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The relevance of *Gmelina arborea* (Roxb.) in agroforestry systens and medicine

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Abstract

The choice of suitable tree species is critical for optimal output in agroforestry systems. A wide range of potential uses of *Gmelina arborea* (Roxb.) remain largely ignored, probably because agroforestry programmes, hitherto, laid emphasis on nitrogen-fixing trees. *Gmelina arborea* is a fast growing multipurpose tree which generates high biomass but does not fix nitrogen. It has excellent coppicing capacity which lends it to rapid regeneration for frequent pruning. It produces an appreciable amount of foliage even at peak of dry season, thereby ensuring a yearround supply of forage and fodder for livestock, such as goats, sheep and cattle which relish the plant. Pruning from Gmelina is also useful for mulching. Favourable reports on the wood properties of *Gmelina arborea* indicate that it is suitable for general purpose timber, utility furniture, pulpwood and for making match sticks. The high regenerative ability of the roots and stems cuttings, aid vegetative propagation. Gmelina has a vigorous root system which enables it to effectively act as a nutrient pump for the uptake of leached nutrients from subsoil to the soil surface through leaf litter. *Gmelinaarborea* is tolerant to bush fire, thereby making it adaptable to the common practice of shifting cultivation which frequently involves burning of debris during land preparation. Studies are required to elucidate information on the compatibility of *Gmelinaarborea* in agroforestry systems.

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Introduction

The search for compatible multipurpose trees in agroforestry programmes in Nigeria is a continuous process. The wide range of potential uses of *Gmelina arborea* (Roxb.) have hitherto been largely ignored, probably because, agroforestry programmes emphasised nitrogen-fixing species. This is understandable, in view of provision of a free supply of nitrogen to the soil for crop growth by nitrogen-fixing plant species, brought about by *Rhizobium* spp. bacteria in their roots. However, Amara *et al.* (1992) reported unexpectedly high nitrogen content in the leaves of gmelina. With declining forage and fodder supply for livestock, the need to highlight other non-leguminous multipurpose trees, such as,*Gmelina arborea* has become necessary and urgent. *Gmelina arborea* is a fast growing multipurpose tree. Nwoboshi (1982) stated that species like *Tectona grandis* and *Gmelina arborea* owe their popularity in forestry to their capacity to establish and grow well in plantations. Gmelina generates high biomass and excellent coppicing capacity. The plant produces appreciable amount of foliage even at the peak of dry season, thereby ensuring a year-round supply of forage and fodder. Sheep, goats and other ruminants relish its succulent foliage.

In Nigeria, *Gmelina arborea*was originally introduced for fuelwood and poles in plantations. A notable example is the Enugu pitwood plantation (Pringle, 1960). *Gmelina arborea* (Roxb.),is native to Asia. It was introduced from South-East Asia to tropical Africa and introduced to Enugu State, Nigeria in1921 (Rotowa and Adeagbo, 2019). More recently, it was planted as a shade tree in residential quarters and homes. Large areas in tropical locations of Africa, America and Asia, such as Nigeria, Ghana, Colombia, Venezuela and Malaysia have undertaken extensive planting of this fast-growing tree and most of them are intended for the production of paper-pulp (Adam and Krampah, 2005; Deepthi, *et al.,* 2015). The objective of this study were to examine the characteristics of *Gmelina arborea* in line with the potential uses, asses its present role in agroforestry and medicine and suggest the way forward.

Environmental requirements of Gmelina

Certain conditions are necessary for proper growth and development of *Gmelina arborea* plant. Deepthi, *et al.* (2015) observed that it is not a shade tolerant plant. It grows well in locations that receive 750-4500mm or more of rainfall per annum. It does not flourish on poorly-drained and waterlogged soils. It remains stunted on sandy or dry and infertile soils. Drought condition also reduces it to a shrubby form. Adam and Krampah (2005) also noted that deep fertile soil that is well-drained is suitable for Gmelina. When it is planted under unsuitable conditions, Gmelina grows into a little more than a shrub and often remains stunted.

Characteristics of Gmelina

Agroforestry is becoming a popular component of sustainable agriculture and environmental enhancement in Nigeria. The success of such programmes will depend on availability of information on the components. Such knowledge will include the growth and utilization of agroforestry species, and probably their potentials for enhancing yield of companion crops. Effective integration of *Gmelina arborea*in agroforestry systems therefore requires such basic information to enable successful harnessing of its potentials.

