. (WHO, and FAO, 2006).

The potential of the Acha (Fonio) grain to serve as a food fortifier and diet cannot be over emphasized judging by its composition. From literature and survey conducted in the Northern part of Nigeria (Kano) it was discovered that Acha grains are mostly consumed whole, perhaps because of their small size (Jideani and Akingbala, 1993). There is now sufficient evidence showing that higher whole grain diets (such as obtained if Acha (Fonio)) compared with refined grain diets are beneficial for several health purposes (Jones, 2009).

Consumption of the grain as whole grain makes it an excellent source of dietary fibre and associated benefits include cholesterol lowering, and cancer-risk-reduction potential. (Kasarda, 2001; Kahlon, 2009). This is as a result of its composition and nutritional value.

6.1. Supply of Amino Acids

Acha (Fonio) is one of the most nutritious of all grains. It is so rich in Amino acids, particularly Methionine, Cystine and Phenylalanine (EFRT, 2000) which the body cannot synthesize on its own. These are essential amino acids, which the body needs for health but cannot synthesize. Cystine is a major constituent of the proteins that make up hair, nails and skin, and is involved in major detoxification processes in the body. The body needs Phenylalanine to create various brain chemicals and thyroid hormones as well as tyrosine (another amino acid that it uses to make proteins).

Investigations and research have shown that the methionine level in Acha (fonio) is twice that found in egg protein (Adoukonou, 2010). This makes fonio a complement standard diet. It supplies sulfur and other compounds required by the body for normal metabolism and growth. These amino acids are reportedly deficient in other major cereals such as wheat, rice, barley and rye (CIRAD, 2000). The high content of these sulphur amino acids make Acha (fonio) an excellent nutritional complement to legumes as most legumes are low in methionine (but high in lysine, which is lacking in cereal grains).

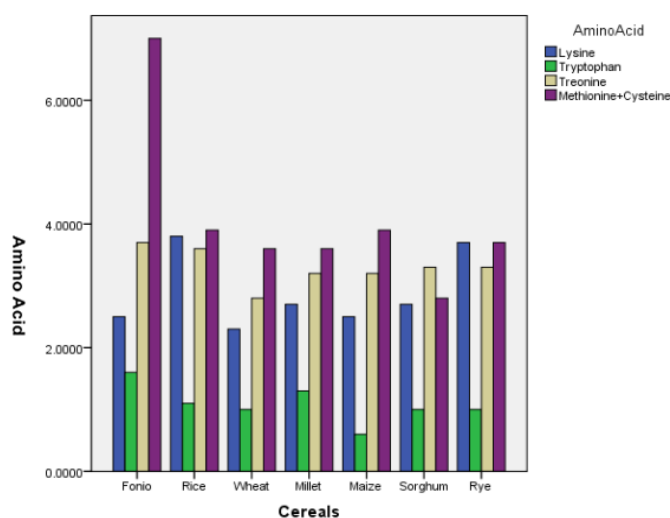


Figure 5. Amino acid content in cereals

Source: [The National Academies | 500 Fifth St. N.W. | Washington, D.C. 2001]

6.2. Low Glycemic Index

In Nigeria, Fonio sellers identify diabetic patients as their major customers and it is also reported that doctors are recommending fonio to diabetic patients because it is more appropriate for them. This is due to the low Glycemic Index (GI) of Acha, compared to sorghum, maize & white rice which have intermediary GIs, and sorghum paste & corn paste which had elevated GIs.

The Glycemic Index of a food is the rate at which sugar is released from that food into the blood. The lower the number, the slower the process. Hence choosing low GI foods like Fonio is important for those with diabetes because these foods could be of great help, and they can also reduce the risk of heart disease. It is also important for those with high sugar level.

Low GI means a smaller rise in blood sugar which will help control established diabetes condition, it is also shown that diets with low GI can help people lose weight and lower blood lipids and can improve the body's sensitivity to insulin.

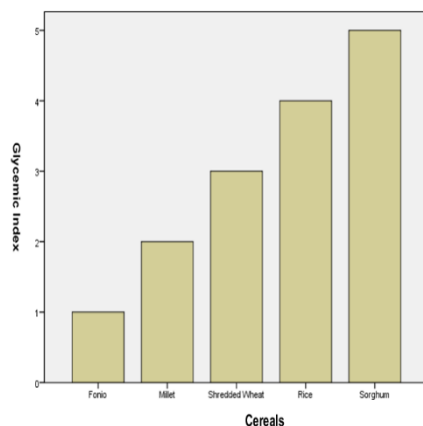


Figure 6. Glycemic index of Fonio and other cereals.
Source – [USDA/Institute of Food Science Technology Dakar]

6.3. Minerals and Iron

According to the National Academy Press, (1996), Fonio is richer in Magnesium, Zinc, and Manganese than other cereals. It is also significantly richer in Thiamine (Vitamin B₁), Riboflavin (Vitamin B₂), Calcium and Phosphorous than white rice

The Laboratory of Food Technology and Animal Nutrition in Mali indicate that Phosphorous and Potassium are major minerals in Fonio grains. Phosphorous is found mainly in bones and is a constituent of many vital compounds in the body, including ATP, DNA, and Phospholipids. Potassium is crucial to heart function and plays a key role in skeletal and smooth muscle contraction, making it important for normal digestive function. Fonio also appears to have appreciable amounts of Iron and when compared to white rice, is significantly richer in this essential mineral. Studies had showed that fonio that had been cleaned, steam cooked and drums dried contained 10.74mg iron/100g when compared to brown rice in a separate study, contained 1.1 ± 0.1 mg/100g appreciably less than A.

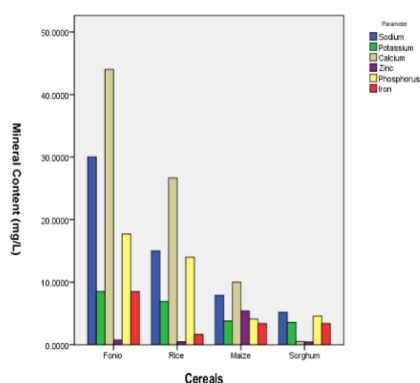


Figure 7. Mineral Content in Cereals
Source [The National Academies | 500 Fifth St. N.W. | Washington, D.C. 2001]

7. CONCLUSION

Acha (Fonio), remains vital to the food security of millions of Africa Farmers who use it in several ways. While most countries in Africa still import substantial amount of wheat and wheat end products causing a serious implication on their already weak economy due to the high importation rate, there is the need for concerted effort to develop the Acha (Fonio) grains propagation, cultivation and harvest due to the fact that it can perform almost same function as Wheat grains. Reports show that these grains, based on the functionality of the Proteins, Amino acid and Vitamin content can be used to create a number of value added food through fortification of the foods with Acha (Fonio). These attributes of Acha

(Fonio) shows its uniqueness and potential in contributing significantly to whole grain diets in Africa and undoubtedly, it's proper utilization would lead to improvement in economic status of the producers in Africa and the continent at large. Research and development on Acha grains is experiencing renewed interest in Africa and the rest of the world, particularly for its flavour and exceptional nutritional qualities, providing resource for poor farmer, alleviating poverty, fighting malnutrition and ensuring food security for the economy revival of Africa. The fortification of nutritional deficient food with fonio will go a long way in ensuring public health.

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