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Mechanizing *Ugu* (*Telfairia occidentalis)* Production and Postharvest Operations

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Abstract: - *Telfairia occidentalis (ugu)* is an important crop grown for its leaf vegetables and edible seeds. It ranks first among many consumed vegetables in Nigeria, and it brings good returns compared to other common tropical leafy vegetables (TLVs). Currently, producers are finding it difficult to expand their capacity due to the predominant traditional methods of its production and postharvest operations. It is found that the lack of engineering research input is responsible for non-mechanization of *Telfairia occidentalis* production and postharvest operations. Researchers have concentrated on the crop breeding, its dietetics, economics, and food science. In order to boost *Telfairia occidentalis* production and enhance its postharvest operations for the satisfaction of the local market all year round, and for possible export in the global market, the crop mechanization will have to replace the traditional methods. So, development of seed drill / planter, packaging and handling techniques for the pods, seeds and freshly harvested leaves, and designing of pods and seeds storage facilities become a necessity. However, the mechanization can only be achieved if engineering properties of both the pods and the seeds are determined to generate empirical data for design purposes. Besides, effective storage technique for the fresh leafy vegetables needs researchers' attention since the drying method currently in use shows great loss of pigmentation and valuable nutritious constituents.

Keywords: *Telfairia occidentalis*, *ugu*, mechanization, storage, leaf, seed, pod.

I. INTRODUCTION

Telfairia occidentalis commonly known as *ugu*, *iroko* or *apiroko*, *ubong*, *umee*, and *umeke* among the Igbo, Yoruba, Efik, Urhobo and Edo people of Nigeria, respectively, (Akoroda, 1990) is found in the daily diet of most families in eastern Nigeria, and has equally gained wide acceptance in other parts of Nigeria. The seeds and leaves are highly nutritious (Table 1). It belongs to the Cucurbitaceae family. The consumption, which is usually reduced during dry season, because of decline in production, has been improved by the use of irrigation. The pod can contain up to 196 seed (Axtell and Fairman, 1992). The seed contains oil of specific gravity higher than palm oil; and it makes good cooking oil and it is also suitable for margarine production (Agatemor, 2006). Besides, the seed oil, which has high flash point and low pour point, can be used in the production of biodiesel (Bello *et al*., 2011). The high flash point makes it a safe fuel and the low pour point allows it to be used in cold climate. Incorporating boiled fluted pumpkin seeds in diets results to good growth and shows no detectable toxicity in rats (Ejike *et al*, 2010), so the seeds can be used to augment energy and protein requirements of man, especially among rural dwellers. The leaves and shoots, used as food and pasture, are ready for harvest after a month of germination, and subsequent harvest occur every 2–4weeks. (Akoroda, 1990). It is widely used in traditional medicine especially as a hematopoietic agent (Saalu *et al*., 2010). The ability of the plant to combat certain diseases may be due to antioxidant and antimicrobial properties and its minerals (especially Iron), vitamins (especially vitamin A and C) and high protein contents (Kayode and Kayode, 2011). The stem waste can produce activated carbon (Ekpete and Horsfall, 2011). It ranks highest, in terms of net income (Agbugba and Thompson, 2015), among the notable and common tropical leafy vegetables (TLVs) grown in South-eastern Nigeria (see Table 2). Ugu is a dark green leafy vegetable (DGV), and DGVs contain vitamins, minerals, and carotenoids and act as antioxidants in the body. Also, compounds present in GDVs can inhibit the growth of certain types of cancer (Adams, 2013). Therefore, *ugu* is of great benefit to man.

II. SOME RECENT RESEARCH ADVANCES

The interests of many researchers have been drawn to the crop because of its value and wide utilization. Okpashi *et al* (2013) investigated the physico-chemical properties of oil extracted from fluted pumpkin seeds using two different solvents, petroleum ether and n-hexane. They found the following for extraction with petroleum ether and n-hexane respectively: oil yield of 44.67% and 46.20%; saponification value of154 ± 0.08mgKOH/g and 147 ± 0.05mgKOH/g; iodine value of 104.7 ± 0.07mgI_2/g and 104.7 ± 0.07mgI_2/g; refractive indices of 1.4349 and 1.4348, and a peroxide value that is not significantly different ($p>0.05$) for the petroleum extract (0.22 ± 0.00) when compared with n-hexane (0.20 ± 0.01). Akang *et al*., 2010 investigated the potential of fluted pumpkin oil seed to reduce lipid peroxidation and enhance fluidity of cell membrane. Their work was intended to boost male fertility. They divided 24 adult male Sprague-Dawley rats into three groups, A, B and C of 8 each. Group A, which served as the control, received distilled water, while group B and C received 400mg/kg and 800 mg/kg body weight of Fluted Pumpkin Seed Oil (FPSO) respectively for 56 days. Afterwards, the ventricular blood samples, the testis and the cauda epididymis were harvested and analyzed. They observed that fluted pumpkin seed oil improves semen parameters and has little or no effect on testicular histology when administered at a low dose of 400 mg/kg body weight. Saalu *et al*., 2010 evaluated the dose-dependent testiculoprotective and testiculotoxic potentials of *Telfairia occidentalis* Hook f leaves extract in rat. They administered 200, 400 and 800 mg/kg/day oral route *Telfaira occidentalis* leaves (TOL) extract on three groups of Sprague-Dawley rats respectively for 56 days. They found that rats administered with 200 mg/kg of the extract showed improved sperm parameters and a fairly preserved testicular oxidative status. Agbede *et al*., 2008 evaluated the nutritive value of *Telfairia occidentalis* leaf protein concentrate in infant foods. They found that the leaf concentrate is nutritionally adequate, and therefore opined that most developing nations with low economic strength can use it in infant food formulation for weaning. They, however, raised the acceptability challenge of the greenish colour.

