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Variability in *Balanites aegyptiaca var. aegyptiaca* seed kernel oil, protein and minerals contents between and within locations

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ABSTRACT

Balanites aegyptiaca, deep rooted arid zone tree has a very wide natural range. The tree is valued for its fruits and seeds. The seed kernel is rich in oil, protein, minerals and edible as snacks after boiling. The wide range under which this species is occur suggests high pattern of variation among and within locations. The aim of this study was to assess the variability in seed kernel chemical contents between locations and individual trees with locations. Seed kernel from three distinct ecological zones in Sudan and individual trees within each zone were analyzed for minerals (N, P, K, Ca, Mg and Fe), oil and protein contents. The results showed a very high significant variation in all seed kernel chemical contents analyzed among and within locations. The oil content range from 50% to 20%, while protein varied from to 37% to 27%. The study revealed that Balanites seed kernel chemical content was remarkably variable among and within locations, that should be considered in conservation, domestication and improvement plans for this tree.

Key words: *Balanites aegyptiaca*, oil, protein, minerals, domestication.

INTRODUCTION:

Balanites aegyptiaca, Hegleig tree is indigenous to all dry lands south of Sahara and extending southwards (Sands, 2001; Hall and Walker, 1991; Shanks, 1991; Sidiyene, 1996). It is also found in Arabian Peninsula (Arboneir, 2004), India, Iran and Pakistan (Amalraj and Shankarnarayan, 1986). In Sudan it is more likely the species with widest natural range, occur in all zones, except in very high altitudinal areas or when the rainfall exceeds 1100 mm/annum (Badi *et al*, 1989). It makes up to one third of the total tree population in central region of the Sudan (NRC, 2008).

B. aegyptiaca had been used over thousands of years (Von Maydell, 1986). The fleshy pulp of the fruit is eaten fresh or dried. It contains 64 – 72% carbohydrates, plus crude protein, steroidal saponins, vitamin C, ethanol and other minerals (Abu Al-Futuh, 1983). All parts of the tree has a medicinal uses including fruits, seeds, barks and roots. The most important is a steroidal saponins, which yield diosgenin, a source of steroidal drugs, such as corticosteriods, contraceptives and sex hormones (Farid *et al.,* 2002; Pettit *et al*., 1991; FAO, 1985).

Balanites seed kernel is considered as an extremely useful edible product. It contains good quality oil and high protein content (Mohamed *et al*, 2002; Abu Al-Futuh, 1983). The debittered kernel is used as snacks (nuts) by humans. The extracted oil used for many uses and the remaining cake is used as animal feed (Nour *et al.,* 1985). Both fruits and kernel were widely used in many countries during the dry season and drought periods including Nigeria (Lockett *et al.*, 2000), Ethiopia, (Guinand and Lemessa, 2001) and Sudan (Grosskinsky and Gullick, 2001).

Schmidt and joker (2000), Hall and Walker, (1991) and Sayda, (2002) were recorded that balanites appears to be highly variable in growth and seed chemical contents. The wide variation under the range in which the tree is found suggests genetic differences between and within locations. Determining this genetic variation is very important for improvement and domestication of this species based on seed parameters.

Therefore, the objective of this study is to assess the variation in seed kernel chemical contents between different locations and individual trees within locations in Sudan. Specifically to investigate variation in seed kernel Nitrogen, phosphorous, calcium, potassium, iron, magnesium, protein and oil contents between and within three different locations.

MATERIALS AND METHODS

Seed sources: Three distinct ecological zones of the species across Sudan were identified for seed collections. These are: one, Balanites – Acacia zone in dark cracking clay (represented by Um Abdalla). Two, Baggara Catena of Western Sudan

(represented by Ed Alfrissan). Third, Nuba Mountains (represented by Rashad). These locations were varied in soil type, rainfall and altitude as indicated in table (1).
Seed collection: Seeds was collected from 25 trees per location. The trees selected were widely spaced between each other to avoid collecting seeds from related trees. Seed of each tree was kept separate as an open-pollinated family.

Chemical analysis: seed subsamples from Seven trees per location was drawn. The seeds was then broken open to remove the kernel. Ca, Fe, K and Mg were analyzed using atomic absorption spectrometer model 3110 according to PERKIN ELMER CORP, 1994. Nitrogen was analyzed according to micro-jedahl methods and the result was multiplied by 6.25 to get protein content. The Oil was extracted by ether extraction using soxlet apparatus. for oil bulked seed kernel per location was used.

Data analysis: Nested analysis of variance was done to determine the effects of geographical sources and individual tree within sources on chemical contents. Duncan's multiple range test was carried to separate between means. Cluster multi-variate analysis was done to group the three locations according to the chemical contents. Average linkage cluster between sources was analyzed.SAS statistical analysis (SAS system, 8) was used for data analysis.

