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Review Paper

Fonio (*Digitaria spp.*): The Good Tasting, Potential Food Security Cereal for Africa begs for Research Attention

[*1]Enyiukwu, D. N. and [2]Bassey, I. N.

[1]Department of Plant Health Management, Michael Okpara University of Agriculture, Umudike PMB 7267 Umuahia, Abia State, Nigeria.
[2]Department of Botany and Ecological Studies, University of Uyo, Ikpa Road Uyo, PMB 1017 Uyo, Akwa Ibom State, Nigeria.
*Corresponding Author E-mail: enyidave2003@gmail.com

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ABSTRACT: Cereals are important components of human nutrition the world over. In Africa millets including fonios are integral parts of cereal-based staples of several millions of peoples in the continent. Fonios otherwise called *acha* or hungry rice are small-sized, low glycemic index grains that provide good amounts of calories for people with or without metabolic dysfunction. Sulphur-based amino acids especially methionine and cysreine are also in rich supply in the grains in amounts higher than those of popular legumes. However, this crop is neglected and suffers greatly from lack of scientific attention in several crop improvement progammes. Herein are presented sizeable information about the uses, constraints, prospects and potential health benefits of fonios. Efforts were made to highlight or pinpoint possible areas to beam strong research focus, or attention on the crop. Such gray areas include their agronomy, profiles of their field and storage arthropod-pests, the complete nutritional composition of the grains, grain size enhancement and inherent mycotoxin contamination inhibitors in the grains, de-husking and de-stoning machines, anti-lodging genetic engineering, etc. Improving the crop in these areas will make these valuable indigenous cereals contribute their quota to food security and public health especially in Africa south of the Sahara.

Keywords: Fonio, *Acha*, hungry rice, research attention, *digitaria spp.*, cereals, millets

INTRODUCTION

Digitaria spp. commonly called Fonio, *Acha*, Hungry rice in Nigeria is reported as the oldest cereal crop domesticated and cultivated in several countries of West Africa from Cape Verde to Lake Chad in the Sudan-Sahel region even extending southwards to the edge of the tropical rain forest zones. Fonio belongs to the family poaceae, subfamily panicodeae, tribe Paniceae and genus *Digitaria*. The genus is made up of 225-230 annual or perennial grass crops of which fonio is the only crop of economic significance amongst them. Two species of the crop are widespread in the regions of its cultivation; namely *D. exilis* (white fonio, hungry rice) and *D. iburua* (black fonio, *iburu*). Except for few features, the two species are not morphologically distinct from each other (PROTA, 2014). However, Taylor (2019) argued to the contrary, that molecular amplified fragment length polymorphism analysis of the respective genomes of the crop, revealed clear-cut differentiation of the species. Generally speaking, some authorities believe that knowledge of the evolution, origin and genetic diversity of the crop is scanty even within West Africa (NAP, 2016) Notwithstanding, *D. exilis* is thought to have originated

from the upper middle area of the Niger Basin where large diversity of landraces of the crop occurred while the Hausa dominated northern Nigeria is fingered as possible center of speciation of *D. iburua* (Adoukonou-Sagbadja, 2010; Ballougou *et al*., 2013; Kaleisekar *et al*., 2017).

Botany, ecology and distribution of the crop

Fonios are herbaceous, free-tillering, carbon-4 (C_4) plant of the grass family; with erect, slender and glabrous culms (Figure 1). White fonio attains a height of 1.5 m while black fonio reaches only a maximum height of 1.0 m. Leaves of the crop are simple, alternate with upward tapering linear blades; while their inflorescences are finger-shaped terminal panicle with 2-5 digitates measuring 5-10 cm in length (Figure 1). The ellipsoidal grains of the crop measuring 0.5-1.0 mm in diameter and 0.75-2.0 mm in length; are extraordinarily tinted being enclosed within 2 brown husks which may be darker in the black fonio varieties (Figure 1). One thousand of these tiny grains weigh about 0.5-0.6 g (Figure 1). Generally, it takes between 60-150 days for the crop to attain full maturity in the field; with the gestation period being longer in the humid rain forest than in the arid zones of the tropics (Gomez and Gupta, 2003; Adoukonou-Sagbadja, 2010; PROTA, 2014) and shorter (60-70 days) for some early maturing varieties in the arid zones (Del Coro, 2019).