Table 1: Nutritive contents and values of ugu seed and leaf

Nutrient	Seed	Leaf
Water (ml)	6.0	86.0
Calories	543.0	47.0
Protein (g)	20.5	2.9
Fat (g)	45.0	1.8
Carbohydrates (g)	23.0	7.0
Fibre (g)	2.2	1.7
Calcium (mg)	84.0	0.0
Phosphorous (mg)	572.0	0.0

Source: Alegbejo (2012)

Ajayi *et al*. (2004), studied the conservation status of *Telfairia* spp in sub-saharan African, and their work aimed at identifying the sex of *Telfairia* spp, by determining seed and seedling makers for sexual differentiation; extend the short-to-medium-term storage potential of seeds by suitable pre-treatments. The effects of climate change on fluted pumpkin production and adaptation measures used among farmers in Rivers State of Nigeria were evaluated by Ifeanyi-Obi *et al*., (2012). They found that unpredictable climate condition changes in rainfall pattern, changes in rainfall distribution, reduced yield of fluted pumpkin and reduction of family income were the major effects of climate change on fluted pumpkin production. They recommended improved extension services and useful / relevant information on climate change and adaptation strategies to be made available to people to obviate these challenges. Opukiri and Nwonuala (2013) were interested in the prevalence of sexes and yield characteristics of hormone induced fluted pumpkin in the humid tropics of Southern Nigeria. They induced the fluted pumpkin seeds with 0, 100, 200 and 300 parts/million (ppm) each of Gibberellic Acid (GA_3), Indole-3-Acetic Acid (IAA), Naphthalene Acetic Acids (NAA) and Ethrel (ET) before planting the seeds.

Table 2: Net income of common tropical leafy vegetables (TLVs) in South-Eastern Nigeria

Selected TLVs	Income (N)	Cost (N)	BCR
Telfairia occidentalis	30,108.23	14,565.44	2.61
Amaranthus cruentus	12,663.59	5,996.50	2.11
Talimum triagulare	1,066.80	300.50	3.55
Vernonia amygdalina	2,564.05	1,000.00	2.56
Solanum nigrum	853.53	388.01	2.20
Ocimum grattisimum	1,600.90	402.20	3.98
Gnetun africanum	23,234.00	11,234.42	2.07
Piper guineense	525.00	150.00	3.50
Gongronema lagitifolium	450.00	100.00	4.50

Source: Agbugba and Thompson (2015).

They reported significant reduction in the number of days before first flower initiation on both males and females to be 94 and 155 respectively. Besides, the highest yield of 2.2kg/vine was obtained using Ethrel 100ppm; the highest seed yield of 90 seeds/pod was obtained with IAA 300ppm; pod yield/vine significantly increased at above 100 ppm for all the treatments. Another important result of their study was the observation that lowest sex ratio male: female of 0.30: 1.00 was gotten with IAA3 300 ppm. This implies that treatment with IAA3 300 ppm will increase the number of female plants / plots of fluted pumpkin and the production of more seeds for propagation. Soyingbe *et al* (2012) investigated *Telfairia occidentalis* waste (leaves and stalk) potential in supplementing the natural low nutrients in compost. Alegbejo (2012) studied the production, marketing, nutritional values and uses of fluted pumpkin in Africa.

III. HARVEST AND POSTHARVEST OPERATIONS

3.1 Harvest

The leaves are harvested by pruning with knife. Harvesting by hand picking damages the plants and hinders development of side shoots (Ubani and Okonkwo, 2011). More than 20 harvests are possible within the production cycle, and with good management, the yield of fresh shoot could be up to 10 t/ha (Alegbejo, 2012). The female plants are generally known to give better yield than male plants. Upon the setting of the fruits, the pods are harvested 9 weeks afterwards (Adetunji, 1997). Improper handling like tying and heaping of the harvested long shoots in bundles result in faster damage of the leaves.