Table (1): Locations of *B aegyptiaca var aegyptiaca* seed sources used in this study.

Location	Lat.^{o}N	Long.^{o}E	Soil	Rainfall mm	Elevation (meter) masl	Seed[1] zone
Rashad	11.85	31.06	Rocky soil	800	1,030	6.2
Um Abdalla	11.73	30.80	Dark cracking clay	700	615	4.1
Ed Alfrissan	11.48	24.30	Hard compact Sandy clay loam (nagaa soil)	700	585	5.2

[1] Seed zone as delineated by Aelbaek and Kananji, (1995).

RESULTS AND DISCUSSION:

The results of this study showed that Balanites has a very high variation in all seed kernel chemical contents among and with locations (p= 0.0001)(table 2). All chemicals contents were higher in Um Abadalla locations except CA which is lower in Um Abdalla location (Table 3). Um abadalla is a typical *B. aegyptiaca – Acacias* woodland on clay. The association of balanites with leguminous acacias in this zone may supply more nutrients, especially nitrogen to the balanites resulting in this higher values. The others two locations although were highly different in altitude and rainfall but both its soils characterized by hard compact soil. The significance of the effect of soil was further supported by the cluster analysis (Fig. 1), which group Rashad and Ed Elfrissan in the same distance while Um abdalla was highly separated from them. This is in accordance with Elfeel and Warrag (2006) who found balanites seed morphology was higher in clay than the other soils. The very high variation between individual tress between location may suggests that potential gain can be obtained for this species by selecting trees on individual trees basis, as best tree improvement gains normally based on variation between individual trees (Zobel and Talbert, 1984).

Among the three locations, the greatest oil content was found in Um Abdalla (49.5%) and the lowest oil content was found in Ed Alfrissan (19.8%) (Fig. 1). Taking into account that the oil has the same quality as sesame and ground nut oils that were most popular edible oils in Sudan (Abu Al-Futuh, 1983), a wide range of medicinal uses (Hanan, 2009) and can be used as biodiesel (Bishnu *et al*, 2009), oil can be considered as one of most important products of this trees. The problem associated with a good utilization of oil in this tree is removal of the kernel from the hard woody endocarp. Economically feasible techniques for crushing the endocarp, will enhance oil production from this species, especially in rural areas. The protein content ranged between 37% to 27% (Fig. 1). Similar results were obtained by many authors (Mohamed *et al.,* 2002; Abu Al-Futuh, 1983; El Khidir, 1983).

The very high pattern of variation obtained among and within locations, indicates that potential gain in oil and protein contents can be obtained by selection of a good seed sources for planting. Also, low input domestication of this species can be achieved by planting a high yielders trees. The high contents of oil and protein seed kernel can contribute to the economic importance of this tree in Sudan. According the forest national inventory, Central Sudan alone contains more than 93 million trees (FNC, 1998). In addition to that one tree can produce up to 100 –

150 kg of fruits per year (Schimdt, and Joker, 2000), and the kernel represents 15% of fruit (Elfeel and Warrag, 2006). This clearly highlights the potential of fruit and seed products of this tree as earlier pointed out by Abu Al-Futuh, (1983) and recently by the National Research Council (2008). This is in addition to the fact that the trees is a very deep rooted, makes it one of most promising arid zone tree species.

This study reveal that there is a great variation between locations and individual trees within locations in all seed kernel chemical contents. This type of variation must be considered when planning conservation, domestication or improvement of this species.

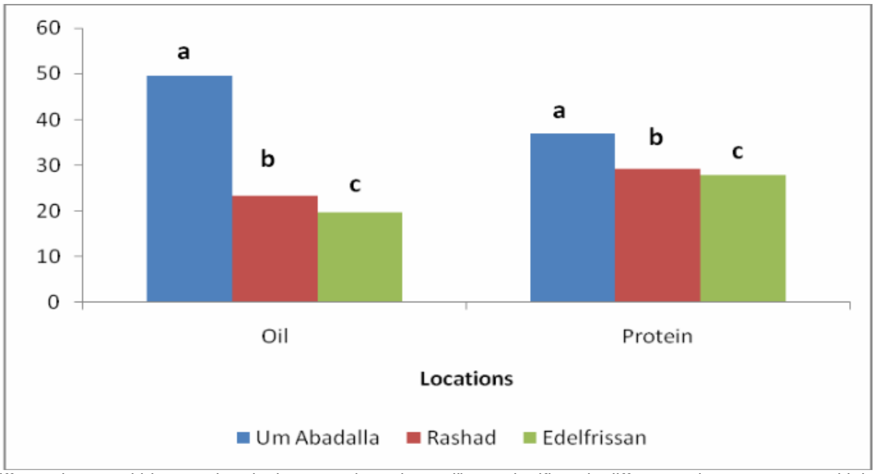
Table (2): ANOVA Results for the effect of geographical locations and individual trees with locations on *B. aegyptiaca var. Aegyptiaca* seed kernel mineral contents.

