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SOURCE VARIATION IN MORPHOLOGICAL TRAITS OF *BUCHHOLZIA CORIACEA* ENGLER SEEDLINGS

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ABSTRACT

Investigations were conducted on the effects of source variation on the morphological traits of *Buchholzia coriacea* Engler seedlings, a medicinal plant in southwestern Nigeria. The sources were Erifun, Olukosi, Ore Forest Reserve, Ogbere, Ago-Owu, Omo forest reserve and Eleiyele. Two hundred (200) seeds were randomly selected from the seven sources and sown in germination boxes. The seedlings from each source were arranged in the greenhouse in three replicates with each having thirty seedlings using the completely randomized design. Seedlings were assessed for shoot height, leaf production, collar diameter, leaf area and biomass production for six months. Data collected were subjected to analysis of variance and significant means separated using least significant difference. The tallest seedlings were from Olukosi seeds with mean value of 33cm. This was followed by seedlings from Eleiyele seeds, 31.7cm and Erifun, 29.1cm. Erifun seeds had the highest mean value (6.6mm) for collar diameter and (14.4 leaves) for leaf production. Seedlings from Olukosi seeds had 13.2 leaves and those from Ago-Owu seeds, 12.9 leaves. The highest mean leaf biomass, 2.2g was recorded in seedlings from both Olukosi and Ogbere seeds. Mean stem biomass of seedlings from Ogbere source, 3.3g was the highest while the highest mean value for root dry weight, 40.8g was recorded for those from Ore forest reserve. Seedlings from Olukosi and Ogbere sources performed best out of the seven sources. Erifun was the poorest followed by Eleiyele. Seeds from Olukosi or Ogbere could be recommended for the establishment of plantations of *B. coriacea*.

Keywords: ***Buchholzia coriacea*,** Medicinal plant, Morphological traits, Sources, Variation

INTRODUCTION

Buchholzia coriacea Engler, a medicinal plant, is an indigenous forest tree of West Africa, with large, glossy, leathery leaves and conspicuous creamy white flowers (Keay, 1989). It is an evergreen under storey plant with distribution extending from Cote d'Ivoire to Gabon. Its popular use in traditional medicine and the increasing rate of deforestation has led to its decrease in the wild populations and sources where this species could be obtained. According to Cuningham (1993), an estimated 80% or more of the world's population depends primarily on traditional medicine for the treatment of various ailments. Therefore, a possible tool in the sustainable management of this resource is plantation forestry. However, it is important to have knowledge of variation, within the species to be able to determine their response to environmental changes.

Variation, a product of interaction between the environment and inherited qualities could be defined as the difference between and within population of a species (Dutta, 1981). This is true because individual differences exist between members of any normal population. In reality, no matter their similarities, no two members of any population are completely identical. The success of restoration efforts is profoundly affected by the source of seed materials because most species exhibit adaptive genetic variation within their range (O'Brien *et al.* 2007). Ruiz -Jaen *et al* (2010) opined that environmental and spatial variation affect tree diversity and carbon storage. Therefore, the existence of variations within food yielding trees which could be exploited for their conservation, domestication, improvement and utilization was reported by Hamrick and Godt (1989). Oni and Gbadamosi (1998) studied the variations in progenies of *Dacryodes edulis* G. Don. from four sources in South western Nigeria and they reported significant différences in the fruit characters of the species. Variations were also observed in the relative growth rate, net assimilation rate and root/shoot ratio among the sources. While significant variations were observed in seedling height and diameter of seedlings of seeds from various sources in the study of source variations in *Terminalia ivorensis* A. Chev carried out by Oni (2000), parameters such as leaf area, leaf thickness, height of first branch from collar and crown area were not influenced by source at six months. Ngulube *et al.* (1997) also explored the variations in fruit, seed and seedling traits within *Uapaca kirkiana* Muell. Arg species. There were significant differences in fresh fruit weight and dependent parameters (exocarp, mesocarp and seeds) and seed length, width, thickness and weight (following processing) among 12 natural populations. There were also significant differences in germination capacity, seedling height, and root collar diameter and biomass production of the seedlings at 6 months. The variation in the traits reported emphasized the importance of selecting suitable seed sources before commencing domestication programme. Upadhaya *et al*., (2007) investigated the effect of seed mass on germination, seedling survival and growth in *Prunus jenkinsii* Hook.f. & Thoms. Information on effect of seed weight on growth of seedlings of most tropical forest species is scarce or not available at all. Therefore, in this study, investigations were conducted on the effects of source variation on morphological traits of seedlings of *Buchholzia coriacea* Engler. Mature seeds of *Buchholzia coriacea* were collected from seven (7) sources viz: Erifun, Olukosi, Ore forest reserve, Ogbere, Ago-Owu, Omo forest reserve and Eleiyele.

