Potentials of Hausa Potato (Solenostemon rotundifolius (Poir.) J. K. Morton and Management of its Tuber Rot in Nigeria

By

Enyiukwu D. N.
Awurum A. N.
Nwaneri J. A.
Review Article

Potentials of Hausa Potato (*Solenostemon rotundifolius* (Poir.) J. K. Morton and Management of its Tuber Rot in Nigeria

*1*Enyiukwu D. N., *1*Awurum A. N. and *2*Nwaneri J. A.

*1*Department of Plant Health Management, Michael Okpara University of Agriculture, Umudike, P.M.B 7269 Umuahia, Abia State Nigeria.

*2*Lesser and Minor Root Crops Unit, National Root Crop Research Institute Umudike, PMB 7006 Umuahia, Abia State, Nigeria.

*Corresponding Author’s Email: enyidave2003@gmail.com, Tel: +234 803 744 6891

ABSTRACT

*Solenostemon rotundifolius* (Poir) J. K. Morton commonly called Hausa potato in Nigeria, is a herbaceous, annual crop, with distinctive fragrance and peculiar tuber taste. Ethnomedicinally, leaves of the crop are used to treat dysentery, blood in urine and eye disorders. The tubers are eaten as a main starchy staple or part of it in combination with legumes, vegetables or cereals. The crop which is popular in the middle belt and Northeastern Nigeria, is constrained by edaphic factors, extremes of climatic variables and biotic pressures resulting in tiny tuber formations, tuber branching, low yields and poor tuber storability due to rots and poor storage methods. Amongst these, rots have been identified as the greatest constraint; followed by dearth of documented information on proper methods of its storage. Synthetic fungicides are veritable agents of fungal rot control; however their use is being de-emphasized due to ecological and human health concerns occasioned by residues in crops as well as development of resistance to chemical control agents in pathogens. Phytopesticides have been advocated as viable alternatives for tuber rot control. However, their use has not been sufficiently researched on Hausa potato. Besides, the phytochemical constitution of the leaves and tubers of the crop underpinning their fragrance, peculiar taste and ethnomedicinal uses have not been fully documented. So are the mineral and vitamins composition of the tubers. Poor scientific research attention is considered as the reason for the poor performance of some tuber crops in Africa, both in the field and store. If given adequate and focused research attention, Hausa potato as a delicate vegetable crop holds prospects for enlarged adoption into other agro-ecological zones of Nigeria, and thereby contribute to food security. This communication therefore enumerates the importance of Hausa potato and presents significant researchable opportunities on the crop.

Keywords: *Solenostemon rotundifolius*, *Coleus rotundifolius*, *Plectranthus rotundifolius*, Hausa potato, Frafra potato, rots.

INTRODUCTION

*Solenostemon rotundifolius* (Poir) J. K. Morton (Synonyms: *Plectranthus rotundifolius* Poir, *Coleus rotundifolius* A. Chev and Perrot, *C. parviflorus* Benth, *C. dysentericus* Buk., *Plectranthus tenatus* Sims, *Germania rotundifolius* Poir) (Common names: Hausa potato, Frafra potato, Sudan potato, Zulu round potato. Coleus potato, Chinese potato) is a member of the Family Lamiaeae (*Labiatae*) (Mint family) which consists of heterogeneous assemblage of over 300 plants. According to Blench and Dendo (2004) there is a confusing plethora of taxonomy about this crop, being reported under the genera *Coleus*, *Plectranthus* and *Solenostemon*. Its local names also vary with geographic locations, for instance while in Ghana it is known as Salanga potato, in Nigeria it is called Hausa potato. Hausa potato is a small herbaceous annual crop (Alleman, 2002; Dupriez and De Leener, 1989; PROTA, 2013). The crop is thought to have originated in Kenya or Ethiopia in East Africa from where it spread throughout tropical Africa through the savannas of Togo, Guinea and then into Southeast Asia including India, Sri Lanka, Malaysia and Indonesia (Harlan et al., 1976). Hausa potato is a small herb that has prostrate or ascending succulent stems and branches. It attains a height of 15-30 cm and presents a distinctive, distinctive, lightweight odour due to presence of volatile oils in the glands or sacs of its leaves (Alleman, 2002; Phungpanya et al., 2013). The flowers are small and may be white, blue, pinkish or pale violet in colour, being borne on distal inflorescences with slender false spikes measuring up to 15 cm in length. These flowers are hermaphrodite and the fruits consist of four nutlets which rarely develop. In Africa today, cultivation of this crop is mostly limited to Burkina Faso, Eastern Mali, Northern Ghana and South Africa. In Nigeria, Hausa potato is still popular in the middle belt and Northeastern regions of the country especially around the states of Bornu, Taraba, Nasarawa, Jos Plateau and Kaduna. On the world scale, the crop is the most widespread of the cultivated Lamiaeae
Hausa potato is an important crop which has contributed immensely in alleviating poverty, hunger and starvation in various farm-families. Properly directed researches to find solutions to the many agronomic and storage-health challenges besetting the crop are imperative; towards making the crop to achieving its full quantitative and qualitative yields potentials and contributing immensely to the drive for food security in Nigeria.

