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Conservation Status and Research Gap**

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SHEA BUTTER TREE (*VITELLARIA PARADOXA*): CONSERVATION STATUS AND RESEARCH GAP

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ABSTRACT: *Vitellaria paradoxa*, commonly known as Shea tree belongs to the family Sapotaceae and is commonly found in the tropical zone of Africa. It is a deciduous tree that grows to about 25m in height. *V. paradoxa* is the source of a rare vegetable fat that is second in terms of importance after palm oil. Most of its trees are however only found in the wild as it is yet to receive the needed attention in terms of regeneration. Although now fast disappearing, the Shea butter tree can play a significant socio-economic role in sub-Saharan Africa due to domestic and commercial values of its fruits/nuts. Furthermore, whilst Shea fruit production may commence at 15 or 20 years, evidence has revealed that full production can take up to 40 or 50 years. These factors have been reported to discourage farmers from planting Shea tree unless more productive planting stock can be developed. It is against this backdrop that this communication critically reviewed the cultivation status and research gap of this important specie, while proffering solution.

Keywords: Shea butter tree, regeneration, cultivation, socio-economic.

1. INTRODUCTION

The shea tree (*Vitellaria paradoxa* C.F. Gaertn., syn. *Butyrospermum paradoxum*, Family: Sapotaceae) is indigenous to the semi-arid zone of sub-Saharan West Africa and commonly seen at high densities on inter-cropped farms in the parkland landscapes of the Sahel–Savannah (Loveth and Haq, 2000a; Elias, 2012). Two sub-species have been proposed, *V. paradoxa* subsp. *paradoxa* and *V. paradoxa* subsp. *nilotica* (Hall *et al.*,

1996), but there is no clear distinction between them based on leaves, inflorescences and flowers, fruits or morphology implying that the differences may be due to environmental rather than genetic differences. (Hall *et al.*, 1996) opined that the difference is based on the origin of the populations, which originated in the eastern (subsp. *nilotica*) and western (subsp. *paradoxa*) parts of the natural range of the species. Moreover, chemical analysis by (Maranz *et al.*, 2004) indicates different fatty acid profiles of this specie across Africa.

In French it is called Karité or Arbre a beurre ('Butter tree') and in English 'The shea butter tree' (Moore, 2008). It is a tree widely encountered in dry savannas, forests, and parklands of the Sudan zone, but it does not extend into coastal areas. Its natural distribution cuts across Benin, Burkina Faso, Cameroon, Chad, Cote d'Ivoire, Ghana, Guinea, Mali, Niger, Nigeria, Senegal, Sudan, Togo and Uganda. The exotic type can be found in the Honduras and the Dominican Republic. The species which is light-demanding can be found on various soil types but avoids alluvial hollows or land subject to flooding. The extensive root system is essential for survival in the 5-7 month dry seasons of savannah climates and can withstand quite severe fires.

Vitellaria is popular for the oil present in the kernels. According to (Teketay *et al.*, 2003), this oil has played an important part in local economies in west and central Sub-Saharan Africa for centuries. Today, *Vitellaria* produces the second most important oil crop in Africa, after oil palm, but as it grows in areas unsuitable for oil palm, it takes on primary importance in West Africa. Shea butter is a vital source of energy for those who cannot afford other fats although its energy values given by different authors are rather low, ranging from 2.3 - 2.6 MJ 100 g⁻¹. The solidified shea oil is called 'butter'. It is constituted primarily of heavier carbon molecules and is more or less solid at room temperature. It has been suggested that the stearic acid content has a beneficial effect on total cholesterol, low-density lipoprotein cholesterol and factor VII Coagulant activity in humans. The kernel itself is rich in vitamin A (Orwa *et al.*, 2009).