Fonios are warm season cereals which grow well in tropical areas having annual rainfall ranging between 900-1000 mm. Fonios are cultivated sporadically in the West African savannas from Mali, Burkina Faso, Cote d'Ivoire, sierra Leone, Ghana, Benin Republic to some parts of northern Nigeria, southern Niger, Cameroun, Guinea, Mali, Burkina Faso and Democratic Republic of Congo (Maji and Imolehi, 2013; PROTA, 2014). In 2002, about 300,000-350,000 ha of farmlands were reported to be devoted annually to the production of fonios in the West African region with Nigeria almost providing half of it (Bashiri *et al*., 2010; NAP, 2016). FAOSTAT revealed that the total hecterages planted to the crop increased to about 450,000 ha in 2009 with nearly 480,000 Mt of grains produced from them; the bulk of the grains was produced in Guinea, followed by Nigeria, Mali and Burkina Faso (Gomez and Gupta, 2003; Adoukonou-Sagbadja, 2010). However, in 2017, the production figure of fonio grains the world over stood at 671,000 (FAO, 2019).

In cereal growing locations of Nigeria, most varieties of the crop are planted in June, and harvested during November or December (PROTA, 2014). The crop is well adapted to local growing conditions of Plateau, Niger, Nasarawa, Bauchi, Gombe, Kebbi, Abuja and Kaduna States of Nigeria where conditions in most areas are warm and arid for most of the year (Animasaun *et al*., 2014). Plateau State with annual production of 20, 000 tonnes of fonio grains is regarded as the highest producer of the crop in Nigeria (Bashiri *et al*., 2013). In these states fonios are major constituents of their cereals diet or a huge component of it (NAP, 2016).

Fonio is a fast growing, drought tolerant cereal, a factor which could make it assume a greater importance as a potential component of tropical farming systems for food security given the challenges of extremes of environmental conditions due to climate change (Animasaun *et al.,* 2014). They are also tolerant to marginal or acid soils occasion by aluminum ion toxicity as in Futa Djalon area of Senegal; the crop produces small-sized good tasting, low glycemic index, sulphur amino acids-rich grains (Del Coro, 2019). However, this valuable crop is grossly overlooked in many agricultural development programmes for indigenous crops of the region, neglected and poorly researched (Durand, 2008; Del Coro, 2019). For instance, NAP (2016) noted that only 19 brief scientific papers were published on fonios from 1976-1996. Therefore the objectives of this review are to sensitize growers on the prospects and constraints of fonios (*D. exilis; D. iburua*) in the farming systems; pinpoint their nutritional significance in diets of peoples of tropical households in Africa south of the Sahara and highlight gray areas that could stimulate researches geared towards improvement of the crop.

METHODOLOGY

Data presented in this work were generated from searches on the subject matter from current literature conducted in the databases of ResearchGate, Google and Google Scholar based on the methodology adopted by Mgbeahuruike *et al*. (2017; 2018) and Enyiukwu, (2019). The search terms amongst others included description and distribution of fonios, significance of fonios in farming systems, African diets and health, constraints and prospects of growing fonios etc. Published papers and other useful materials presented on some URLs from 19 - 2018 were considered for inclusion for review in this work. However, papers and other materials not written in English or written in English prior to the above timeframe tailored for consideration of materials for review for this work were excluded from consideration.

Why grow fonios?

Fonios in ethno-botanical and phyto-therapeutic systems

Fonios are important ethno-botanic plants that have been used for treating a variety of sicknesses in farm-families of rural settings in West Africa. The crop is reputed to have played important roles in the development of

Figure 1: (From top left to right) Fonio growing in the field, fresh immature panicle of fonio (From mid left to right) mature drying paddy on panicles, dried paddy Sources: Koreissi (2015). (From bottom left to right). White fonio processed grains, black fonio processed grains. Photos: DN Enyiukwu.

traditional medicine in the sub-region (Ballougo *et al*., 2013). In traditional medicine fonios are used for treating health challenges bordering on blood clotting due to post-partum bleedings, accidents or injuries. They are also used for the treatment or management of chronic diarrhea, chicken pox, and stomach ache, loss of appetite, constipation, dysentery and asthma. In other instances they have been used also as diuretic (Aboukonou-Sagbadja *et al.,* 2006). These wide-spectrum traditional medicinal claims about fonios need scientific justification through targeted and well tailored research.