Selection criteria for tree species include value of fruit, oil, erosion, medicines, timber, fodder and fuelwood (Myonk, *et al.*, 2015). It should also be noted that the traits of a good agroforestry species include good coppicing and ability to promote soil fertility through nitrogen fixation.

In a fertilizer trial carried out in Yurinaguas, Peru, *Gmelina arborea* did not respond to the application of nitrogen, phosphorus, potassium, magnesium, lime and zinc with respect to height and diameter (Perz*et et al.*, 1987). The implication of this is that Gmelina may tolerate non-fertile soils common in the humid tropics. The plant can be integrated as pasture crop at

a low input level with regard to fertilizer application. Perez *et al.* (1987) observed that *Gmelina arborea* planted at a spacing of 3m x 3m in Peru, grew quickly and reached a height of over 7m, with 10cn diameter at breast height in 3½ years. When intercropped with pineapple and plantain, no significant negative effects on *Gmelina arborea* was noticed. However, the growth of Gmelina was retarded by the companion cassava and legume species used in the study. Basanda *et al.* (2017) discovered higher gross income in the integration of crops such as okra with Gmelina than growing the tree alone; the outcome of the study further showed that intercropping trees with arable crops have promising effect on building up of soil fertility. *Gmelina arborea* grows rapidly and produces plenty wood and foliage. Because of its good coppicing ability, it lends itself to frequent harvesting. The tree regenerates harvestable foliage all the time, either pruned or un-pruned, and good proportion of this remain green in the dry season. The species is highly tolerant of bush burning. This is evident from the regenerative ability of the plant following intensive burning as has been observed in gmelina plantations located at Anwai, Asaba, Nigeria for over ten years.

Gmelina is propagated sexually through seeds and asexually through stem and root cuttings. The seeds are available from the plant most of the time and it germinates easily. The main period of seed availability is at the peak of rainy season in West Africa. This is advantageous for the survival of the seedlings as moisture will be available for seed germination and for early plant establishment. There may also be no need for long period of seed storage before they are put out for planting. The high regenerative ability of the stem and root cuttings aids vegetative propagation. Wounds on sub-surface roots commonly cut during cultivation often regenerate adventitious roots and shoots which develop into established stands. The stems of the plants used for erecting uprights for stakes and fencing usually produce roots and foliage, particularly if the operation is carried out during the raining season. These could eventually become trees, if undisturbed.

Potentialities of Gmelina arborea

Gmelina in crop production

The high vigor of the plant and the well-developed root system which gives support to the luxuriant growth enable the retrieval of leached nutrients from the sub-soil profile outside the reach of most arable crops. Thomson (2010) noted that in time to come, production of livestock is likely to be progressively characterized by differences between smallholder and agro-pastoral systems on the other. Ota *et al.* (2019) reported the high the capacity of Gmelina and Gliricidia plantations to ensure nutrient cycling, restore degraded soil, conserve soil moisture and to protect the soil through the soil plant system.

Excellent canopy is provided by Gmelina as a shade in the farms, at homes and roads for man and livestock. Implicitly, it serves as wind break. The plant could act as wind break for such crops as plantain and banana that are often very susceptible to lodging, if proper canopy management is practiced through pruning. The materials pruned find use in the mulching of crops, thereby suppressing weeds and also protect the soil from direct impact of rain. There is also the interference of the canopy for light. It is also common to find crops etiolating under the canopy of young Gmelina plants. During cropping periods, Gmelina has high potential for shading the companion crops. Plenty of human labour may be required for maintenance practices to ensure that the canopy is regularly pruned or controlled to reduce its interference for light to crops.

Interference is expected between extensive root system of Gmelina and the adjacent crops in the alley or in mixed agroforestry systems for growth resources, such as plant nutrients and soil moisture. The roots of Gmelina also interfere with tillage implement. Currently in Nigeria, only a small proportion of farmers use personal land for farming. Majority of tenant farmers are discouraged from establishing permanent crops, such as Gmelina. Even when the establishment of Gmelina is undertaken by a farmer for agroforestry purposes, such a piece of land may be leased out to other tenant farmer. Envisaged benefits of planting Gmelina would have been lost by the original farmer. However, an

agreement can be reached so that the period of leasing the land will cover the time when the benefits of planting Gmelina would be enjoyed by the farmer.

Gmelina in animal production

Foliage of Gmelina is readily available for livestock, especially when other feed-stuffs are limited. Sheep and goats have been observed to cherish it and probably prefer it to some other feeds. Voluntary intake of Gmelina foliage by sheep and goats is a common observation. Goats in a confinement were cited feeding on Gmelina fodder (Fig. 1). Livestock often feed on the leaves.