Table 1: Nutritional constituent of *Vitellaria* kernels

Nutritional constituents	Value (%)
Fat	31.3 – 62.0
Protein	8.4 – 8.8
Carbohydrate	31.0 – 37.0
Unsaponifiable fat	4.6 – 11.0

Table 2: Mineral elements of *Vitellaria* kernels

Mineral Elements	Value (mg 100 g ⁻¹)
Magnesium	26.30
Calcium	36.40
Zinc	0.47
Molybdenum	0.24
Copper	0.11
Iron	1.93
Phosphorus	18.00

Source: Adapted from (Hall *et al.*, 1996)

Vitellaria paradoxa has been propagated principally by seedlings. The tree takes up to 30 years to mature although on good soil with initial care it may bear fruits in 15-20 years (Katende *et al.*, 1995). The 1st fruits are

borne 3-4 years after flowering, whilst fruit production may commence at 20 years, full production is only reached after 40 to 50 years (Ruysen, 1997).

These factors have been reported to discourage farmers from planting Shea tree unless more productive planting stock can be developed. Shea nut tree is also regarded as the most difficult-to-propagate tree species in the tropics (Zewge, 2003). Farmers tend not to plant these trees because they view the trees as 'wild' – nature gifts, which are now fast disappearing. Because of its value as a source of oil, Shea butter tree has long been an integral component of wooded farmland agriculture. Often, it is the only tree to be spared when woodland is cleared for cultivation. These preserved specimens may be as much as 150-200 years old (Orwa *et al.*, 2009).

Although the Shea butter tree can play a significant socio-economic role in sub-Saharan Africa due to domestic and commercial values of its fruits/nuts (Sanou, 2004), a wide variety of useful products are made from this tree. But, by far, the most important is the oil derived from the kernels traditionally extracted by women through a laborious and time-consuming process (Hall *et al.*, 1996). Besides oil, some common uses of *V. paradoxa* include food, fodder, fuel, apiculture, timber, latex/rubber, dye and traditional medicine. Other uses of *V. paradoxa* include erosion control, soil conditioner, and pollution control.

Currently, shea butter fruit production has been constrained by the quick loss of viability of its seeds, long juvenile phase, old age with low regeneration potential and lack of knowledge on its silviculture (Zewge, 2003), hence the need for improve regeneration approaches in order to address some of these constraints effectively.



Figure 1: Immature seeds of *V. paradoxa* on the tree



Figure 2: Matured/harvested seeds of *V. paradoxa*

1.2. Cultivation

1.2.1. Propagation from seed

Farmers generally do not plant shea butter tree, hence there is little local experience in seedling production. The seed is recalcitrant, hence cannot be stored using normal methods. Germination rate decreases considerably after three weeks storage under room temperature (30 to 35°C). Germination time varies from 7 days to 3 months. Germination rate, under good conditions, varies between 30–75% (Orwa *et al.*, 2009).

1.2.2. Vegetative propagation

The principal reason for using vegetative propagation is to capture and fix desirable traits, or combinations of traits, of individual trees (Leakay and Newton, 1994). Because higher yields and better products are desired, vegetative propagation is a useful tool for the domestication of indigenous fruit trees. The adapted varieties and cultivars are propagated vegetatively to maintain their desired characteristics, which would, if sexually propagated, be diluted over time (Nyambo *et al.*, 2005). According to (Hartmann *et al.*, 1997), grafting can be used to enhance the multiplication of trees in the reproductive phase through plus tree selection and by taking scions from ontogenetically mature crowns of large trees. In this way the juvenile phase of trees is greatly shortened. For example, preliminary results from ICRAF (2002) and its research partners have shown that grafting can accelerate fruit precocity (shortening the period to first fruiting) compared with plants produced by seed. According to (Orwa *et al.*, 2009) grafting is capable of reducing the fruiting period from 20 to 6 years for *Vitellaria paradoxa*, from 6 to 3 years for *Parkia biglobosa*, from more than 10 years to 4 years for *Adansonia digitata*, and from 2 years to 6 months for *Ziziphus mauritiana*. (Hall *et al.*, 1996) reported that *V. paradoxa* can be propagated by root suckers, grafting, budding, cuttings

