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The Resource Role of Morula (*Sclerocarya birrea*): A Multipurpose Indigenous Fruit Tree of Botswana

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Abstract: *Sclerocarya birrea* (morula) is a common and wide spread indigenous fruit-bearing tree species throughout much of sub-Saharan Africa. It is widely used by rural populations in most countries wherever it grows. In Botswana the species is protected and preserved by local people in areas of its natural occurrence. Local people in the northern part of Botswana also plant the tree in their homesteads. It is a multipurpose tree whose fruits are eaten fresh or fermented to make a beer, the kernels are eaten or the oil extracted. The leaves are browsed by livestock and have medicinal uses as does the bark. The wood is used to make a variety of implements. The kernel is rich in protein and minerals. The morula fruit produce juice, which has high vitamin C than orange juice. The paper reviews *Sclerocarya birrea*, which is an important multipurpose tree of social and economic value in Botswana and other African countries where it grows.

Key words: *Sclerocarya birrea*, multipurpose tree, nutrient composition

INTRODUCTION

Many wild plant food resources are eaten across Africa in addition to the more commonly known agricultural foods^[1]. The significance that edible wild indigenous plants make to the diets of many people living in sub-Saharan Africa is increasing^[2-5]. Sub-Saharan Africa continues to be visited by drought and other weather related calamities such as floods, which reduce the yields of staple grains such as maize, millet and sorghum^[6] and therefore, edible wild indigenous plants become an alternative source of food. They are a source of vitamins, minerals, amino acids and trace elements^[7-9].

Wild edible plants promote development in rural areas and contribute to food security, community upliftment, job creation and improved quality of life. Wild edible plants are used particularly during periods of seasonal food shortages and are often the only available fruit and vegetable source of high nutrients. In Botswana wild edible plants yield a crop in poor rains when arable crops fail^[10] and thereby improve food security for people living in rural areas. *Sclerocarya birrea* (morula) is an integral part of the diet, tradition and culture of rural communities in southern Africa^[11]. In Botswana the species is protected and preserved by local people in areas of its natural occurrence. Local people in the northern part of Botswana also plant *Sclerocarya birrea* in their homesteads. Local farmers always select and retain the species when clearing the woodland for arable

agriculture. People living in rural areas of Botswana have developed techniques of using many parts of the tree and this knowledge is well distributed throughout southern Africa.

Plant description: *Sclerocarya birrea* subsp. *Caffra* is one of the commonly utilized indigenous fruit trees of Africa. Archaeological evidence suggests that the fruit of *S. birrea* was known and consumed by humans in southern Africa as far back as 9 000 BC^[12]. *Sclerocarya birrea* is a single stemmed tree belonging to the Anacardiaceae family normally about 10 m tall but on favourable sites grows up to 20 m^[13-15]. The distinctive feature of the tree is the pale-grey bark flaking in patches and exposing the underlying light yellow tissue^[14,16-18]. The bark of young trees is smooth and grey or pinkish grey. The inner bark is red or pink to yellowish with darker stripes^[19,20]. The inner bark is red or pink to yellowish with darker stripes^[19].

Leaves are borne in a spiral phyllotaxy at the extremities of the shoots; each leaf is compound, usually with 7-13 leaflets in opposite and a single terminal leaflet^[19]. The leaflets are dark above, much paler and bluish-green below. The leaves are crowded near ends of branches.

The species is primarily dioecious with male and female flowers on individual trees, but occasionally a tree can bear flowers of both sexes^[14,21,22]. Female flowers are more conspicuous and borne on sparse drooping racemes

and pinkish in colour^[22]. Female flowers are smaller, red-purple and white in colour. Flowers are in 5-8 cm long inflorescences at the end of branches.

Fruits are round or oval and green when young, becoming butter-yellow^[22] and developing in clusters of three to five at the ends of twigs and always on new growth. On average each fruit is 3-5 cm in diameter and yellow at maturity^[21]. The pulp is juicy and adheres tightly to the stone. The stone is 2-3 cm long, hard with one to four cavities, each usually containing one seed. Seeds are small and fragile, covered with thin seed coat.