Tuber rot diseases are controlled using synthetic chemical agents such as captan, borax, napthalene acetic acid and orthophenylphenate (Okigbo and Nmeka, 2005). Synthetic chemicals remain the most popular and effective means of controlling plant diseases. However, following their obvious demerits such as residues in crops and environment, and the attendant mammalian toxicity and development of pathogen resistance to some of the most effective fungicides etc., alternatives are being sought in agriculture. Such alternatives include microbial antagonist and plant-based pesticides. The challenge with bio-control however, lies in developing safer and acceptable formulations and application methods that can be used on a broad scale in agriculture (Supraptap, 2012). Many higher plants on the other hand in plant health management are being screened for pesticidal properties and their effects against storage fungi (Amadioha, 2004; Enyiuwku and Awurum, 2013). These plant-based preparations are cheap, easy to prepare and use by all classes of growers especially in the developing countries of the tropics (Awurum and Enyiuwku, 2013).

Hausa potato is an important crop which has contributed immensely in alleviating poverty, hunger and starvation in various farm-families. Properly directed researches to find solutions to the many agronomic and storage-health challenges besetting the crop are imperative; towards making the crop to achieving its full quantitative and qualitative yields potentials and contributing immensely to the drive for food security in Nigeria.

According to Taiga (2011), 40% of yams are lost to postharvest spoilage organisms and rots. Some of rots and spoilages represent the greatest constraints to tuber production in Nigeria (Alexandratus, 1995; Taiga, 1999). Tubers of the crop provide essential dietary and energy requirements to the populace during the lean periods. The tubers taste similar to Irish potato and trifoliate yam, and can be eaten as the main starchy staple or part of it in combination with legumes, rice and vegetables. It can also be prepared in Indian and African cuisines as boiled, baked or fried (Schipper, 2000; Wulung et al., 2000). Some workers reported that the tubers of Hausa potato can be used to make aromatic, alcoholic beverages (Schipper, 2000; Phungpanya et al., 2013) while the leaves sometimes may also be eaten as pot-herbs (PROTA, 2013). Compared to other tuberous staples in Nigeria, the tubers of this crop are rich in protein, vitamins and minerals. One hundred grams of the raw tubers contain water 76%, carbohydrate 21%, protein 1.4%, fibre 0.7%, fat 0.2%, and ash 1.0% amongst other important nutrients (PROTA, 2013).

Yields averaging 5-15 MT/ha have been reported from the crop in Ghana and Nigeria. The potential yield of the crop could be up to 18-20 MT/ha (PROTA, 2013). A study in South Africa however, indicated that potential yield from the crop may amount up to 45 MT/ha under favourable conditions of rains, soil fertility and texture (Jansen, 1996; Nkansah, 2004). Such optimum yields could be obtained on well drained light sandy loams while heavy soils prone to waterlogging are unsuitable for the crop. Hausa potato may be propagated vegetatively by suckers or like cassava by soft woody stem cuttings as well as by tubers as yams and cocoyams. However stem cuttings are scarcely used. Plantings are done on mounds, ridges and on flats in well drained locations at the beginning of the rains as sole crop or intercrop with maize, yam, millet, sorghum and Bambara groundnut (Apoobl, 1997; PROTA, 2013). The ridges are incorporated with farmyard manure, wood ash, cattle dung and/or inorganic fertilizers (Tetter and Guo, 1993; Ololoye et al., 2005).

Tuber yield from the crop have been reported to correlate strongly with amount and regularity of rain (Nkamah, 2004). A well distributed rainfall of 1000mm have been reported sufficient for the crop while excessive rainfall which could lead to waterlogging is detrimental to its tuber development (Gubber and Denton, 2004; Alleman, 2002). Besides these climatic constraints, Hausa potato is attacked by various pathogens leading to tuber quality reduction, yield losses and rots. These diseases include nematode infestations, virus molting, scab and tuber rot (Okorocha et al., 2006; PROTA, 2013). Root knot nematodes have wide host ranges and have been associated with lesser root crops including Hausa potato (Okorocha et al., 2006). It galls affected roots, impairs water and nutrient uptake by the crop, reduce marketable root yield and quality, and results in total crop failure in severe cases (Jonathan and Hedwig, 1991; Asawalam and Adesanya, 2001). Infestation of root tubers by root knot nematodes in the field in addition to abrasions sustained during harvesting, strongly predispose tubers to rapid decay during transit and storage (Okigbo, 2004; Okigbo and Nmeka, 2005; Okigbo et al., 2009). A variety of fungi are known to cause important diseases in crops. For instance, besides causing charcoal root rot, stem cankers, stalk rot etc. in 500 plant species, Macrophomina phaseolina incites tuber rots in a number of tropical tuber crops such as sweet potato and yam (Amienyo and Ataga, 2007; Nahunnaro, 2008). Postharvest rots and spoilages represent the greatest constraints to tuber production in Nigeria (Alexandratus, 1995; Taiga, 2011). According to Taiga (2011), 40% of yams are lost to postharvest spoilage organisms and rots. Some of these organisms include species of Fusarium, Colletotrichum, Geotrichum, Penicillium, Heminiththorpium, Alternaria, Pythium, Phytophthora, Erwinia and Staphylococcus. Recent investigations in Yola, Northeast Nigeria showed that Fusarium oxysporum, Aspergillus niger, Penicillium expansum and Rhizopus stolonifer were implicated with tuber rot of Hausa potato (Mohammed et al., 2013a; 2013b). Preliminary studies into the cause of rot of tubers of the crop in Southeast Nigeria suggested the association of Colletotrichum spp. with rot of the tubers in storage in the zone (Nwaneri, 2013). However organisms responsible for the spoilage and rot of Hausa potato have not been fully documented.

