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Domestication potential of Marula (*Sclerocarya birrea* subsp *caffra*) in South Africa and Namibia: 2. Phenotypic variation in nut and kernel traits

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Abstract

As part of a wider study characterizing tree-to-tree variation in fruit traits as a pre-requisite for cultivar development, fruits were collected from each of 63 marula (*Sclerocarya birrea*) trees in Bushbuckridge, South Africa and from 55 trees from the North Central Region of Namibia. The nuts were removed from the fruit flesh, and the kernels extracted, counted and weighed individually to determine the patterns of dry matter partitioning among the nut components (shell and kernel) of different trees. Mean nut, shell and kernel mass were not significantly different between the two countries. Between sites in South Africa there were highly significant differences in mean nut mass, shell mass, kernel mass and kernel number. In Namibia, there were highly significant differences between geographic areas in mean shell mass, kernel mass and kernel number, but not in nut mass. These differences had considerable impacts on shell:kernel ratios (8.0 − 15.4). In South Africa, mean kernel mass was significantly greater in fruits from farmers' fields (0.42 g) than from communal land (0.30 g) or natural woodland (0.32 g). Within all sites, in both South Africa and Namibia, there was highly significant and continuous variation between individual trees in nut mass (South Africa = 2.3 − 7.1 g; Namibia = 2.7 − 6.4 g) and kernel mass (South Africa = 0.09 − 0.55 g; Namibia = 0.01 − 0.92 g). The small and valuable kernels constitute a small part of the nut (Namibia = 6.1 − 11.1%; South Africa = 7.6 − 10.7%). There can be 4 kernels per nut, but even within the fruits of the same tree, kernel number can vary between 0-4, suggesting variation in pollination success, in addition to genetic variation. The nuts and kernels of the Namibian trees were compared with the fruits from one superior tree ('Namibian Wonder': nuts = 10.9 g; kernels = 1.1 g). Oil content (%) and oil yield (g/fruit) also differed significantly between trees (44.7 − 72.3% and 8.0 − 53.0 g/fruit). The percentage frequency distribution of kernel mass was skewed from trees in farmers' fields in South Africa and in some sites in Namibia, suggesting a level of anthropogenic selection. It is concluded that there is great potential for the development of cultivars for kernel traits, but there is also a need to determine how to increase the proportion of nuts with four kernels, perhaps through improved pollination success.

Introduction

Sclerocarya birrea (A. Rich.) Hochst. subsp. *caffra* (Sond.) Kokwaro is one of the traditionally important indigenous fruits of southern Africa and is now gaining commercially importance (Shackleton et al. 2002a; Wynberg et al. 2002). A previous paper in this series (Leakey et al., 2004b) has indicated its grow-

ing importance as indicated by a number of domestication initiatives in South Africa, Botswana and in Israel. More recently, the World Agroforestry Centre (ICRAF), has also initiated germplasm collection and field trials, as part of its internation agroforestry tree domestication programme (Leakey and Simons 1998; Simons and Leakey, in press).

Initiatives in four regions of Africa are developing techniques and strategies for the domestication and commercialisation of trees producing agroforestry tree products (AFTPs) for integration into farmland (Simons and Leakey, in press). This is seen as an approach to poverty alleviation (Leakey and Simons 1998; Poulton and Poole 2001) and the environmental rehabilitation of degraded farmland (Leakey 1999a, 2001). The present study, as part of a resource inventory, quantifies the phenotypic variation in fruit, nut and kernel traits in marula, within the framework of a broader project examining the benefits and opportunities for domesticating and commercialising the fruits and kernel oil of marula in South Africa and Namibia (Sullivan et al. 2003). Chemical analysis of fruits and kernels has indicated the potential of marula nutritionally, and as a source of high quality oil, rich in tocopherol (Burger et al. 1987; Leakey 1999b). Recent collections of marula fruits and nuts from individual trees in Makueni district of Kenya have been analysed for a wide range of nutritional compounds and minerals, and the kernels were rich (56-64%) in oils (Thiong'o et al. 2002). Kernels are traditionally used extensively in some areas in southern Africa (e.g., Inhambane, Mozambique; Owambo, Namibia; KwaZulu-Natal, South Africa), but little used in other areas (e.g., Kavango, Namibia; Northern Province, South Africa) as a nutritious food, a meat preservative and as a skin moisturizing agent (Shackleton et al. 2002a; Wynberg et al. 2002). The oil is also starting to become important in the cosmetics industry (Wynberg et al. 2002).

Methods and materials

As already reported for a study of marula fruit characterization, ripe and unblemished fruits were collected from beneath the crown of marula trees in villages in Limpopo Province, South Africa (Bushbuckridge) and Namibia (North Central Region), in 2002 (see details in Leakey et al., 2004b). Fruits from each tree were separately bagged and labelled for use in the study of fruit characteristics (Leakey et al., 2004b) and for the present study. As soon as possible (usually 2-3 days later), the nuts were soaked and scrubbed to remove the flesh before being set in the sun to dry for about 10 hours. When dry, the nuts were weighed and numbered still in the same order as for the study of fruit traits (Leakey et al., 2004b) so that their identity was maintained for subsequent cracking and kernel removal. The kernels were then weighed using a laboratory (0.001 g) balance (Mettler Toledo PB 3002) and packaged for later oil extraction. Shell mass was derived by difference (Nut – kernel = shell).

Addition samples were collected (see Leakey et al., 2004b for details) from the Mhala Development Centre (MDC), in Bushbuckridge, South Africa and from a superior tree (identified here as 'Namibian Wonder').

SPSS 10.0 for Windows was used for the Analysis of Variance, Duncan's Multiple Range tests, and tests for skewness and kurtosis.

Oil extraction from the South African and Namibian kernels was done by Analytical Laboratory Services in Windhoek using a petroleum ether extract, according to the Deutsche Einheitsmethoden zur Untersuchung von Fetten, Fettprodukten, Tensiden und Verwandten Stoffen (Method code = DGF 8-15 (B7)) method.

Table 1. Comparison of marula (*Sclerocarya birrea*) nut traits between South Africa and Namibia.

Trait	South Africa	Namibia	Probability
Nut mass	3.96	4.06	P=0.040
Kernel mass	0.34	0.36	P=0.027
Shell mass	3.62	3.68	P=0.212
No of kernels	1.54	1.50	P=0.286
Shell:kernel ratio	9.4	9.8	

Results

Variation between sites

Comparison of mean values between South Africa and Namibia

Mean nut, shell and kernel mass were not significantly different between the two countries (Table 1).