Fonios in farming systems

Fonios are one of the oldest of the five indigenous cereals (Table 1) grown in the savannas of West Africa (Ezekiel *et al*., 2014). They represent warm season cereals thought to have played significant roles in the development of traditional West African agriculture; being particularly tolerant to droughts, flooding and pathogenic diseases (Ballougou *et al*., 2013). Fonios are adapted to poor, marginal or sandy soils; reasonably tolerate soil reactions, and can do well in areas with low (about 120 mm) annual rainfall. The crop could be established by seed broadcasting; and being low in nutrient demands they are compatible with conventional rain-fed agricultural systems of the tropics; and can grow well in many forms of crop rotation or intercrop systems involving pearl millet, beans, groundnuts or sorghum either as sole or companion crop (Brink, 2006; Adoukonou-Sagbadja, 2010). As fast maturing cereal which could attain maturity 6-8 weeks after planting in some early maturing varieties, fonios effectively contribute to alleviating hunger and poverty during the lean periods between harvest seasons (Enyikwu *et al*., 2014; Del Corro, 2015). Fonios are hardy crop, not easily prone to attacks of pests and pathogenic diseases. Shoot flies (*Atheigona spp*.), stem borer (*C. partellus*), bugs, thrips, grasshoppers and

Table 1: Some indigenous cereals and legumes of West Africa.

Crop Type	Common name	Scientific name
Cereal	Bulrush millet	*Pennisetum typhoides*
	Guinea corn	*Sorghum bicolor*
	Finger millet (*Tamba*)	*Eleucine coracana*
	Rice	*Oryza glaberrima*
	White Fonio (*Acha*, Fonio, Hungry rice)	*Digitaria exilis* Stapf
	Black fonio (Fonio, *Iburu*)	*Digitaria exilis* Stapf
Legume	Cowpea (Southern pea)	*Vigna unguiculata* L. Walp.
	Pigeon pea	*Cajanus cajan*

Source: Onwueme and Sinha, (1991), Jideani, (2012).

white-black plant hoppers (*Sogatella furcifera*) are some insects pests reported to attack the crop in the field (Kaleisekar *et al*., 2017). However, no reports of storage insect pests of whole grains or flours of the crop have been documented in literature. Though some workers belief that the corn and rice storage bruchids *Sitophillus zeamais* and *S. oryze* could attack fonio grains and flour in storage (Personal communication, 2020).

On the other hand, pockets of some fungal diseases such as brown spot (*Dreschlera oryzae*), smut (*Ustilago sp*.) and blast (*Pyricularia oryzae*) have been reported to affect the crop in the field. Nevertheless, neither the extent of damages on the tissues of the crop; nor reductions in their grain yield by these biotic agents was reported in literature. In storage however, though the grains have been reported to be contaminated by diverse genera of mycotoxigenic fungi including *Aspergilli, Fusarium, Mucor, Rhizopus*, and *Trichoderma*; but little or no deposits of fungi-derived toxins on the grains have been documented. Its grain size or possible presence of natural inhibitors of biosynthesis of mycotoxins in the grains has been adduced as reasons to explain these effects (Ezekiel *et al*., 2014). Also, the crop hardly requires application of fertilizers and pesticides to perform well in tropical field conditions. For instance, high rates of N-fertilizers greatly encouraged development and severity of brown spot disease (*Dreschlera oryzae*) on the crop. Combination of low N fertilization and careful application of a synthetic fungicide Kitazine® was noted to result in lower incidence and severity of the disease, higher numbers of panicles and ultimately higher grain yield. Though the crop's seed viability decreases with increasing storage time (about 2 years), the threshed grains could store well for between 5-10 years and remain in good conditions for consumption (Adoukonou-Sagbadja, 2010; Meji and Imolehi, 2013)..

Fonios in animal husbandry

Livestock farming is an integral part of African agriculture. In arid locations of West Africa, thrashes and haulms of fonios are used for feeding large domestic animals like cattle, sheep, goats, donkey and horses (Adoukonou-Sagbadja *et al*., 2010; Animasuan *et al*., 2014). In marginal soils were other cultivated grasses do not grow well, fonios are reported to be planted in such locations to provide pasture or forage for livestock. In fact bran got from threshing fonios are used for the production of feed for poultry. The crop in the overall is noted to provide up to 2.3 million MT of straw each year used for feeding various ruminant animals in the sub-region (Heuze *et al*., 2019). In an evaluation of fonio grains for poultry feed production, Ukam *et al*. (2013) found that substituting maize grains flour with fonio grains flour sufficiently increased broiler starter feed intake, growth rate and weight gain in a dose-wise manner; indicating that grains of fonios are dense in metabolizable energy, amino acids and other nutrients.