Distribution: *Sclerocarya birrea* subsp. *caffra* is native to Africa where it is widely distributed between 16°N and 20°S in wooded grasslands, riverine woodlands and bushlands. It is found in Southern Africa in areas with warm, frost-free climate but is also found at altitudes where temperature may drop below freezing point for a short period in winter. It occurs at low to medium altitudes in areas with 200-1600 mm rain per year^[19,23]. It grows well in areas with sandy to loamy soils^[24].

Propagation: Little is known about the silvicultural characteristics of *Sclerocarya birrea*; however, the tree species regenerates natural from seed, coppice, truncheon and gregarious root suckering^[15,25]. If the operculum has been opened germination is fast and uniform reaching 70% after one week and 85% after two weeks from sowing^[25]. Without treatment, germination may take as long as nine months. For good germination, seeds should be soaked in water for 12 h before sowing^[19,25]. Over 95% success has been achieved by grafting 5-10 cm scion material cut from tips of branches. The vegetative methods of propagating morula were developed by Hotzhausen^[26]. The field performance of grafted morula plants indicate that they started to produce fruits after 4-5 years whereas seedling plants did not fruit for 8-10 years^[27]. Propagation by truncheons has been successfully done using truncheons of 10-15 cm in diameter and 2 m long^[22]. Cuttings on the other hand are currently only practical for juvenile tissues, although potentially have the advantage of higher multiplication rates easier low-technology vegetative propagation methods^[28].

Pest and Diseases: The major pests affecting both trees in the wild and seedlings in the nursery are psyllid mites^[13,15]. Powdery mildew and aphids can be prevalent on *Sclerocarya birrea* under humid conditions especially in the nursery and can spread to all seedlings in the net house^[15].

Resource role of morula

Wood: The wood is off-white with reddish tinge, very light in weight (air-dry 360 kg m⁻³) and has course texture,

making it tough and difficult to work^[22]. The wood is suitable for making mortars, canoes and livestock feeding troughs, local crafts, traditional ritual bowls, wooden spoons, saddles stools, drums and ploughing implements.

Bark: The bark contains 10-20% tannin as well as traces of alkaloids^[22]. It provides fibre and gum, which is mixed with soot and water to give ink or red dye. The bark is commonly used for medicinal purposes^[18,20,25,29,30] and treats a variety of ailments, notably fever, boils and diarrhoea and blood circulation problems. When mixed with other medicinal plants the bark treats various infections such as syphilis, leprosy, dysentery, hepatitis and rheumatism^[20].

Leaves: The leaves are cooked as relish^[24]. During drought, branches of *Sclerocarya birrea* are lopped by livestock owners to use leaves as fodder for livestock^[13,15,18,25].

Fruits: The most valuable asset of this tree is the fruit it bears^[23] and the recognition of *S. birrea* as an important food source for rural communities has generated much interest in the nutritional values of the plant and its potential for product development^[11]. Considerable research has been conducted over the years on the properties of *S. birrea* fruits, juice and oil. All parts of the fruits are edible. Morula fruit and juice is extremely high in vitamin C providing about 2 mg g⁻¹ of fresh juice^[31]. This is approximately four times the vitamin C of orange juice^[23,32,33]. The tree produces an outstanding and famous wine (marula wine). The wine comes about when the juice is squeezed out of the marula fruits and it is fermented for a few days. The wine is thereafter properly cleaned by sieving the liquid. The alcohol content is quite high. It is estimated to be up to 15% per volume, depending on the tree and period of fermentation. A second drink from morula fruit is a very sweet and almost non-alcoholic drink.

Fruits can be eaten fresh or made into jams jellies and sweets. The fruits are eaten by variety of domestic and wild animals^[34,35]. On average, mature trees produce between 5000 and 90000 fruits per season^[19,22,27,34,36]. Seed kernels are used as nuts eaten fresh or roasted. In Botswana morula kernels or nuts are used as a substitute for groundnuts in vegetable relish and consumed with sorghum, millet or maize porridge by local people. The fruit and the kernel are rich in protein and minerals (Table 2 and 3). According to Quint^[37] the morula nut oil extracted from the nuts is highly valued by the domestic industry due to its slow oxidising properties. Unlike other nut oils morula oil is poor source of Vitamin E due to low level of B-tocopherol^[33]. The nut comprises an average