MATERIALS AND METHOD

Sources of seed samples

Mature seeds of *Buchholzia coriacea* were collected from seven sources in Southwestern Nigeria. Table 1 shows the sources as well as their geographical locations.

Selection of seed samples

Two hundred (200) good seeds (free from pests and diseases) from each source were randomly selected and sown in germination boxes filled with topsoil under the high humidity propagator. At the six leaf stage, thirty (30) uniformly growing seedlings from each source were transplanted into medium sized polythene pots measuring 16 x 14 x 12 cm^3 filled with topsoil.

The seedlings were laid out in a completely randomised design in the green house. Watering was done to field capacity once daily. The following growth parameters: height, collar diameter and number of leaves per seedling were measured at two weeks interval for 6 months. Leaf area, stem weight, leaf weight, root weight and total biomass were also measured at three harvests through out the study period. Biomass assessment and leaf area were used to calculate the relative growth rate (RGR) and net assimilation rate (NAR). At the start of the experiment, the seedlings were paired and samples were taken and used for the determination of initial dry weights of plants and leaf area. Three harvests were made at two months interval. At each harvest, ten seedlings were harvested from each source. The seedlings were partitioned into root, stem and leaves for biomass measurement. Leaf stalks were included in stem biomass. Leaf area was obtained by using the grid method. Fresh weight of the various components (root, stem and leaves) were determined before the samples were oven dried at 80^{o}C for 24 hours. The dry weights and the leaf areas were then used to calculate the relative growth rate (RGR), net assimilation rate (NAR) and shoot/root ratios using the formulae earlier used by of Oni (1989) as follows:

$$NAR\ (gm^{2}wk^{1}) = \frac{w_2 - w_1}{A_2 - A_1} \times \frac{LnA_2 - LnA_1}{t_2 - t_1}$$

$$RGR\ (gg^{-1}wk^{1}) = \frac{Lnw_2 - Lnw_1}{t_2 - t_1}$$

where w_1 and w_2 = biomass at times t_1 and t_2

A_1 and A_2 =leaf area at times t_1 and t_2

LnA_1 and LnA_2 = natural logarithm of leaf area at times t_1 and t_2

Data collected were subjected to analysis of variance (ANOVA) and significant means were separated using least significant difference (LSD) at p=0.05.

Table 1: Selected sources of *B. coriacea* in south western Nigeria

S/N	Selected source	Identification			Location			
		Code	Country	State	Latitude	Longitude	Rainfall (mm)	FAO soil type
1	Erifun	L1	Nigeria	Ogun	6o93’	3o46’	1488	Dystric nitosols
2	Olukosi	L2	Nigeria	Ogun	7o46’	3o03’	1174	Lithosols
3	Ore Forest Reserve	L3	Nigeria	Ondo	6o74’	4o86’	1749	Ferric luvisols
4	Ogbere	L4	Nigeria	Ogun	6o73’	4o15’	1687	Dystric regosols
5	Ago-Owu Forest Reserve	L5	Nigeria	Osun	7o24’	4o33’	1466	Ferric luvisols
6	Omo Forest Reserve	L6	Nigeria	Ogun	6o35’	4o05’	2180	Ferric luvisols
7	Eleiyele	L7	Nigeria	Oyo	7o51’	3o56’	1253	Ferric luvisols

Source: GIS through the Agroecological Studies Unit, IITA, Ibadan

RESULTS

Seedling height

Seedling heights varied significantly among the seven sources (p=0.05) (Table 2). The tallest seedlings were from Olukosi seeds with mean value of 33cm. This was followed by seedlings from Eleiyele seeds at 31.7cm and those from Erifun at 29.1cm. The shortest seedlings (19.9cm) were obtained from Ogbere seeds (Table 3). Shoot height of seedlings from Omo Forest Reserve and Erifun seeds were not significantly different from each other.