Fig. 1. *Gmelia arborea* fodder being fed to goats (A), sheep (B) and cattle (C) and Gmelina trees recovering from bush fire.

Gmelina in food and feed

Kayode *et al.* (2015) reported successful production of oyster mushroom on Gmelina wood. Adam and Krampah (2005) added that the fruit is edible. The leaves are used in silkworm culture. Abundant nectar is obtainable from the flowers by bee and high quality honey is produced from it.

Gmelina in preparation of medicines

The high value of Gmelina has been long-established in India because of its diverse medicinal characteristics. *Gmelin aarborea* is a well-known medicinal plant in traditional Indian medicine (Ashalathaand Sankh, 2015.).

Deepthi, *et al.* (2015) reported the importance of *Gmelina arborea* as one of the classical curative plants. According to their report, Gmelina is widely used traditionally

-as antimicrobial,
-as diuretic,
-as anti-helmintic,
-as anti-epileptic and
-and as anti-diabetic agent.

The study reported by Acharya *et al.* (2015) justifies the multilevel therapeutic uses of heartwood and stem bark of *Gmelina arborea* in Indian medicine and that in tropical Asia, the roots, fruits and leaves are used in Hindu medicine and noted the following:

-That good free radical scavenging activity and appreciable amount of phenolics and flavonoids in the extracts might have assisted in protection brought about with good anticonvulsant effects.
-That the leaf sap is useful for the treatment of ulcers and wounds.
-That the fruit and bark of Gmelina have medicinal properties used for bilious fever treatment.
-That the roots are considered to have laxative and tonic, properties;
- Adam and Krampah (2005) on their own observed that leprosy and blood diseases are treated using the flowers

Gmelina in the provision of stakes for crops

Some crops have been reported to give enhanced yields when staked compared to the un-staked ones. Gmelinain agroforestry system c reliable ommonly find use as a potential source of stakes for vine crops, such as yam (*Dioscore aspp*) and fluted pumpkin (*Telfairia ocidentalis*). The use of *Gmelina* as livestake could be made popular among yam growing communities in the middle belt and the rain forest zones of Nigeria if the growing of Gmelina is introduced into these areas. The larger stakes are used for ware yam why the small branches find use in seed yam production. The stakes that later dry up and

prunings from overgrown twigs are used as fuel wood after harvesting the crop. There is need to evaluate if stakes of *Gmelina* can withstand re-use as stake after a season and to know how many times or seasons it can be re-used before it starts failing as a stake during which time it may be exploited as fuel wood, as common with baobaos.

Gmelina has appreciable suitability for general utility purposes, especially light construction and structural work and general carpentry, packaging furniture, utility, and decorative veneers and carvings. It has tremendous woodworking properties.

Gmelina in the provision firewood

The wood is regularly used for charcoal and as firewood. The charcoal burns without smoke and burns well, but at the end much ash is left behind (Adam and Krampah, 2005).

Limitations in the use of Gmelina and research needs

In spite of its multipurpose applications, the plant has some characteristics that limit its acceptability in agroforestry systems. There is also a dearth of knowledge for which application of research could unravel. For example, Gmelina does not grow well in poorly drained soils and it is also severely affected by leaf cutting ants (Perez, Davey and Benites, 1989).

Deepthi, *et al.* (2015) reported that Gmelina trees tend to branch or fork frequently. The primary axis (top shoot) may receive competition from one or more side branches resulting in the loss of apical dominance and even death of the top shoot. This is the reason why Gmelina usually has poor stem formation for long span timber. It is probable that this trend can be forestalled during the early growth of Gmelina in the nursery by growing them proximally and removing all lateral branches, as well as transplanting them as overgrown nursery plants at the peak of rainy season.

The tree tends to recover quickly from attempts at killing it, if it becomes a nuisance. It recovers very fast from the debarking of the tree. When burnt after debarking, it recovers except when the fire is intensive and the burning exercise prolonged. Most woods undergo fast growth at the expense of wood density; for instance, pines have fast growth but possess poor wood density.This unlike *Gmelina*, though has fast growth as well, has high wood density. This makes the wood suitable for fast production of plenty stable utility timber (Hughes and Esan, 1969).