Table 1: Mean levels of moisture, protein, oil, ash, fibre and carbohydrates of *Sclerocarya birrea* nuts in four countries in southern Africa

Composition (g/100 g)	Angola	Botswana	Mozambique	S.Africa
Moisture	3.9	4.0	9.0	4.0
Protein	27.6	28.3	27.6	30.9
Oil	56.2	57.3	54.3	57.0
Ash	4.1	3.8	3.7	4.2
Fibre	4.5	2.9	2.8	2.4
Carbohydrates	-	3.7	5.3	1.5

Source: Taylor and Kwerpe^[15], Macucle^[39]

Table 2: Mineral content of fruit and nut of *Sclerocarya birrea* (μg dry weight)

Mineral content (μg dry weight)	Fruit	Seed
Fe	24.9	27.8
Cu	ND	ND
Ca	4810	1560
Mg	3100	1930
Mn	ND	ND
Zn	ND	26.5
Mo	ND	ND
Na	15.2	11.9
P	2640	2120

ND not detected (< 10.0 mg/g dry weight), Source: Glew *et al.*^[6]

Table 3: Amino acid composition of the crude protein fraction of *Sclerocarya birrea*

Amino acid (mg/g dry weight)	Fruit	Seed
Aspartic (Asp)	3.77	5.17
Glutamin (Glu)	4.52	13.10
Serine (Ser)	1.91	2.64
Glycine (Gly)	1.98	2.68
Histidine (His)	0.80	1.22
Arginine (Arg)	2.12	6.76
Threonine (Thr)	1.45	1.79
Alanine (Ala)	2.66	2.53
Proline (Pro)	3.28	2.57
Tyrosine (Try)	1.32	1.47
Valine (Val)	2.17	3.03
Methionine (Met)	0.51	0.68
Isoleucine (Ile)	1.83	2.53
Leucine (Leu)	2.74	3.78
Phenylalanine (Phe)	1.60	2.37
Lysine (Lys)	1.57	1.29
Cysteine (Cys)	0.97	1.95
Tryptophan (Trp)	0.52	0.83
Total protein	36.00	56.00

Source: Glew *et al.*^[6]

90% shell and only 10% kernel, making kernel and oil yields relatively low per fruit^[11]. According to Quin^[37] and Shon^[33] the oil yield per kernel is high at 56%. The energy value of the kernel is approximately 2699 to 2703 kJ/100 g of kernel^[38] which is considered higher than most commonly eaten nuts^[37].

Nutritional importance of *Sclerocarya birrea*: Like many traditional food plant the tree species provide food at all times and times of food scarcity. In times of the year characterised by subsistence shortages, such as a season of hungers preceding the first harvest, or in times of famine and drought, *Sclerocarya birrea* can become a crucial source of nutrition.

Nutrient composition: Mean levels of moisture, protein, oil, ash, fibre and carbohydrates are shown in Table 1. Levels of calcium (Ca), magnesium (Mg), iron (Fe), nitrogen (N), potassium (K), copper (Cu), zinc (Zn), phosphorus (K) of fruit and nut are shown in Table 2. Amino acid composition of the crude protein fraction of *Sclerocarya birrea* is shown in Table 3.

Economic role: All products from morula, wine, juice, unprocessed kernels and wood products are available in open (informal) markets in Botswana. The morula fruits have been developed in South Africa and mixed with cream to make up a famous liqueur known as Amarula, which is available in most countries in southern Africa.

Sclerocarya birrea is an important indigenous multipurpose tree in Botswana and other countries of southern Africa. It provides miscellany of products (edible and non-edible) to people living in rural areas. Research has proved that morula play an important role in the lives of the rural population. It is a source of food, medicine, home utensils etc. It is an important source of fodder for animals. The rural population can sell morula products to the urban areas for income generation. *Sclerocarya birrea* like other indigenous food plants is always present during drought and non-drought years and therefore its domestication and use is important for food security.