3.2 Cleaning and preparation of *ugu* leaves

Ugu leaves should be cleaned before cutting them up. Wet cleaning with uncontaminated water inside a big bowl is the best. To ensure a better cleaning, the water and leaves are stirred. Vegetable leaves should not be allowed to soak (Adam, 2013), but repeatedly washed with fresh water until the wash-water is free from dirt after removing the leaves. Then, the water can be drain using sieves.

3.3 Preservation of *ugu* leaves, pods and seeds

Extensive work is yet to be done on the best methods for *ugu* preservation. Food preservation does not involve engineering alone; rather it include the relationship among engineering, nutritional, biochemical, microbiological, entomological and economic aspects (Ubani and Okonkwo, 2011). The fresh leaves start deteriorating immediately after harvest. The low shelf life is common to leafy vegetables because of high moisture content. *Ugu* leaves can be store at the same temperature range of 34-38^{o}F (1.11-3.33^{o}C) recommended for storing DGVs, and should not be stored together with other fruits and vegetables that give off ethylene gas to avoid wilting and quick spoilage while in storage (Adams, 2013). Ubani and Okonkwo (2011) found that the leaves can only be kept for 6 days at 29.1^{o}C and 64.5% r.h.

The use of evaporative coolant was found to extend the shelf life of *ugu* for 5 days (Iwagwu *et al*, 2013). Sun drying of green leafy vegetables leads to decrease in vitamin C content (Oboh and Akindahunsi, 2004). Water stress could be alleviated by sealing the vegetable leaves with thin plastic film and this will restrict loss of chlorophyll, soluble protein and ascorbic acid (Lazan *et al*, 1987 and Nwufo, 1994). Also, wrapping with dried leaves extend the shelf life of leaves that are not wet for few days. The seeds are usually left with the pod until their utilisation. The pods are kept under shade or on top of wooden support in barns. With proper care and routine checks, to avoid rodent attack, pods can store for up to 4 months. Mechanical damaged pods should be sorted out and disposed of as soon as possible.

IV RESEARCH NEEDS

4.1 Engineering properties of *Telfairia occidentalis* seeds

The first step in mechanizing the production and postharvest operations of the seeds of *Telfairia occidentalis* is the thorough knowledge of its engineering properties. The absence of this appears to be a major setback in any meaningful step toward mechanizing seed handling, storage, processing, and production. The importance and thorough understanding of such engineering properties like physical, mechanical and thermal properties cannot be over-emphasized (Pradhan *et al*, 2013; Igbozulike and Aremu, 2009; Ogunjimi *et al*, 2002 and Joshi *et al*, 1993).

4.2 Engineering properties of *Telfairia occidentalis* pods

Pods of *Telfairia occidentalis* contain the seeds, and the deterioration of the pods leads to the deterioration of the seed, especially before the seeds are extracted from the pods. Since the seeds are used for propagation, loss in the seeds viability or the seeds proper will definitely affect production. Designing handling equipments and storage facilities require the good knowledge of some engineering properties of the pod. The proper storage of the pods will reduce loss usually arise from physical and physiological damage, and eliminate possible rodents attack.

4.3 Storage of freshly harvested leaf vegetables of *Telfairia occidentalis*

Vegetables and fruits are usually stored in cold storage, and their shelf life ranges from few weeks to months. The energy required for cold storage is a major factor in designing and using of cold storage systems. However, some researchers have adopted drying as an alternative means of storing fruits and vegetables. Drying, however, has its challenges like loss of valuable soluble constituents, colour changes, nutrients diminishing, and appreciable loss of original taste. Efforts to obviate some of these challenges have led to the use of dewatering impregnating soaking, among other pre-treatment techniques prior to drying.

4.2 Designing a mechanized *ugu* seed drill / planter

In order to move on from planting small fragments, as the case of the current prevailing subsistence agriculture, to production on large scale of hectares, there is a need to develop seed drill / planter for *Telfairia occidentalis* seed. This will take care of drudgery arising from manual seed sowing, and encourage many young entrepreneurs to venture into large scale *Telfairia occidentalis* production. So, empirical data generated from determining the engineering properties will aid in designing various element of *Telfairia occidentalis* seed drill.

4.5 Other research potential

The bio-energy potential of *Telfairia occidentalis* waste is another area of research interest. The pulp from the pods and seeds and other waste can be used as biomass.

V CONCLUSION

The development of appropriate techniques and equipments for the production and efficient postharvest operations of *Telfairia occidentalis* 'ugu' (fluted pumpkin) will bolster the potential of the crop in providing food security and guarantee producers good economic returns. The prevailing traditional methods of postharvest operations lead to great loss in *ugu* food production chain. These losses could be minimized through appropriate technology. In view of the many uses of the crops seeds and leaves, it is possible to access the international market and earn foreign exchange with enhanced processing and packaging. So, there is need for in-depth study that will lead to mechanizing *ugu* production and postharvest operations.

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