Tuber rot diseases are controlled using synthetic chemical agents such as captan, borax, napthalene acetic acid and orthophenylphenate (Okigbo and Nmeka, 2005). Synthetic chemicals remain the most popular and effective means of controlling plant diseases. However, following their obvious demerits such as residues in crops and environment, and the attendant mammalian toxicity and development of pathogen resistance to some of the most effective fungicides etc., alternatives are being sought in agriculture. Such alternatives include microbial antagonist and plant-based pesticides. The challenge with bio-control however, lies in developing safer and acceptable formulations and application methods that can be used on a broad scale in agriculture (Supraptap, 2012). Many higher plants on the other hand in plant health management are being screened for pesticidal properties and their effects against storage fungi (Amadioha, 2004; Enyiuwku and Awurum, 2013). These plant-based preparations are cheap, easy to prepare and use by all classes of growers especially in the developing countries of the tropics (Awurum and Enyiuwku, 2013).
Therefore this work reviews the potentials of Hausa potato (*Solenostemon rotundifolius* Poir) J. K. Morton and management of its storage tuber rot in Nigeria.

**POTENTIALS AND PROSPECTS OF RESEARCH IN HAUSA POTATO**

**Source of important nutrients**

Recent anthropological proposal assumes that human evolution is significantly tied to dependence on tubers (Schoeninger *et al.*., 2000). Hausa potato is one of the lesser root crops and is generally a women-grown crop (NRCRI, 2006; Dung *et al.*, 2010). The tubers are thin skinned, cylindrical in shape and weights approximately less than 100g (Ukpabi *et al.*, 2011). Others are *Plectranthus esculenthus* (Rizga), *Ampelocissus granti* (Rogon Daji), *Curcuma longa* (Tumeric) and *Tacc leotapetaloidae* (Arrow root). Consumption of root and tuber crops are higher in developing economies where food problems are not only quantitative (food production being less than food demands) but qualitative (deficient in nutrients and calories) as well. It is now increasingly realized according to Idusigie and Olayide (1975) that inadequacy of food calories in diets as well as protein deficiency contributes to malnutrition in Nigeria. Lesser root crops can contribute to food security being high in caloric values and other essential nutrients (Kana *et al.*, 2012). Hausa potato plays a very significant role in providing the dietary and energy requirements of the local people during lean periods. The crop is rich in major and minor nutrients and all the nutrients are reported to be essential for proper functioning of the body (Kana *et al.*, 2012). In addition, Hausa potato plays the role of a substitute for sweet potato in most parts of Africa. Aside of being quantitative, food problems remarked Kana *et al.* (2012) could be qualitative in which case the ingested food fails to meet the calorific and nutrients demands of an individual. According to Alleman (2002) the content of 14% protein in Hausa potato on dry matter basis, for instance compares well with Irish and sweet potatoes as well as other tuber crops. The principal amino acids present in the protein of the crop are arginine, aspartic and glutamic acids (Appropedia, 2013). The tubers are also a rich source of dietary energy and 100g of the tubers provides 392-394KJ of metabolisable energy (Schoeninger *et al.*, 2000; PROTA, 2013) and mean starch percentage of 28.62 on dry matter basis of less than 100 gram tuber (Ukpabi *et al.*, 2011). A standard serving dish of the crop is reported to provide in addition, a large proportion of the daily requirements of calcium, vitamin A and iron. Dietary iron, calcium and vitamin C for instance have been recommended in preventing lead poisoning especially for those living in industrialized areas (Afolabi *et al.*, 2012). Inadequate quantity of food (those deficient in calories) and not merely protein deficiency is reported as the cause of widespread protein-calorie malnutrition, since with insufficient calories, protein in diets is used to supply energy instead of fulfilling its body building roles (Idusigie and Olayide, 1975).