Uses of fonios as food and nutritional values of the crop

Millets of which fonios are members ranked sixth amongst the most important cereals in the world (Taylor, 2019). They are appreciated for their good tastes; in fact they are reported as one of the world's best tasting cereals (NAP, 2016). They constitute the staple food or major part of the diets of 4 million of its consumers in West Africa; including the Biram tribe of the Jos Plateau of Nigeria where they are eaten 2-3 times per day over other cereals (Madan, 2010; Adoukonou-Sagbadja, 2010). Fonios are prepared as poriridge, mixed with other cereals, cooked and eaten like rice with stews, used to make couscous and in some cases for brewing local beers and non-alcoholic drinks (Brink, 2006; Adoukonou-Sagbadja, 2010). In diverse African settings fonios are used to make *tuwo, kunu acha* and pudding (Jideani, 2012; Personal Communication, 2020). The crop is rich in varied nutrients, minerals and vitamins. One hundred grams (100 g) of its grains delivers 343 Kcal of metabolizable energy, and contains protein (8.9 g), fat (3.0 g), carbohydrate (75.6 g), fiber (6.2 g), P (234 mg) and Fe (10.0 mg) amongst other nutrients (Irving and Jideani, 1997; Brink, 2006). Studies in Mali and Senegal

Table 2: Amino acids and anti-nutrient contents of 100 g fonio grains.

Phyto-nutrients	Amounts/Quantity Present (mg)
Amino acids	
Methionine	355
Tryptophan	215
Lysine	225
Leucine	1390
Phenylalanine	803
Threonine	389
Valine	614
Isoleucine	508
Non-nutritional compounds	
Tannins	0.18
Phytate	1.03
Oxalate	0.05
Cyanide	0.05

*Source: Brink (2006); Ukam *et al.* (2013)

ranked fonios as low glycemic index foods over whole sorghum; this in addition to being high in composition of minerals and amino acids had given impetus to fonios being recommended for diabetics and lactating mothers by health practitioners in some countries like Nigeria (Bailey, 2011; FFBPR, 2013). The nutritional composition of fonios is presented in (Table 2). The grains are rich in fibre and also contain low amounts (about 1 %) of soluble sugars such as sacchrose, starchyose, raffinose and fructose (Ballougou *et al*., 2013). Fibre is composed of non-digestible, non-starchy polysaccharides. High fibre containing foods noted these authors have the potential to contribute to reduced risk or even incidence of cardiovascular diseases, colon cancer and diabetics. Fonios however contain negligible amounts of some non-nutritional compounds (NNCs) such as tannins, phytate, oxalate and cyanide (Table 2). However, processing by fermentation and cooking such as those adopted by many West African natives in making *akamu, fufu, tuwo* or *kunu* have been reported to reduce contents of these compounds to their barest minimum, while increasing the mineral and proximate contents of the grains (Echendu *et al*., 2009; Ukam *et al*., 2013; Olu-Owolabi *et al*., 2014).

High composition in sulphur-based amino acids such as methionine and cysteine makes fonios good complements to legumes such as mung bean, cowpea, jack bean, French bean etc. methionine aids the liver to process lipids acting as a methyl donor in several essential metabolic reactions. On the other hand, cysteine is a major constituent of hairs, nails and skin; is involved in major detoxification proces of the human body (FFBPR, 2013; Kaleisekar *et al.,* 2017). Fonio grains are gluten-free (Taylor and Emmabux, 2008); this thus makes them possible substitute or complement for wheat in improving the fermentation and sensory attributes in baking sour dough and bread (Bailey, 2011). In the confectionery, fonios are used for making bread and pasteries (Bashiri *et al*., 2010). In a study to find alternative or at least complement to wheat for making bread for diabetics and those allergic to gluten Jideani *et al.* (2014) demonstrated that addition of 2 % yeast, 5 % sprouted soybean flour and 20 % Irish potato starch resulted to consumers accepted fonio (acha) bread devoid of added sugars. These researchers advanced that addition of the sprouted soybean flour made the bread softer, and improved the crude protein content and the overall nutritional quality of the loaves whereas the Irish potato starch effectively improved the gas retention during baking. However, the mean scores of taste, odour of crust, colour of crumbs, texture of crumbs and outward appearance of the loaves in other evaluations decreased with increasing substitution of wheat with fonio flour. In fact, substitution of about 30 % of the wheat with fonio flour gave rise to unacceptable quality bread (Igyor, 2005; Ayo and Nkana, 2007).

