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Morphological Characterization of Four Selections of *Vernonia Hymenolepis* A. Rich. (Asteraceae)

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Abstract: *Vernonia hymenolepis* A. Rich. is an African indigenous vegetable that is commonly cultivated by resource-poor farmers in Cameroon and other parts of West and Central Africa, where it is cherished for its leafy shoots. Its production as landraces precludes the horticultural advantages of homogeneity and uniformity. As a prelude to enhance this vegetable, four selections based on stem pigmentation and taste, were planted in a completely randomized design and characterized using thirteen morphological descriptors in 2005 and 2006. Analysis of variance revealed that morphological characters significantly differed between purple-stemmed and green-stemmed selections irrespective of taste while the bitter and non-bitter selections for each pigmentation type could not readily be differentiated morphologically. The green-stemmed selections showed robust luxuriant vegetative growth attributes with delayed flowering, attributes cherished commercially. The data set was reduced to four significant principal components (PCs) in multivariate analysis that cumulatively explained 80% of the variation. The green non-bitter selection is recommended for commercial production pending the development of appropriate cultivars, whereas there is need to develop a cheap and simple biochemical technique of quantifying bitterness for use as a selection tool.

Key words: Indigenous vegetables · landraces selection

INTRODUCTION

Vernonia hymenolepis is a widely acclaimed indigenous leafy vegetable in South Western Cameroon and other West and Central African countries where its production and marketing is an important economic activity amongst rural and peri-urban woman [1]. It is often given the choice of place relative to the other three cultivated species: *Vernonia amygdalina* Del, *Vernonia colorata* (Wild) Drake and *Vernonia thomsoniana* Olive and Hein- because of its reduced bitterness [2]. Apart from its use as a vegetable, *Vernonia hymenolepis* has been used traditionally for medical purposes [3].

Production of *Vernonia hymenolepis* grossly falls short of the highest market demand. Like for many other indigenous vegetables, this has been attributed to lack of appropriate production technology, seed shortage, absence of high yielding cultivars amongst other factors [2]. Unlike exotic vegetables, which have properly characterized cultivars, African indigenous vegetables exist as landraces with enormous heterogeneity that hinders the full exploitation of their genetic potentials [4]. The heterogeneity in landraces of *Vernonia hymenolepis* precludes the horticultural advantages of homogeneity. The dire need for cultivar development for this vegetable must be preceded by appropriate and proper characterization of the existing landraces. Dupriez and De Leener [5] have been able to differentiate between three cultivated species of *Vernonia* on the basis of stem color and leaf size, but there are no reports on intraspecific characterization. We here report the results of the morphological characterization of four selections of *Vernonia hymenolepis* based on stem color (purple or green) and taste (bitter or non bitter) taken from landraces commonly grown around the mount Cameroon area with the aim of contributing towards the enhancement of the vegetable.

MATERIALS AND METHODS

The selections of *V. hymenolepis* were made on the basis of stem colour and the presence or absence of a

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Table 1: Selections of *Vernonia hymenolepis* for characterization

Selection name	Code	Description
Green bitter	GB	Green stem and midrib with a distinctly bitter taste
Green non-bitter	GS	Green stem and midrib but with no distinctly bitter taste
Purple bitter	PB	Purple stem and midrib with a distinctly bitter taste
Purple non-bitter	PS	Purple stem and midrib with no distinctly bitter taste

Table 2: Quantitative estimation of morphological traits of *Vernonia hymenolepis* landraces

Traits	Technique of measurement
Plant height/cm	Length from soil surface to the tip of terminal flower head
Number of leaves per plant	Counting the total number of fully opened leaves per plant
Number of branches per length	Counting the total number of branches with at least two fully opened leaves
Petiole length/cm	Measured from main stem to leaf base of the third fully opened leaf from the tip using a mm tape
Peduncle length/cm	Length from base of the terminal inflorescence to the point of first branching of pedicel measured with a mm tape
Pedicel length/cm	Measured from base of the third capitulum of the inflorescence to the junction with the peduncle using a mm tape
Number of flower heads per plant	Measured by counting the total number of flower head per plant when the first capitulum is fully ripe
Diameter of flower head/mm	Measured on a ripe capitulum using a digital calipers
Leaf length	Distance between the leaf tip and base measured on the third fully opened leaf from the tip, using a mm tape
Leaf width	Breadth of the broadest portion of the third fully opened leaf from the tip measured using a mm tape.
Length of serrate/mm	Measured on the third fully opened leaf from the tip using a mm tape as length from tip to base
Number of serrations	Measured by counting the total number of serrates on the margin of the third fully opened leaf from the tip
Days to flowering	Determined by noting the number of days that 50% of plants had at least one flower.
Spherical index	Estimated as ratio of leaf width to length.

bitter taste as shown on Table 1. Seeds obtained from stocks maintained in the Crop Science Research Laboratory of the University of Buea were sown in nursery trays containing a potting medium made of garden soil and well decomposed poultry manure in the ratio of 3:1 v/v. The ensuing seedlings were transplanted at the four-leaf stage to 3 x 2m plots in a completely randomized design with four replicates, at a spacing of 50cm between rows and 30cm within rows. At the onset of flowering, data of vegetative and reproductive characters including plant height, number of leaves per plant, petiole length, peduncle length, pedicle length, number of flower heads per plant, number of serrations per leaf, length of serrate, relative leaf area, spherical index, time to flowering and diameter of flower heads were collected as specified in Table 2. Data of morphological characters were subjected to the one-way analysis of variance using MINITAB TM (Minitab Inc. 2000, statistical package release 13.1). Fisher's least significant difference (LSD) was used to separate the treatment means and multivariate analysis was done by principal component analysis [6] to estimate the variability among the selections.