The comparative yield of nutrients and minerals of major tuber staples are presented in Table 1. The crop holds potentials as seen from Table 1 to meet the calorific needs of an average Nigerian. Besides, recent organoleptic evaluation of the mealy boiled tubers and crispy fried French fries from the tubers were found generally acceptable by sensory assessors (Ukpabi *et al.*, 2011). Hausa potato can be used in the confectionery industries where it could act as colouring agent in bread production. At 10% substitution of wheat with its flour, no significant difference was observed in all the sensory attributes of taste, texture, and general acceptability of the bread produced from the composited flour (Aniedu and Agugo, 2010). Disintegrants such as starch and cellulose aids in breaking of tablets into smaller fragments in a fluid environment prior to dissolution of the active principle of the drug and its absorption in the gastro-intestinal tract. A trial in Maiduguri by Muazu *et al.* (2012) found that the starch of Hausa potato compared well to Maize starch BP in the formulation of paracetamol tablet excipient both in disintegration and dissolution times. A viable raw material no doubt in pharmaceuticals. However, being a starch-rich staple biochemical studies to determine its tolerance by diabetics is urgently warranted for the confectioneries.

Generally, several researchers agree that there is strong need to give greater prominence to root and tuber crops development especially the under-utilized and neglected species, in the agricultural scheme of things to meet economic, quantitative and qualitative nutritional needs of the nation (Idusigie and Olayide, 1975; Olojede, 2013).

**Table 1: Comparison of nutrient contents of major tuber staple foods in Nigeria**

<table>
<thead>
<tr>
<th>Component/100g portion</th>
<th>Yam</th>
<th>Cassava</th>
<th>Cocoyam</th>
<th>Sweet potato</th>
<th>Potato</th>
<th>Hausa potato</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (KJ)</td>
<td>494</td>
<td>670</td>
<td>594</td>
<td>360</td>
<td>322</td>
<td>394</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>1.5</td>
<td>1.4</td>
<td>0.52</td>
<td>1.6</td>
<td>2.0</td>
<td>1.3</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>0.17</td>
<td>0.28</td>
<td>0.11</td>
<td>0.05</td>
<td>0.09</td>
<td>0.20</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>28</td>
<td>38</td>
<td>34.6</td>
<td>20</td>
<td>17</td>
<td>21</td>
</tr>
<tr>
<td>Fibre (g)</td>
<td>4.1</td>
<td>1.8</td>
<td>5.1</td>
<td>3.0</td>
<td>2.2</td>
<td>1.1</td>
</tr>
<tr>
<td>Sugar (g)</td>
<td>1.5</td>
<td>1.7</td>
<td>0.49</td>
<td>4.18</td>
<td>0.78</td>
<td>-</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>17</td>
<td>16</td>
<td>18</td>
<td>30</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>17.4</td>
<td>20.6</td>
<td>2.4</td>
<td>24</td>
<td>19.7</td>
<td>1.0</td>
</tr>
<tr>
<td>Thiamine (mg)</td>
<td>0.11</td>
<td>0.09</td>
<td>0.11</td>
<td>0.08</td>
<td>0.08</td>
<td>0.05</td>
</tr>
</tbody>
</table>
Riboflavin (mg)  0.03  0.05  0.28  0.06  0.03  0.02  
Niacine (mg)  0.55  0.85  0.51  0.56  1.05  1.0  
Iron (mg)  0.54  0.85  0.72  0.61  0.78  6.0  
Vitamin A (IU)  138  13  -  14138  2.0  -  
Beta-carotene (mcg)  87  8.0  -  8509  5.0  -  
Vitamin B6 (mg)  0.29  0.09  0.331  0.21  0.30  -  
Pantothenic acid (mg)  0.31  0.11  0.336  0.80  0.30  -  
Folate (Vit. B9) (mg)  23  25  9  11  16  -  
Vitamin E (mg)  0.39  0.19  2.93  0.26  1.10  -  
Magnesium (mg)  0.40  0.38  30  0.26  0.15  -  
Potassium (mg)  816  271  484  337  421  -  
Phosphorus (mg)  55  27  76  47  57  -  
Zinc (mg)  0.24  0.34  0.27  0.30  0.29  -  

Sources: Schoeninger et al., 2000; Wikipedia, 2013; PROTA, 2013
Key: - = not determined

Yield of the crop

Hunger reported by Kana et al. (2012) stares most third world economies in the face because of their inability to modernize their agriculture. Due to extreme poverty remarked this source chronic hunger is commonplace in these nations. It is a known fact that nearly 1 billion people the world over are seriously affected by hunger, out of which 10 million hunger-related deaths occur annually. Many of these low-income, food deficient nations particularly in Asia and SSA may have relied on few crop species for their food supply to the detriment of lesser known crop plants. Lesser root crops hold potentials to serve as sources of foods, raw materials, animal feed, medicines and industrial raw materials for these nations. Hausa potato like aerial yam can be cultivated with very little attention. They require low inputs hence contributing to sustainable agricultural production (Blench and Dendo, 2004; Kana et al., 2012). The crop takes 5-6 months to mature in the field and like cassava provides a wide harvesting window since it can be left in-field for ½-2 years post-maturation and can be relied upon during famine or civil unrest (Kana et al., 2012) However, farmers usually grow this crop around homesteads, long farm boundaries and marginal lands with little agronomic attention paid to them. They also follow indigenous crop husbandry methods which culminate ultimately to low yields. Reasons behind the low yields are traceable to farmers’ non-adoptions of improved crop production techniques and lack of improved and high yielding varieties of the crop as well as lack of capital for acquiring improved inputs (Dung et al., 2010; Abate et al., 2011). Lack of cultivars tolerant or resistant to water logging, submersion or flooding has been advanced as other yield non-enhancing factors (Bill and Melinda Gates Foundation, 2011). Comparative yield values of the various tuber crops in Nigeria are presented in Table 2.