Comparative proximate, amino acid compositions of fonios with other cereals and albumin

With the exception of Posso millet (12.5 g/100 g) and Foxtail millet (12.3 g/ 100 g), 8.9 g of protein in fonios compares favourably with 8.3 g, 7.3 g and 7.7 g for 100 g of kodo, finger, and little millets respectively (Jideani, 2012). Compared to finger and pearl millets, fonios are richer in content of phenylalanine. This amino acid is required for various brain chemicals, thyroid and thyrosine. Generally wheat, oat, barley, rice, rye and sorghum are reported to be deficient in certain amino acids namely cysteine and methionine; which amino acids however are present in fonios being even greater in quantity compared with pearl millet, sorghum and modern processed rice (Adoukonou-Sagbadja, 2010; Bailey, 2011; FFBPR, 2013). FFBP (2013) and Del Coro (2019) reported further that the amino acid profile in general and quantity of methionine and cysteine in particular

contained in fonios is similar and twice that present in whole egg albumin respectively. However, 3.7 mg/100 g methionine reported for fonios is closely marked by 3.1 mg/100 g obtained from finger millet (Jideani, 2012). Hence fonios are a good source concluded Koreissi (2015) of metabolizable methionine to detoxify cyanides from cassava based recipes. Other amino acids contained in higher amounts in fonios comparative to other cereals are glycine, glutathione, proline and leucine; but the grains are relatively low in content of lysine (Glen *et al*., 2013). Above all, fonio protein is reported to present better digestibility than those of sorghum and other millets (Koreissi, 2015).

Starch granules of this crop are polygonal in shape and are relatively smaller than the starch granules of wheat and contain about 22.6-26.1 % amylases (Serna-Saldivar and Espinosa-Raminez, 2019).

Fonio starch has low glycemic index than other cereals due to its branched chain carbohydrates that releases glucose units slowly into the blood stream, to keep a steady sugar level in the body, the reason why it could be eaten by diabetics (Ballougou *et al*., 2013; Koreissi, 2015).

Fonios contain significant amounts of vitamins and minerals. In terms of minerals, the mean mineral value of 1.4 g reported for fonio compares favourably with values of 2.7 g, 1.9 g and 1.5 g per 100 g of finger, prosso and little millet respectively, but it is inferior to mean mineral contents of 4.4 g and 3.3 g detected in barnyard and foxtail millets respectively (Jideani *et al*., 2014).

Compared with other West African cereals fonios are richer in vitamins B_1, and B_2, Mg, Zn, Fe and Mn. Though they have higher Ca and K values than what obtains in white rice (Ballougou *et al*., 2013), they were considered to be low in content of Sn, Mn and Ca compared to other kinds of millet grains.

It is noteworthy that potassium plays essential role in maintaining normal functioning of all human cells, DNA and ATP and phospholipids. The grain is made up of glume, tegument, endosperm and embryo.

The endosperm consists of polyhedral starch granules measuring 2-3 µm in diameter (being smaller to those of rice); impregnated with lipids and proteins which increased progressively towards the center of the grain. The embryo and scutellum are also rich in amounts of protein and lipids and contains globoids composed of crystals of Ca, Mg and double salts of myoinostol hexaphosphates unlike cool season cereals such as oat, barley and wheat where these substances occur in the aleurone layer (Ballougou *et al*., 2013).

About 2 mg/g of polyphenolics was detected in fonios which compares well with values of 2.3-3.2 mg/g for rice, 1.29 mg/g for wheat and 1. 4 mg/g for oats (Glen *et al*., 2013). Glen *et al*. (2013) also detected some fatty acids namely oleic acid (47.4 %) and linoleic acid (30.5 %) in fonio grains, but noted that they are poor sources of α-linolenic acid compared to other cereals or legumes.

Constraints and challenges of fonio production, adoption and utilization in some parts of West Africa

The crop is prone to logging; this affects its yield and makes harvesting the crop to be difficult. Harvesting and postharvest activities are regarded as the most labour-intensive phases in the production line of fonios (Adoukonou-Sagbadja, 2010). The crop is extremely small-seeded; and prone to seed shattering which is reported to result in about 25 % yield losses in delayed harvested fields. Being small seeded, it takes about 1 h to manually mill and clean up to 2 kg of fonio grains (Durand, 2008). Dehusking and seeds dehulling machines for the crop are scarcely available making effective processing and marketing of grains of the crop to be greatly constrained (Bashiri *et al*., 2010). To this end Durand (2008) held the opinion that dehusking machines will make fonio processing easier, quicker, which will in the long run translate to increased production and returns on investment.