Seedling diameter

Variations were observed in the collar diameter of seedlings from the seven sources (p=0.05) (Table 2). Seedlings from Erifun source had the highest mean value of 6.6mm for collar diameter followed by those from Ago-Owu and Eleiyele at 5.9mm. The least value for seedling collar diameter 4.4mm was obtained from seedlings from Ogbere source (Table 3). Diameter of seedlings from Ogbere seeds was significantly lower than that of seedlings from other sources. However, there was no variation in the diameter of seedlings from Ago-Owu, Omo Forest Reserve, Eleiyele and Olukosi.

Table 2: Analysis of variance for effect of source on growth of seedlings of *B coriacea*

Parameter	Degree of freedom	Means of squares	F	p-level
1) Seedling height				
Source	6	699.9	364.59*	0.0001
Error	232	1.91		
2) Collar diameter				
Source	6	16.66	147.1*	0.0001
Error	232	0.11		
3) Leaf production				
Source	6	160.62	124.58*	0.0000
Error	232	1.28		

*=significant at a=0.05

Table 3: Effect of source on growth of seedlings of *B coriacea*

	Parameter		
Sources	Shoot height (cm)	Collar diameter (mm)	Number of leaves
Ogbere	19.9a	4.4a	8.6a
Ore	25.1b	5.7b	9.4b
Ago-Owu	25.9c	5.9c	12.9c
Omo Forest Reserve	28.5d	5.8bc	12.2d
Erifun	29.1d	6.6d	14.4e
Eleiyele	31.7e	5.9c	12.7cd
Olukosi	33.0f	5.8bc	13.2f

a, b, c, Means with different letters within column are significantly different at a=0.05 according to LSD.

Number of leaves per seedling

Leaf production by the seedlings varied significantly among the seed sources (p=0.05) (Table 2). Erifun source had the highest mean value of 14.4 leaves while Olukosi had 13.2 leaves and Ago-Owu, 12.9 leaves. The least value of 8.6 leaves was observed in the seedlings from Ogbere seeds (Table 3). While variations were observed in number of leaves of seedlings from Ogbere, Ore, Erifun and Olukosi seeds, those from Omo Forest Reserve, Eleiyele and Olukosi sources did not vary significantly in leaf production.

Effect of source on seedling biomass

Leaf dry weight

Source and age significantly affected the leaf dry weight recorded for seedlings from the seven sources (p=0.05) (Table 4). The highest mean leaf biomass, 2.2g was recorded in those of Olukosi and Ogbere sources. Omo forest reserve and Eleiyele had mean values of 2.0g while Erifun had 2.1g. Ore forest reserve and Ago-Owu forest reserve had the least mean values of 1.9g and 1.8g respectively (Table 5).

Stem dry weight

Seed source significantly affected the stem dry weight of the seedlings. Age also had a significant effect on the stem dry weight at p=0.05 (Table 4). Mean stem biomass of seedlings from Ogbere source, 3.3g was significantly higher than those of the remaining six sources, although it was not significantly different from that of Ore forest reserve which was 3.1g. The difference among the values for Olukosi, Ago-Owu forest reserve, Omo forest reserve and Eleiyele sources was not significant (Table 5).

Table 4: Analysis of variance for the effect of source on biomass assessment

Parameter	Degree of freedom	Mean of squares	F	p-level
a. Leaf dry weight				
Source	6	0.1210	7.805*	0.000041
Age	5	3.901	251855*	0.00000
Error	30	0.0155		
b. Stem dry weight				
Source	6	1.312	29.545*	0.000000
Age	5	4.939	111.169*	0.000000
Error	30	0.0444		
c. Root dry weight				
Source	6	238.49	284.21*	0.000000
Age	5	104.02	123.96*	0.000000
Error	30	0.839		
d. Total biomass				
Source	6	275.38	264.75*	0.000000
Age	5	36.84	35.81*	0.000000
Error	30	1.028		
e. Leaf area				
Source	6	113425.0	5.87*	0.000385
Age	5	3798217.0	196.58*	0.000000
Error	30	19321.11		

*=significant at a=0.05

Root dry weight

Source and age significantly affected the root dry weight (p=0.05) (Table 4). The highest mean value for root dry weight, 40.8g was recorded in seedlings from Ore forest reserve seeds. This was followed by a mean value of 39.7g in those from Ogbere sources. Mean values of 28.2g, 27.1g and 26.2g were recorded in those from Ago-Owu forest reserve, Omo forest reserve and Eleiyele sources respectively. The values for these three sources were not significantly different from one another (Table 5).