Hausa Potato

![Hausa Potato Farm in Manchok, Kaduna State](image)
![Hausa Potato Field at NRCRI, Umudike](image)
![Hausa Potato on Display at Gombi Market, Adamawa State.](image)
In Nigeria mean yield range of 7-15 MT has been reported from Hausa potato. As seen from Table 2, at N300 (nearly US$2.00) per kilogram of tubers of Hausa potato, the crop could impart the farm economy to the tune of 2.1-4.5 million Naira (US$ 14,000-30,000) all things being equal. Similarly, its potential yield in Nigeria has also been reported at 18-20 MT/ha, in which case it translates to 5.4-6.0 million Nigerian currency (US$ 36,000-40,000). Higher potential yield of 45 MT has been reported from the crop in South Africa. And besides its nutritional attributes the crop holds strong economic potentials and could be financially rewarding to the farm economy (Table 2). Being a mid-duration crop two cycles of its production in both sole and intercrop production systems are feasible in our agro-ecological zones. Which no doubt would translate to several millions of financial returns to its growers. From the foregoing therefore, one agrees with Olojede (2013) that Hausa potato holds strong potential to becoming a commodity crop for food security, poverty alleviation and economic growth in Nigeria. However, neglect of scientific research attention, funding and capacity building with reference to Hausa potato and other lesser root crops informed their neglect and under-utilization. According to Anonymous (2004) neglected and underutilized crops have great potential in the future sustainable food system. Many workers argue that they can contribute to improved and increased farm economy (Kana et al., 2012; Mohammed et al., 2013b). Especially if given adequate research focus remarked some investigators (Talwana et al., 2010). The use of resistant varieties is the first major way of tackling recalcitrant abiotic and biotic constraints to crop production. It is considerably cheap, easy to use and integrable with wide ranging crop production systems. The tuber yield and production of Hausa potato can be increased by breeding the crop for resistance to edaphic and climatic extremities such as water logging or aridity and drought. This has been achieved in some companion crops. For instance in the Sudan and Sahel agro-ecologies Bill and Melinda Foundation (2011) reported that maize varieties instance in the Sudan and Sahel agro-ecologies Bill and Melinda Foundation (2011) reported that maize varieties suitable for growers in the region that are tolerant or resistant to extreme aridity have been developed while rice cultivars capable of tolerating and surviving submersion under floods for up to 2 weeks are currently being circulated in South Asia.

With respect to Hausa potato breeding for increased tuber size is imperative. Tuber size tends to put the crop at a disadvantage vis-a-viz rizga (P. esculentus). Besides, tuber branching is another discouraging parameter against the crop. It behoves breeders to develop high yielding varieties with non-tuber branching capacity in addition to withstanding the vagaries of the weather. Many varieties of Hausa potato in circulation today produce tiny and/or branched tubers. Branched, tiny tubers make the crop unattractive and reduce the marketability of the tubers. In general, average yield of the crop is grossly small and does not compare to yields of other tuber crops such as Irish potato, sweet potato, yams, cocoyams and cassava in most farm situations. Cumulatively these constrain the adoption, spread and distribution of the crop in Nigeria. Overcoming these drawbacks through proper germplasm selection, conventional breeding research, genetic engineering and crop modification, human capacity development, education and awareness creation of the benefits of the crop through buttressed agricultural extension services will undoubtedly translate to attaining the potential tuber yield of the crop, higher incomes and improved farm economy (Dung et al., 2010; Talwana, 2012; Olojede, 2013).

**Phytochemical constituents of Hausa potato**

The *Genus Plectranthus* contain 300 plant species which occur in Africa; around half are distributed within SSA while 70% occur in Asia and Australia. The genus is plagued with numerous nomenclatural disharmonies that make it difficult to collate accurate data. *Coleus* is considered as an old name for most members of the genus. The crops in this *genus* may be used as food; food additives for flavouring and marinating beef, chicken, masking strong smells associated with goat, sheep and spicing tomato-rich dishes. The genus serves also as dry season fodder for domestic animals like cattle, camel, rabbit and wild species such as elephant. Most members of the *genus* are frequently used as medicines and are used to treat a range of ailments especially those relating to digestive, skin, infective and respiratory problems (Lukhoba et al., 2006). Hausa potato besides agricultural importance has ornamental, medicinal, culinary and many other uses including perfume making and alcoholic beverages. The plant in addition as reported by Dung et al. (2010) can be used as food protectants in just the same manner as neem (*Azadirachta indica*) and pepper (*Capsicum sp.*). The crop contains saponins and anthraquinones. Saponins have been reported to reduce blood cholesterol levels in humans, and ward off fungal and viral infections. They also impair cell membrane integrity and ensure translocation of macromolecules across cells (Okwu and Njoku, 2009; Kana et al., 2012; Enyiuwku and Awurum, 2013). Hausa potato finds topical application as cicatrizants and antiseptics. In the ethnomedicine of African and Asian countries members of the *Coleus* genera have been reported useful for treating dysentery, blood in urine, insomnia, convulsion, lung