RESULTS AND DISCUSSION

The vegetative characteristics of the four selections are shown on Table 3. The green-stemmed selections were significantly taller than the purple-stemmed selections. They also had significantly boarder leaves, which were more spherical than those for the purple-stemmed selections. It was also observed that, the green-stemmed selections flowered significantly later than the purple-stemmed selections (Table 4). It would appear that the early production of flower buds in the purple-stemmed selections suppressed apical dominance, accounting for the shorter plants [7]. Generally, there were no significant differences between selections with the same stem pigmentation. The ability of the green-stemmed selections to produce luxuriant vegetative growth over a long period of time gives them an edge over the purple-stemmed selections, since these are desirable characteristics of leafy vegetables [8]. However, the sharp bitter taste in the GB selection can be deterrent for its use commercially. Also, consumers usually vary in their color preference [9] and some may still prefer the purple-stemmed selections to the green.

Within species variation is a common feature with landraces and has been encountered by Baye *et al.* [7], Ercan *et al.* [10], Fawole and Afolabi [11] and Loi *et al.* [12]. In the present study, the principal component analysis (PCA) grouped the 13 variables into 10 components with Eigen values lying between -0.008 and 0.893, with the first four components explaining a little over 80% of the total variation (Table 5). Principal

Table 3: Vegetative features of four selections of *Vernonia. hymenolepis* at flowering

	Selection				
Character	GB	PS	GS	PB	$LSD_{0.05}$
Plant height /cm	50.6	36.0	53.2	33.0	3.7
No. of leaves per plant	63.7	84.2	70.7	91.7	3.2
No. of branches per plant	8.6	11.2	15.2	12.4	3.0
Leaf petiole length/cm	4.7	4.3	4.6	4.6	NS
Relative leaf area	174.5	112.5	139.2	106.2	4.2
No. of serrations per leaf	49.3	40.8	46.1	41.6	6.0
Length of serrates / cm	0.3	0.2	0.3	0.2	0.1
Spherical Index	0.53	0.37	0.51	0.37	0.06

Table 4: Reproductive features of four selections of *Vernonia hymenolepis*

	Selection				
Character	GB	PS	GS	PB	$LSD_{0.05}$
Diameter of flower head in mm	36.2	34.3	34.5	35.4	NS
Peduncle length per inflorescence in cm	6.0	12.9	7.2	10.0	1.3
Days to flowering	58.5	32.0	56.0	32.0	1.5
Number of heads per plant	2.3	10.0	4.5	9.3	1.0
Pedicel length in cm	10.5	12.5	9.3	11.6	1.4

Table 5: Principal Component Analysis of four selections of *Vernonia hymenolepis*. (Values for first four PCs shown)

	Eigen vectors			
	PC1	PC2	PC3	PC4
Eigen value	4.9803	2.3729	1.6608	1.4045
Proportion	0.3830	0.1830	0.1280	0.1080
Cumulative	0.3830	0.5660	0.6930	0.8010

Table 6: Eigen Vectors for the first four Principal Component axes of four selections of *Vernonia hymenolepis*

	Eigen vectors			
Characters	PC1	PC2	PC3	PC4
Plant height in cm	-0.388	-0.262	0.121	-0.019
Number of leaves per plant	0.017	-0.538	-0.296	-0.168
Number of branches per plant	0.074	-0.566	0.107	0.180
Petiole length in cm	-0.156	-0.090	0.370	0.625
Diameter of flower head in mm	-0.171	-0.044	-0.579	-0.058
Peduncle length in cm	0.300	-0.267	-0.151	0.310
Days to flowering	0.397	0.022	-0.223	-0.160
Number of heads per plants	0.292	-0.240	-0.086	0.097
Pedicel length per flower in cm	-0.076	-0.401	0.392	-0.448
Relative leaf area in cm^2	-0.333	-0.136	-0.372	0.210
Length of serrates in cm	-0.210	-0.001	-0.014	-0.067
Number of serrations	-0.379	0.041	-0.202	0.244
Spherical index	-0.390	-0.026	0.031	-0.325

component 1 (PC1) associated with days to flowering, spherical index and plant height, accounted for 38% of the total variation (Table 6). This means that these descriptors are very important in differentiating between the selections. PC2 consisting mainly of number of branches per plant, number of leaves per plant and pedicel length per flower and accounted for 18% of the total variation, while PC3 associated with diameter of flower head, pedicel length and relative leaf area explained 13% of the total variation. PC4 accounted for 11% of the total variance and consisted mostly of petiole length, pedicel length and spherical index. From the principal component analysis therefore, traits such as days to flowering, spherical index, plant height, length of serrates and number of serrations were the most effective characters for distinguishing among the four selections of *Vernonia hymenolepis*. All of these characters are of comparative morphology origin, which has been the principal source of taxonomic characters because of their ease to assess and associated minimal cost [13]. However, these descriptors were still not effective in differentiating the bitter from the non-bitter selections within each stem pigmentation class. The presence or absence of the bitter taste is a function of the type of secondary plant products present within the plant. Given the commercial importance of the taste character, there is need to develop a cheap

and easy biochemical technique of quantifying bitterness for subsequent use as a selection tool.

This study provides a morphological basis for differentiating four selections of *Vernonia hymenolepis*. The genetic basis of some of these key characters needs to be studied to ascertain their constancy within the population. The development of a simple and cheap biochemical technique for quantifying bitterness will be an important complement to the morphological descriptors that can be used for subsequent selection in the development of commercial cultivars.

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