REFERENCES

1. Murray, S.S., M.J. Schoeninger, H.T. Bunn, T.R. Pickering and J.A. Mallert, 2001. Nutritional Composition of some wild plant foods and honey used by Hadza foragers of Tanzania. *J. Food Composition and Analysis*, 14: 3-13.
2. Grivetti, L.E., 1978. Nutritional success in a semi-arid land: examination of Tswana agro-pastoralists of eastern Kalahari, Botswana. *Am. J. Clin. Nutr.*, 31: 1204-1220.
3. Grivetti, L.E., 1979. Kalahari agro-pastoral-hunter-gathers. The Tswana example. *Ecol. Food. Nutr.*, 7: 235-256.
4. Ogle, B.M. and L.E. Grevitti, 1985. Legacy of the chameleon: Edible wild plants in The Kingdom of Swaziland, Southern Africa. A cultural, ecological and nutritional study. Part IV-nutritional analysis and conclusions. *Ecol. Food Nutr.*, 17: 41-64.
5. Humphry, C.M., M.S. Clegg, C.L. Keen and L.E. Grevetti, 1993. Food diversity and drought survival. The Hausa example. *Intl. J. Food Sci. Nutr.*, 44: 1-16.

6. Glew, R.H., D.J. VanderJagt, C. Lockett, L.E. Grivetti, G.C. Smith, A. Pastuszyn and M. Millson, 1997. Amino acid, fatty acid and mineral composition of 24 indigenous plants of Burkina Faso. *J. Food Composition and Analysis*, 10: 205-217.
7. FAO., 1982. Fruit bearing forest species. Technical notes. Food and Agricultural Organization, Forestry Paper No 34. Rome.
8. Maghembe, J.A., F. Kwesiga, M. Ngulube, H. Prins and F.M. Malaya. 1994. Domestication Potential of Indigenous Trees of the Miombo of Southern Africa. In: Leakey, R.R.B. and A.C. Newton (Eds.). *Tropical Tree: the Potential for Domestication and Rebuilding of Forest Resources*, HMSO, London.
9. Saka, J.D.K. and J.D. Msothi and J.A. Maghembe. 1994. The Nutritional value of edible fruits of indigenous wild trees of Malawi. *Forest Ecology and Management*, 64: 245-248.
10. Mojeremane, W and S.O. Tshwenyane, 2004. Azanza garckeana: A valuable Edible Indigenous Fruit Tree of Botswana. *Pak. J. Nutr.*, 3: 264-267.
11. Wynberg, R.P., J. Cribbins, R.R.B. Leakey, C. Lombard, M. Mander, S.E. Shackleton and C.A. Sullivan, 2002. The Knowledge on *Sclerocarya birrea* subsp. *Caffra* with emphasis on its importance and non-timber forest product in South and southern Africa: A summary. Part 2: Commercial use, tenure and policy, domestication, intellectual property rights and benefit-sharing. *Southern African For. J.*, 196: 67-77
12. Walker, N., 1989. King of foods. Marula economics in the matabos. *African Wildlife*, 43: 281-285.
13. Kokwaro, J.O., 1986. *Flora of Tropical East Africa*. A.A. Balkema. Rotterdam.
14. Palgrave, K.C., 1988. *Trees of Southern Africa*. Struik Publishers. Cape Town.
15. Taylor, F. and B. Kwerepe, 1995. Towards Domestication of Some Indigenous Fruit Trees in Botswana: In Maghembe, J.A., Y. Ntupanyama and P.W. Chirwa (Eds.): *Improvement of indigenous trees of miombo woodlands of southern Africa*, ICRAF, Nairobi, Kenya.
16. Eggeling, W.J. and I.R. Dale, 1951. *The Indigenous Trees of the Uganda Protectorate*. Mill-Bank. London.
17. Dale, I.R. and P.J. Greenway, 1961. *Kenya Trees and Shrubs*, Buchanan's Kenya Estates Limited. Hatchards, London.
18. Van Wyk, B. and P. Van Wyk, 1997. *The Guide to Trees of Southern Africa*. Struik Publishers. Cape Town.
19. FAO., 1988. Non-timber uses of selected arid zone trees and shrubs in Africa. Food and Agricultural Organization, Conservation Guide 19, Rome.
20. Kokwaro, J.O., 1993. *Medicinal Plants of East Africa*. Kenya Literature Bureau, Nairobi.
21. Irvine, F.R., 1961. *Woody Plants of Ghana: With Special Reference to Their Uses*. Oxford University Press. Oxford.
22. Roodt, V., 1998. *Trees and Shrubs of the Okavango Delta: Medicinal Uses and Nutritional Value*. The Shell Field Series. Part 1. Shell Oil Botswana (Pty) Ltd, Gaborone.
23. Peters, C.R., 1988. Notes on the distribution and relative abundance of *Sclerocarya birrea* (A. Rich) Hochst. (Anacardiaceae). Monograph in systematic Botany of the Missouri Botanical Garden, 25: 403-410.
24. Fox, S.W. and M.E.N. Young, 1982. *Food from the Veld. Edible Wild Plants of Southern Africa*. Delta Books Ltd. Johannesburg.
25. Maydell, H.J., 1986. *Trees and Shrubs of the Sahel. Their Characteristics and Uses*. Rossdorf: TZ-Verlags-gesellschaft.
26. Hotzhausen, C.L., E. Swart and R. Van Rensburg. 1990. Propagation of the marula (*Sclerocarya birrea* subsp. *caffra*). *Acta Horticulturae*, 275: 323-334.
27. Taylor, F., S.M. Mateke and H.J. Butterworth, 1996. A Holistic Approach to the Domestication and Commercialization of Non-timber Products. In: Leakey, R.R.B., A.B. Temu, M. Melnyk and P. Vantomme (Eds.) *Domestication and commercialization of non-timber forest products in agroforestry systems*. Non-Wood Products 9. FAO, Rome.
28. Leakey, R.R.B., J.F. Mesen, Z. Tchoundjeu, K.A. Longman, J. McP, Dick, A.C. Newton, A. Matin, R.C. Manro and P.N. Muthoka, 1990. Low-technology techniques for the vegetative propagation on tropical trees. *Commonwealth Forestry Review*, 69: 247-257.
29. Galvez, J., A. Zarzuelo, M.E. Crespo, M.P. Utrilla, J. Jimenez, C. Spiessens and P. De Witte, 1991. Antidiarrhoeic activity of *Sclerocarya birrea* extract and its active constituents in rats. *Phytother. Res.*, 5: 276-278.
30. Iwu, M.M., 1993. *Handbook of African Medicinal Plants*. CRC Press, Inc. Boca Laton, Florida.
31. Shackleton, S.E., C.M. Shackleton, T.B. Cunningham, C.A. Sullivan and T.R. Netshiluvu, 2002. Knowledge on *Sclerocarya birrea* subsp. *Caffra* with emphasis on its importance as a non-timber forest product in South and southern Africa. Part 1. Taxonomy, ecology and role in rural livelihoods. *Southern African For. J.*, 194: 27-41.