<table>
<thead>
<tr>
<th></th>
<th>Yam</th>
<th>Cassava</th>
<th>Cocoyam</th>
<th>S/potato</th>
<th>Potato</th>
<th>H/potato</th>
<th>Tumeric</th>
<th>Rizga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean yield (t/ha)</td>
<td>11.5</td>
<td>12.5</td>
<td>6.7</td>
<td>13.7</td>
<td>16</td>
<td>7.0</td>
<td>4.7</td>
<td>6</td>
</tr>
<tr>
<td>Potential yield (t/ha)</td>
<td>110</td>
<td>90</td>
<td>110</td>
<td>120</td>
<td>80</td>
<td>45</td>
<td>35</td>
<td>-</td>
</tr>
<tr>
<td>Price/kilogram (Naira)</td>
<td>150</td>
<td>250</td>
<td>250</td>
<td>200</td>
<td>700</td>
<td>300</td>
<td>500</td>
<td>200</td>
</tr>
</tbody>
</table>

diseases, intestinal muscular spasms, glaucoma and heart diseases (Alleman, 2002; Kana et al., 2012; Phunganya et al., 2013; My Agricultural Information Bank, 2013). Monoterpenoids, sesquiterpenes, diterpenes and phenolics have been reported as some of the phytochemicals present in species of the genera Coleus with the abietane diterpenoids being the most isolated from *Plectranthus* spp. Forskolin a high profile cardiographic labdane diterpenoid has been extracted from the roots of the india-grown relative of Hausa potato *Coleus forskolin* (Lukhoba et al., 2006; My Agricultural Information Bank, 2013). Hausa potato has been reported to contain volatile oils, sesquiterpenes and diterpenes. For instance, 11-Hydroxy-12-oxo-7,9(11), 13-abietatriene isolated from *Plectranthus elegans* inhibited the spore germination of the fungus *Cladosporium cucumerinum*. Monoterpenoids including humulene and β-caryophyllene are known for their antimicrobial properties while limonene, β-bisabolene and β-cubebene have anti-febrifuge properties (Lukhoba et al., 2006). In a recent investigation, some researchers have isolated a number of biologically active ingredients from the leaves, stems and tubers of Hausa potato. These are γ-murolene (21%), α-humulene (12.5%), E-caryophyllene (5.67%), n-dodecane (5.55%) and 1-octene-3-ol (4.63%). From the tubers however were obtained epι-α-cardiol (15.52%), sesquiceneole (9.36%), cyperene (4.88%), epι-α-bisabolol (3.0%) and α-santalene (2.25%). These compounds exhibited significant antibacterial activity against *Pseudomonas aeroginosa*, *Escherichia coli* and *Staphylococcus aereus* (Phunganya et al., 2013). It follows therefore that these compounds are the underpinning reasons which explain the ethno-medicinal and plant protection uses of Hausa potato plant leaves. Assessment of the above ground tissue effect of the plant to rots of its tubers in storage is suggested in vitro and in vivo. In an evaluation Okoko and Ere (2012) reported that leaf extract of *Solenostemon monostachyus* exhibited antioxidant activities against free radicals, hydrogen peroxide, and hydroxyl radicals in vitro. And thus, the mode of action of leaf extract of the species *Solenostemon* may be linked to the antioxidant properties of the plant. Subjection of the plant to further screenings for active ingredients in our own environment may prove useful since presence and concentration of these secondary metabolites in a plant are environment-mediated. Secondary metabolites from spices and medicinal plants command on a worldwide scale US$14-20 billion, India alone makes US$60-72 million from them (Sofia et al., 2007; Trade Portal of India, 2013) with EU and the USA being the major importers. Therefore screening and isolation of useful metabolites could improve not only our local pharmaceutical industries but will amount to saving scarce foreign exchange for our local economy.

**Storability of Hausa potato tubers**

Hausa potato in general, has been reported as difficult to store crop (PROTA, 2013; Southern Times, 2013). According to Alleman and Coertze (1997) tubers of the crop do not store well. This may be due to influences from pathogenic rot organisms or enzymes-mediated deteriorations (Okigbo, 2004; Okigbo et al., 2009) particularly in hot tropical sub-saharan Africa (SSA) where lack of storage facilities especially hi-tech storage facilities are unavailable (Dung et al., 2010). Many methods have been devised in traditional farmsteads for storing the tubers. In such systems tubers can be stored in the sand in well ventilated sheds (Appropedia, 2013) or in the ground under a tree where it is cooler than the open, in this way the tubers could retain their aromatic flavour for up to 2 months post-harvesting (PROTA, 2013). In some cases remarked this source tubers of the crop are stored in sacks in-laid with straws though it does not store long with this practice in hot farm conditions of SSA, or in sealed earthen vessels especially in highland regions or South Africa (PROTA, 2013).