Table 5: Effect of source on biomass assessment of seedlings of *B. coriacea*

	Parameter				
Effect Source	Leaf dry weight (g)	Stem dry weight (g)	Root dry weight (g)	Total biomass (g)	Leaf area (cm2)
Erifun	2.1ab	2.8a	27.8a	32.7ac	2655.7a
Olukosi	2.2ab	2.4bd	27.8a	32.4ac	2736.8a
Ore forest reserve	1.9bc	3.1c	40.8b	45.9b	2513.8ab
Ogbere	2.2ab	3.3c	39.7c	45.2b	2733.7a
Ago-owu forest reserve	1.8bc	2.1bd	28.2ad	32.1ac	2355.0b
Omo forest reserve	2.0ab	2.3bd	27.1ad	31.4ac	2581.5ab
Eleiyele	2.0ab	2.3bd	26.2ad	30.4ac	2512.2ab

a, b, c, Means with different letters within column are significantly different at a=0.05 according to LSD.

Total dry weight (TDW)

Both source and age significantly affected total biomass accumulation (Table 4). At the end of the experiment, total dry weight of seedlings from Ogbere and Ore forest reserve sources, 45.2g and 45.9g, were significantly different from the remaining five sources. The mean values of total dry weights of these sources were not significantly different from one another. Seedlings of Eleiyele source had the least mean value of 30.4g (Table 5).

Leaf area

Leaf area expansion of seedlings was significantly affected by the source and the age of seedlings ($p \leq 0.05$) (Table 4). Mean values for leaf area of those seedlings from Erifun, Olukosi and Ogbere sources, 2655.7cm^2, 2736.8cm^2 and 2733.7cm^2, were significantly different from those of Ore forest reserve, Omo forest reserve and Eleiyele sources with mean values of 2513.8cm^2, 2581.5cm^2 and 2512.2cm^2. The least mean value, 2355.0cm^2 was obtained among seedlings from Ago-owu forest reserve sources. However, the leaf areas of seedlings from Erifun, Olukosi and Ogbere sources were not significantly different from one another (Table 5).

Shoot/ root ratios of the seedlings

At the 1st harvest, seedlings from all the sources had high shoot/ root ratios. Seedlings from Ago-Owu had the highest shoot/ root ratio of 1:16.6 followed by those from

Omo forest reserve with 1:15.8. The least shoot/ root ratio at 1st harvest, 1:11.7 was recorded among seedlings from Olukosi source (Table 6).

By the 4th harvest (4 months), seedlings from Ore source had the highest shoot/ root ratio, 1:8.0 while seedlings from Eleiyele source had the least value of 1:5.2. At final harvest (6 months), seedlings from Ore forest reserve still had the highest shoot/ root ratio, 1:4.8 while seedlings from Olukosi source had the least, 1:3.2.

Net assimilation rate (NAR)

No variation in the Net assimilation rate (NAR) of the seedlings from all the sources studied. Generally, the data did not follow any distinct pattern as the values were mostly negative (Table 7). Only Erifun and Omo sources had positive value of 1.0×10^{-4} gm^2/ month between the 5th and 6th month. All other sources had negative values from the 1st month to the 6th month. This was followed by seedlings from Ore with the next best performance in NAR having a negative value of -1.1×10^{-3} gm^2/month between the 1st and 2nd month. However, the least value for NAR, -9.0×10^{-4} gm^{-12}/month was also recorded in seedlings from Ore between the 2nd and 3rd months.

Table 6: Shoot/ root ratios for sources

Sources	H 1**	H2	H 3	H 4	H5	H6
Ogbere	1:12.7	1:9.9	1:8.1	1:6.8	1:5.7	1:4.4
Erifun	1:12.9	1:9.7	1:6.4	1:4.7	1:3.8	1:3.3
Ore	1:13.7	1:11.7	1:9.5	1:8	1:6.1	1:4.8
Ago-Owu	1:16.6	1:11.7	1:8.4	1:6.5	1:5.4	1:3.7
Eleiyele	1:13.9	1:10.7	1:6.4	1:5.2	1:4.3	1:3.8
Omo	1:15.8	1:11.4	1:7.1	1:5.6	1:4	1:3.3
Olukosi	1:11.7	1:9.8	1:7.2	1:5.4	1:4.2	1:3.2

**H1= Harvest after 1 month, H2=Harvest after 2 months, H3= Harvest after 3 months, H4= Harvest after 4 months, H 5= Harvest after 5 months