Effect		Minerals					
		N	P	Fe	Ca	K	Mg
Prov	DF	2	2	2	2	2	2
	MS	13.265	0.086	0.352	3.150	7.099	0.694
	F.Value	237.9	39.6	37.1	689.1	88.3	68.9
	P	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Tree(prov)	DF	18	18	18	18	18	18
	MS	0.864	0.320	0.1001	0.466	3.452	4.056
	F.Value	15.5	146.8	9.9	101.9	42.9	402.8
	P	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	RSD%	4.7	2.7	5.9	2.4	6.7	1.8

Table (3): Mean mineral contents in seed kernel of *B. aegyptiaca var. aegyptiaca* between different geographical locations.

Sources	Minerals					
	N%	P%	Fe mg/l (ppm)	Ca mg/l (ppm)	K mg/l (ppm)	Mg mg/l (ppm)
Um Abdalla	5.92^{a}	1.75^{a}	1.07^{a}	2.31^{c}	4.83^{a}	5.60^{a}
Rashad	4.66^{b}	1.63^{c}	0.79^{c}	3.08^{a}	3.73^{c}	5.25^{c}
Ed Alfrissan	4.45^{c}	1.72^{b}	0.97^{b}	2.75^{b}	3.97^{b}	5.51^{b}

Means with different letters in the same column are significantly different using Duncan's multiple range test.



Columns with different letters within one chemical content (protein or oil) are significantly different using Duncan's multiple range test

Fig. (1): Percentage oil and protein contents in seed kernel of *B. aegyptiaca var. aegyptiaca* between different locations.

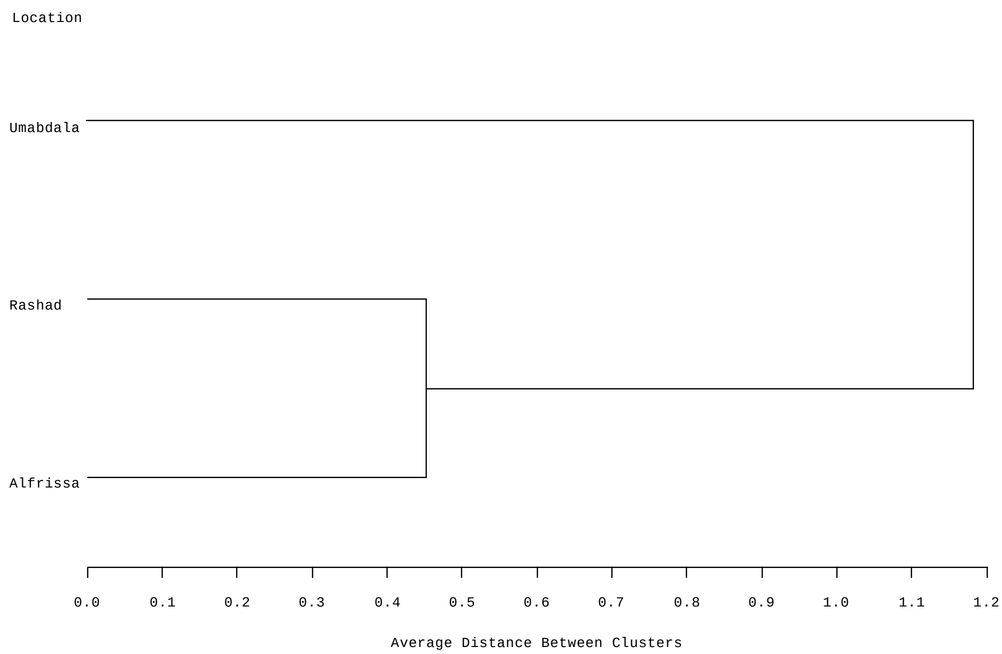


Fig. (2): Dendrogram showing Grouping of *Balanites aegyptiaca* locations according to the seed kernel chemical contents analyzed using average linkage cluster

CONCLUSION:

The study indicate that there is a great variation in balanites seed kernel oil, protein and minerals contents, which should be considered for successful domestication of this drought prone species. Also, the study high lights the potential of Balanites for oil production as an agro-industrial material and the potential of the cake for animal feed.

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