Biotic pressures from some species of *Heministhoporium, Sphaerosperma, Phyllachora* and especially the rust fungus (*Puccinia cahuensis*) and *Striga rowlandi* could typically or potentially challenge meaningful production of this crop in the fonio growing areas (Maji and Imolehi, 2013).

The crop is relatively unpopular compared to other cereals like rice, wheat, maize, sorghum and millet and cash crop like cotton. And over time, production of fonios has depended on the use of well adapted but low yielding landraces. There exists no germplasms for the crop; and there is generally low level of information on the biology, degree and organization of genetic diversity and heritability of agronomic traits present in the crop. The combined effects of these factors have made the crop to command low research and crop improvement attention (Brink, 2006; Adoukonou-Sagbadja, 2010). Some workers argue that poor documentation of improved husbandry practices for the crop contributes to the low yields reported for the crop in the region (Bashiri *et al*., 2010). Moreover, generally speaking the crop is not well studied (Del Coro, 2015); and consequently there are little scientific literature about the crop, making fonios not well known outside Africa and hence unpopular amongst western researchers (Bailey, 2011; Del Coro, 2015).

Goitrre was endemic in some parts of Guinea where fonios constitute the staples of the population. The disease is known to be triggered by iodine deficiency or presence of certain anti-nutrients such as thio-glucosides and hydrogen cyanides (HCN) in foods which can cause some forms of iodine uptake dysfunction or its organic binding and thus unavailability. Presence of certain flavonoids – epigenin (150 mg/kg) and luteolin (350 mg/kg) in fonio grains with demonstrable inhibitory activities against human thyroid peroxidases have been reported. And thus these compounds were suggested to be the underlying incitants of the goiter epidermics in

Guinea (Starlet *et al*., 1996). Another very important factor to consider as constraint to its consumption and utilization is allergy and repeated stomach discomfort following each consumption of fonio-based diets (Personal communication, 2020). This warrants careful investigation to identify, isolate and characterize the compound(s) responsible for this purported allergic claim on the consumers.

Prospects of fonios as economic and health cereal crop

Fonios are easily adaptable, easy to grow crop; which survives in marginal and acid soils, too poor for pearl millets and sorghum (Taylor and Emmabux, 2008). They are amino acid-packed grains and highly digestible cereal. Though widely agreed to be nutritious, however, the crop has long been neglected in many agricultural programmes. Their medicinal properties especially as it relates to their anti-diabetic activities warrant that strong research interest to be devoted to the crop. Moreover, high demand for processed fonio grains exists in many Francophone and Anglophone countries (Jideani, 2012), therefore fear for delayed or no returns on investment on research will be unfounded.

Being prone to lodging, seed shattering and poor yields compared to popular corns and sorghum, conventional breeding and genetically engineered improvements on the crop to offset these shortcomings. It follows also that such breeding programmes especially marker assisted breeding should seek to isolate, delete or silence the gene responsible for the production of the flavonoids (epigenin and luteolin) thought to play roles in human goiter outbreaks in Guinea.

Harvesting and postharvest processing has been reported as the most difficult phase of the production of the crop. Hence, de-husking (de-hulling) and de-stoning machines will in no small measure contribute to ease of processing and increased grain production. Therefore, many non-governmental organizations (NGOs) should borrow a leaf from USAID which has been involved in helping fonio growing women in Senegal to access some of these machines (Madan, 2010)

Industrial applications of fonios in the confectionary and pharmaceutical industries have been reported (Jideani, 2012). Being of high starch quality, use of fonio starch as inert materials in formulating pharmaceutical tablets have been reported and should be encouraged as a means of saving scarce foreign resources in the region (Muazu *et al*., 2010).

Conclusion

Fonios are the oldest indigenous cereal crop of West Africa; thought to be one of the best tasting cereals in the world. They are hardy, tolerant to marginal and acid soils; drought or flooding and less prone to insects and pathogenic disease attacks and mycotoxin contamination. However, they are susceptible to logging; the crop has not featured prominently in indigenous agricultural crop improvement programs and is little known outside the shores of SSA. Irrespective of its botanical goodness, so far only a little more than 19 research articles were published on the crop for about 20 years. Even a comprehensive nutritional composition of the crop unlike others cannot be found in major nutritional databases like the USDA. All these put together makes the crop an inviting specimen for both classical and biotechnological attention ranging from its agronomy, seed size enhancement, plant health management, anti-logging, anti-nutrients and nutritional profile, health benefits, pharmaceutical properties, value chains and scientific validation of its phyto-therapeutic activities and mycotoxins inhibitors.

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