Table 7: Net assimilation rate for source in gm^2/month

Sources	NAR 1**	NAR 2	NAR 3	NAR 4	NAR 5
Ogbere	-1.2 x 10-3	-1.4 x 10-3	-6 x 10-4	7 x 10-4	-2 x 10-4
Erifun	-4 x 10-4	-4 x 10-4	-4 x 10-4	-2 x 10-4	1 x 10-4
Ore	-1.1 x 10-3	-9 x 10-4	-8 x 10-4	-3 x 10-4	-1 x 10-4
Ago-Owu	-5 x 10-4	-8 x 10-4	-5 x 10-4	-8 x 10-4	-2 x 10-4
Eleiyele	-7 x 10-4	-3 x 10-3	-7 x 10-4	-1 x 10-4	-1 x 10-5
Omo	-1.2 x 10-3	-5 x 10-4	-2 x 10-4	-1.3 x 10-3	1 x 10-4
Olukosi	-5 x 10-4	-4 x 10-4	-5 x 10-4	-6 x 10-4	-7 x 10-4

**NAR 1= NAR between 1st and 2nd month, NAR 2= NAR between 2nd and 3rd month, NAR 3= NAR between 3rd and 4th month, NAR 4 = NAR between 4th and 5th month, NAR 5= NAR between 5th and 6th month

Relative growth rate (RGR)

The data did not follow any clearly explainable pattern as the values were mostly negative. Seedlings from Olukosi had the best performance with a positive RGR of 6.1 x 10 $^{-2}$ gg^{-1}/month between the 4th and 5th month (Table 8).

Table 8: Relative growth rate for sources in gg^{-1}/month

Sources	RGR 1**	RGR 2	RGR 3	RGR 4	RGR 5
Ogbere	-4.5 x 10-2	-6.8 x 10-2	-3.7 x 10-2	5.3 x 10-2	1.3 x 10-2
Erifun	-2.0 x 10-2	-2.6 x 10-2	-3.6 x 10-2	-1.5 x 10-2	9.4 x 10-3
Ore	4.1 x 10-2	-4.0 x 10-2	4.2 x 10-2	2.1 x 10-2	9.3 x 10-3
Ago-Owu	2.3 x 10-2	-4.7 x 10-2	3.7 x 10-2	7.3 x 10-2	1.7 x 10-2
Eleiyele	-3.4 x 10-2	-1.9 x 10-2	-5.9 x 10-2	6.9 x 10-3	3.5 x 10-3
Omo	-5.2 x 10-2	-3.0 x 10-2	-2.2 x 10-2	-1.4 x 10-1	1.4 x 10-2
Olukosi	-2.8 x 10-2	-2.6 x 10-2	-4.6 x 10-2	6.1 x 10-2	-7.9 x 10-2

******RGR 1= RGR between 1st and 2nd month, RGR 2= RGR between 2nd and 3rd month, RGR 3= RGR between 3rd and 4th month, RGR 4 = RGR between 4th and 5th month, RGR 5= RGR between 5th and 6th month

DISCUSSION AND CONCLUSION

Trees are predominantly outcrossing, thus resulting in progeny that segregate with respect to parental traits thereby affording the opportunity for selection. The strategy of tree improvement involving the survey and collection of seeds from different sources, structural and agronomic studies of the seeds and seedlings, mass breeding and mass propagation will pave way for the establishment of clonal seed orchards and gene banks of the species for afforestation programme. Since most seed collections for plantation establishment are obtained from naturally occurring trees, the evaluation of the superiority of growth of seedlings from different sources is of paramount importance.

The result of this study showed differences in the various sources. Growth indices such as height, diameter and RGR of seedlings from Olukosi seeds suggest that propagules from this source could maintain good stands of *B. coriacea*.

Many authors (Oyama, 1994; Khasa *et al*, 1995; Probert, 2000; and Dangasuk *et al*. 2001) have observed variations among and between populations of different tree species in different traits studied. The variations in the morphological traits of *B. coriacea* emphasized the importance of selecting suitable sources before commencing domestication programme. The presence of source variation in this species is a strategy for tree improvement involving the survey and collection of seed from different sources, structural and agronomic studies of the seeds and seedlings, mass breeding and mass propagation. Consideration of source variation within this species is important and this information should be integrated into seed collection strategies for tree improvement. This will pave way for the establishment of clonal seed orchards, plantation forestry and gene banks of the species for conservation.

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