Rots lead to reduction in the quality of tubers and storable periods of the crop (Amadioha, 2012). Fungi associated with the rot of Hausa potato tubers are *Apergillus niger*, *Fusarium oxysporium*, *Rhizoctonia stolonifer* and *Penicillium expansum* with frequencies of occurrence as 19.69%, 16.4%, 14.38% and 12.81% respectively (Mohammed et al., 2013a). Infection of the tubers as noted by Mohammed et al. (2013a) leads to discoloration, change in flavor, emission of unpleasant odour and in some cases deposits of mycotoxins in the tubers. Mycotoxins can cause cancer, birth defects, liver diseases and several other health problems (Bankole and Adebamjo, 2003). In a recent investigation Mohammed et al. (2013b) evaluated the response of the tubers to ash of *Anogeissus leiocarpus* wood, saw dust, and chaff of *Sorghum bicolor* as storage media for the crop. They reported *A. leiocarpus* ash to significantly reduce rots of the tuber from 78.81% in the control to 1.56% and remarked that the pathogen *A. niger* was the most resistant to the other treatments. As mentioned earlier, breeding for extended storability of the tubers is imperative towards achieving food sufficiency and security in Nigeria. Conventional breeding, Marker-assisted breeding and molecular/genetic modification of the crop should be fervently researched and pursued to bring about the development of varieties capable of producing tubers that can resist rot pathogens and/or enzymatic deteriorations and store longer after harvesting. Such breeding programs may be collaborative with professionals from other scientific disciplines and will endeavour to prolong the peculiar taste of Hausa potato which is reportedly lost 2 weeks post harvesting in storage (PRORA, 2013). These constraints have consigned the crop to minor root crop and confined its popularity to the middle belt and Northeastern agro-ecological zones of Nigeria. Hence with focused research into the pathologies, agronomic practices and techniques for storing Hausa potato tubers, its popularity and extent of adoption will grow beyond its traditional areas of cultivation, given that the crop has good potential yield values and the tubers have acceptable taste similar to that of Irish potato and trifoliate yam.

Chemical control of pathogenic diseases is one of the most effective means besides use of resistant varieties in the management of diseases of plants. However this approach to disease control has many attendant
drawbacks. According to Tripathi and Dubey (2004) the most important of these drawbacks are the stimulation of development of resistance to fungicides by the pathogens and fungicides residues in crops which leads to intermittent ingestions of toxic chemical compounds from foods. These compounds in the long run get accumulated in the adipose tissues and milk of humans till toxic mammalian levels are attained and death ensues (Enyiukwu, 2002; Taiga, 2011). Other demerits of synthetic pesticides include disruption of the food chain and ecological health (Awurum and Nwaneri, 2010). Plant-based fungicides have been advocated as viable alternatives by several investigators (Enyiukwu and Awurum, 2011; Amadioha; 2012). However relative to Hausa potato and many other minor root crops investigations in this regard are lacking.

A vast range of research opportunities exist therefore in the evaluation of some tropical species against rot and storage pathogens of Hausa potato. In addition, prospect also exist in molecular identification and characterization of the pathogenic entities responsible for rot of the tubers. A similar feet was achieved recently with regard to novel bacterial rot organisms of vegetable sweet potato in southwest Nigeria (Oladoye et al., 2013). Proper pathogen identification is reported essential to tailoring effective management approaches to a given disease problem (Than et al., 2008). For instance, proper pathogen identification is crucial to delaying of appearance of resistance to a fungicidal formula against the pathogen; allowing for proper selection of fungicides with different modes of action to combat the given pathogen than reliance on broad-spectrum, multi-site fungicides (Brown, 2006) which are eco-disruptive (Taiga, 2009; Enyiukwu and Awurum, 2013).