Conclusion

Proximate analysis of the leaf is required to know how useful it is as fodder. Some compounds might be present in the leaf that may be useful for other purposes. The plant produces substantial amounts of fruits. It is pertinent to analyze the fruit content to elucidate information on its economic, nutritional and medicinal potentials. Studies that will evaluate the cutting frequency and cutting height for fodder production may be relevant for sustainable livestock management. There is need to evaluate the level of interference of Gmelina with the crops in the alleys and work out management practices that will make it more compatible with agroforestry systems. Knowledge of the optimum frequency of pruning for mulching will benefit the companion crops.

References

Acharya NS, Acharya SR, Kumar V, Barai P. 2015 . Anticonvulsant and Antioxidant Effects of Methanol Extract of Stems of *G. arborea* Roxb. **Journal of Natural Remedies 15,** 23-32.

Adam KA, Krampah, E. 2005. Gmelinaarborea Roxb.ex Sm. In: Louppe D, Oteng-Amoako A A, Brink M (Editors). PROTA (Plant Resources of Tropical Africa/Ressources végétales de l'Afriquetropicale), Wageningen, Netherlands. Accessed 11 April 2019.

Ashalatha M, Sankh K. 2015. A Morphological Review on *Gmelina arborea* Linn - A Wonder Ayurvedic Herb. International Journal of Health Sciences and Research **5(1),** 304-308.

Basanda GM, Dhara PK,Tarafdar PK. 2017. Differential responses of arable crops with gamhar

(*Gmelina arborea*) and mango (*Mangifera indica*) based agroforestry system in red and lateritic soils of West Bengal, India. Indian Journal of Agricultural Research **51(1),** 86-89.

Chittendon AE, Coursey DG, Rotibi JO. 1964. Paper Making Trial with *Gmelina arborea* Timber in Nigeria. Tappi **47(12),** 186A- 192A.

Deepthi Pathala, Harini A, Prakash L, Hegde. 2015. A Review on Gambhari (*Gmelina arborea* Roxb.). Journal of Pharmacognosy and Phytochemistry **4(2),** 127-132. Available on line at www. phytojournal.com

Hughes JF, Esan D. 1969. Variation in some structural features and properties of *Gmelina arborea*. Tropical Science **11(1).**

Kayode RMO, Olakulehin TF, Adedeji BS,, Ahmed O, Aliyu TH, Badmos AHA. 2015. Evaluation of amino acid and fatty acid profiles of commercially cultivated oyster mushroom (*Pleurotus sajor-caju*) grown on Gmelina wood waste. Nigerian Food Journal Volume **33(1),** 18-21.

Myonk JH, Hyok HO, Jianchu XU. 2015. Participatory selection of tree species for agroforestry on sloping land in North Korea. Mountain Research and Development **35(4),** 318-327.

Nwoboshi LC. 1982. Tropical Silvicultural Principles and Techniques. Ibadan University Press, Ibadan p. 144.

Ojeniyi SO, Agbede OO, Fegbero JA. 1980. 'Effects of Agri-Silvicuture on Soil Chemical Properties' Soil Science **130(2),** 76-77.

Ota HO, Aja D, Okolo CC, Obianuju C, Nwite JN. 2019. Influence of tree plantation Gmelinaarborea and *Gliricidia sepium* on soil physic-chemical properties in Abakaliki, Southeast, Nigeria**.** ActaChemica Iasi **2(2),** 22-28.

Perez JM, Davey B, Benites JR. 1987. Nutritional Requirements of *Gmeliaarborea".* Tropical Technical Report. North Carolina State University, Raliegn pp. 76-77.

Perez JM, Davey B, McCullum RE. 1987. Intercropping, cropping and nutritional requirement". In: Tropsoil Technical Report. (Eds) Candle, N. and C. McCantsTropsoils. North Carolina State University, Raliegn.

Pringle AN. 1960. The Enugu Pitwood Plantations, Nigeria Emp. For. Rev **29(3),** 238-243.

Rotowa OJ, Adeagbo AA. 2019. Provenance trial of *Gmelina arborea* (Roxb.) in iddle-belt zone of Nigeria. Research Journal of Agriculture and Forestry Sciences 7 (3), 27-31. Retrieved 21st Feb., 2020 from: https://www.researchgate.net/publication/334707542_Provenances

Sanchez PA. 1992. Soils in the Humid Trpics: Their Properties and Management. In: Sudlow (Ed.) Studies on Third World Societies. College of William and Mary, Dept. of Anthropology, Public No. **4.**

Thornton PK. 2010. Livestock production: recent trends, future prospects. (Philosophical Transactions B) Philos Trans R SocLond B Biol Sci**. 2010 Sep 27 365(1554),** 2853–2867.