and tissue culture. The top-cleft grafting technique gives a survival rate of about 70% on the farm (Kone, unpublished). However, (Sanou, 2004) reported side-cleft grafting to be an easy way of propagating this species. The recommended grafting period is in May in the Sahel, which is the end of the dry season/onset of the rainy season. Grafting on mature saplings in the field has produced successful results in Mali and is recommended as a way of enriching the parklands-provided that the grafts are not water stressed and that latex does not block the graft stock union (Luedeling and Neufeldt, 2012). Propagation by stem cuttings from hardwood, softwood and coppice shoots of mature trees can be used with 80% success. In addition, apical shoots from seedlings can be established and multiplied *in vitro* (Loveth and Haq, 2000). Layering has also been successful, yet it is difficult (Picasso, 1984). Other methods that have been employed in the regeneration of *Vitellaria paradoxa* include coppicing and raising of seedlings.

1.3. Research Gap

Natural regeneration, protected and wild managed during cycles of cultivation, all account for current populations of shea trees. Because of cross-pollination, these wild-managed stands consist of heterozygous individuals and produce an unreliable crop in terms of quantity and quality. The growing importance of this tree species, cutting for fuelwood, the threat of over-harvesting (Elias, 2012), and the opportunity to produce superior true-to-type varieties in order to capture superior genetic traits (Sanou *et al.*, 2006), has prompted research into the clonal propagation of this tree (Raebild *et al.*, 2011). However, vegetative methods, such as grafting, budding, cuttings and air-layering, have only produced limited success (Loveth *et al.*, 1996); (Sanou, 2004); (Yeboah *et al.*, 2010). Micro-propagation of woody species has become a widely used technique not only for the rapid regeneration of superior germplasm, but also to reduce the post-propagation juvenile period and for conservation purposes (Pijut *et al.*, 2012). Furthermore, *in vitro* propagation techniques have been successful for other members of Sapotaceae, such as *Argania spinosa*, which have previously been difficult to propagate (Nouaim and Chaussod, 1994).

1.3.1. *In vitro* propagation

Tissue culture is the *in vitro* aseptic culture of cells, tissues, organs or whole plant under controlled nutritional and environmental conditions often to produce the clones of plants (Thorpe, 2007). Tissue culture has been used in the production and development of quality and improved cultivars (Lalitha

et al., 2014). It is useful for germplasm conservation, production of Genetically Modified Organisms (GMO), cryopreservation and also helps industries with production of secondary metabolites (Prakash et al., 2004). Cell regeneration by tissue culture is made possible due to the ability of a plant cell to form a multicellular organism, which is commonly called Tortipotency (Lima et al., 2012).

Although information is still scarce on tissue culture regeneration of *Vitellaria*, (Lovett and Haq, 2013) however reported that Shoot regeneration was maximal when the cytokinin/auxin ratio was applied between 5:1 and 50:1 with 6-benzyladenine (BA) in between 8.9 and 22.2mM. Adventitious roots were also stimulated when cultured on rooting media with Murashige and Skoog (1962), macro and micronutrients reduced to quarter-strength in the presence of the plant growth regulator, indolebutyric acid between 4.9 and 14.8mM. Fotso et al., (2008) were also successful in inducing embryogenic callus and somatic embryo formation in leaf fragments of both *Baillonella toxisperma* and *V. paradoxa*, but were unable to induce fully formed shoots or roots. Adu-Gyamfi et al., (2012) successfully germinated somatic embryos from embryogenic callus of immature cotyledon explants of *V. paradoxa*, which subsequently developed shoots, and were rooted and acclimatized. Raebild et al. (2011) highlighted micropropagation as a 'gap in research' for this species.

2. CONCLUSION

Growing evidence has revealed that the population of shea butter tree (*Vitellaria paradoxa*) an important tropical tree with enormous economic and cultural values is rapidly declining due to deforestation, land fragmentation, and high demand for woodfuel especially charcoal. Reversing this trend will depend on conservation efforts, facilitating natural regeneration, and most importantly the massive regeneration through advance techniques like in vitro propagation.

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