USE OF PLANT-BASED PESTICIDES IN THE CONTROL OF STORAGE TUBER ROT

Fungicides have remained a popular and effective input in agriculture following the discovery of boulouseaux mixture. They reduce attacks and infection from photosynthesis, water and nutrient uptake impairing-organisms in the field, arrest the development of rot of produce in transit and storage as well as discourage or minimize deposition of mycotoxins on stored food products (Suprapta, 2012). According to Amadioha (2004), extracts of Azadirachta indica, Cymbopogon citratus and Ocimum gratissimum effectively checked charcoal rot of potato caused by Rhizoctonia solani. Similarly Amadioha and Markson (2007a; 2007b) reported that phytochemicals derived from Ageratum conyzoides and Piper nigrum checked the rot and deterioration of fresh cassava tuber in storage induced by Botrydiplodia acerina and Rhizopus oryzae in vivo. In a parallel study, Ocimum gratissimum was reported to check the rot of Egusi melon in storage incited by R. stolonifer, Aspergillus niger and Penicillium italicum (Chuku et al., 2011). Taiga (2011) found that 40% aqueous extracts of Nicotinia tabacum inhibited the growth and development of R. stolonifer causing postharvest rot of yams in Northern Nigeria. With regard to sweet potatoes, Tijani et al. (2013) reported that phytochemicals derived from Moringa sp. and A. indica retarded the growth of R. stolonifer, an incitant of rot of yam tubers in Northern Nigeria. In a trial Anukworoji et al. (2012) demonstrated the effectiveness of Allium sativum, Garcinia kola, Azadirachta indica and Carica papaya on rot of cocoyam corms caused by Penicillium spp and other pathogens. Similarly extracts from Dennettia tripetala according to Nwachukwu and Osuji (2008) were fungitoxic and seriously prevented the rot of cocoyam corms in storage. Da Costa et al. (2010) reported that neem seed oil effectively retarded production of aflatoxins B1 and B2 by Aspergillus flavus for up to 95% in culture and the authors emphasized that the extracts possessed strong anti-aflatoxigenic activity. In a related study, Reddy et al. (2010) found that solvent extracts of Zingiber officinale and Oxalis corniculata suppressed both growth and aflatoxin production by the fungus A. flavus while Trigonella foenum-graecum only checked production of aflatoxin by the fungus effectively without inhibiting significantly the growth of the fungus. A comprehensive review of essential oils fungitoxic against aflatoxigenic fungi have been done by Shukla et al. (2012). In like manner, a review of extracts and phytochemicals fungitoxic against rots and rot inducing organisms are presented in Enyiukwu et al (2014a) and the mycotoxins they produce along with their implications on animal and human health have been enumerated (Enyiukwu et al., 2014b). According to Mohammed et al. (2013b) studies in Adamawa state of Northern Nigeria, with ash from Anogeissus leiocarpus wood revealed that it significantly inhibited the development and spread of tuber rot (Apergillus niger, Fusarium oxysporium, Rhizoctoniasolotinifer and Penicillium expansum) on Hausa potato (Solenostemon rotundifolius Poir) in storage for four months. This pioneering research is indicative of prospects of controlling rots and rot-inducing organisms with plant-derived pesticides in this crop. A parallel study demonstrated the fungitoxic properties and antifungal activities of dehydrozigerone (DZ) from ginger on these pathogenic organisms. This compound inhibited their spore germination, reduced their mycelial biomass and lysed or altered their hyphal morphology (Kubra et al., 2012). However, investigations on the control of rots and aflatoxination of Hausa potato tubers; to the best of our Knowledge are scanty and have not been fully documented. And therefore needs to be vigorously researched and adopted.

Comparatively little is known about this interesting crop vis-a-vis other tuber crops such as sweet potato, cassava and yams etc. However, the crop has good prospects as a delicate vegetable crop (PROTA, 2013). Improvements in agronomic technologies for the crop is recommended as well as other high target areas such as increased tuber size, developing non-branching tubers, tubers that store longer and retain their peculiar taste, crop tolerance to waterlogging, aridity, and drought. These research prospects into Hausa potato improvements have become inviting given the challenges of greenhouse gas (GHG) emissions and climate change with
pronounced constraints against crop production and food security; so as to enable the crop contribute its quota to food security in Nigeria and elsewhere. To achieve all these will entail:

- Renewed interest by governments and NGOs to fund scientific research in breeding for Hausa potato improvement
- Studies on the biochemical properties of the nutrient components of the tubers especially carbohydrate to determine its tolerance by diabetics.
- Improved agronomic and management technologies for the crop to increase yields.
- Intensive and aggressive extension services to encourage the crop adoption.
- Incentives to the growers such as zero interest loans to boost their production.
- Value addition in time and utility for the crop.
- Low-tech integrable storage methods and practices for tubers of the crop.
- Low-tech tuber rot control techniques and phyto-pesticides use in its tuber rot management.
- Exploitation of the aromatic and medicinal properties of the crop for pharmaceutical and culinary products development.
- Organized market economy to elevate the crop to cash earning status.

CONCLUSION

Hausa potato holds potential to become an important crop which could be cultivated beyond its present areas of adoption. However, the issues of determining and improving its production techniques demand urgent research attention. Above all, its tubers have been noted as difficult to store due to pathogenic influences. Therefore studies to address these issues to proffer best-practices at overcoming them are imperative. There is need, to develop value chains for the crop to reduce wastages, make available foods of better quality and permit fuller and better utilization of the tubers in national dietaries to ensure food security and improved farm economy.

REFERENCES


PROTA (Plant Resources of tropical Africa) (2013). Solenostemon rotundifolius Poir (Synonyms: Germania rotundifolius Poir, Plectranthus roundifolius Sims) database.PROTA.org/db/w-wpd/exec/db Retrieved November


www.gjournals.org 36