32. Fox, F.W. and W. Stone, 1938. The anti scorbutic value of Kaffir beer. *South African J. Med. Sci.*, 3: 7-14.
33. Shone, A.K., 1979. Notes on the marula. *Department of Water Affairs and Forestry Bulletin*, 58: 1-89.
34. Palmer, E. and N. Pitman, 1972. *Trees of Southern Africa*. Volume 2. Struik Publishers. Cape Town.
35. White, F., 1962. *Flora of Northern Rhodesia*. Oxford University Press, Oxford.
36. Mateke, S.M., 1998. *Questions and Answers About: How to Grow Morula*. Veld Products Research and Development. Gabane, Botswana.
37. Quin, P.J., 1959. *Food and Feeding Habits of the Pedi*. University of Witwatersrand Press, Johannesburg.
38. Arnold, T.H., M.J. Wells and A.S. Wehmeyer, 1985. Chosen Food Plants: Taxi with Potential for the Future Economic Exploitation. In: Wickens, G.E., J.R. Goodin and D.V. Field (Eds.): *Plants for arid lands*. Proceedings of the International Conference on Economic Plants for Arid Lands, 23-27 July, 1984. Royal Botanical Gardens, Kew.
39. Macucule, A.J., 1995. *Sclerocarya birrea* (A. Rich) Hoshst: A wild fruit bearing multipurpose trees species. Unpublished MSc. Thesis. University of Wales, Bangor.