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# Morphological Characterization of Vine Spinach (*Basella Alba l.* and *Rubra l.*) in Western Kenya

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## Abstract

*Vine spinach is an important African leafy vegetable in Western Kenya. It is highly nutritious and is a good source of Vitamins A and C, calcium, iron and potassium. It is also source of income for farmers and traders especially women who market indigenous vegetables. It is also valued for its medicinal properties as its shoots can be used as a diuretic or laxative, and to treat boils and sores. The roots can be used to treat diarrhea. However, it is regarded as a rare or lost vegetable or orphan crop as far as breeding improvement is concerned in Kenya. There are no reports of hybrids in cultivation or in the wild for in the world. This needs to be addressed to for proper utilization of this crop as well as to avoid of different genotypes. Genetic augmentation of any crop begins with the assessment of genetic diversity in the area using morphological descriptors. The objective of this study was therefore to characterize various types of vine spinach in an effort to assess the genetic diversity found in Kisii County of Western Kenya. General descriptors such as colour of the leaf, petiole, stem and flower; stem shape; growth habit were used to identify various morphotypes. Leaf length and width were also measured. Statistical analysis for leaf length and width was done using analysis of variance (ANOVA) and means were separated using Fisher's Least Significant Difference (LSD). Statistical package used was GENSTAT. Morphotypes were identified using descriptors found in literature. Five vine spinach morphotypes were identified. These belonged to Basella alba and Basella rubra. Data obtained can be used by breeders their efforts to come up with high yielding morphotypes (that are well adapted to local ecological conditions) to supply to farmers.*

**Key words:** ***Basella alba, Basella rubra, morphotypes***

## Introduction

Vine spinach (*Basella alba L. & rubra L*) is a tropical vine used as a vegetable in Africa. It is highly nutritious supplying vitamins, minerals, proteins, carbohydrates and soluble fiber (Gruben and Denton, 2004). It has high amounts of Vitamin A and C, potassium, calcium and iron (PROTA, 2018). Itp43 has over 3 times more vitamin C than ordinary spinach and 1.5 times more vitamin A than Kales. It is also medicinal. Young leaves are used as a laxative, poultice to sores and the red fruit juice is used to treat conjunctivitis. It is used to treat diseases such as dysentery,


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diarrhea anemia and cancer. The juice from the fruits is used as a dye, ink, in cosmetics and coloring food (PROTA, 2018).ine spinach is a good source of revenue for farmers and traders especially women. A study inWestern Kenya found that men were hardly involved in traditional vegetable production but women owned three to four plots of traditional vegetables (Walingo Lungaho, & Shibaro,

2001). Traditional vegetables grown by the women were used in the home and surplus was sold in the local markets. The sale of the vegetables provided income to the women. Majority of the traders involved in the sale of traditional vegetables in the local markets are women (Walingo, Lungaho, & Shibaro, 2001). Traditional vegetables, vine spinach included, therefore, offers income generation opportunities to women who are economically marginalized

The vegetable belongs to the family Basilleceae and order Caryophyllales. It is a short lived perennial herb that can grow 4-8m long. It is planted on hedges or staked near homesteads or picked from the wild (Pasquini & Drescher, 2009). The stem is succulent, smooth and twinning and can be green or purple. The leaves are alternate, stipules absent (PROTA, 2018). The blade can be ovate, heart shaped or oval, usually cordate at the base, acute or acuminate at apex, dark green or purple. The inflorescence is an axillary spike up to 22-30 cm long with a long peduncle. The flowers are bisexual, regular, 2-6 mm long, white, pink or purple in color. The fruit is subglobose pseudo berry 1-10 mm in diameter enveloped by a fleshy perianth. It is purplish black and contains a violet juice. It contains one seed (PROTA, 2018). Seed is globose 3mm in diameter, dark brown to black in color.

Despite its multiple uses vine spinach is not listed among the top ten African leafy vegetables for research in Kenya (Abukutsa, 2007). There are no reports of hybrids in cultivation or in the wild in the world. No breeding programmes are known to exist, although several seed companies in India and the United States produce seeds to be sold locally and internationally (PROTA, 2017). Due to the little preference among researchers for this crop it is sometimes termed as an 'orphan crop.'

Germplasm of vine spinach is also mostly held in situ in the custody of the farmers. This has the inherent disadvantage of loss of germplasm through disuse. Morphological and genetic characterization and evaluation of germplasm is critical as it increases utilization and better use of biodiversity (Biodiversity International, 2007). Genetic improvement of crops for quantitative traits needs estimates of genetic diversity, genetic variability, heritability and genetic advancement is necessary to plan for efficient breeding programs (Chand, et al, 2008). Genetic variability in agronomic traits is a critical component of breeding which broadens the gene pool of crops. The objective of this study was therefore to collect the vine spinach samples from Kisii county (where it is widely cultivated and utilized in Kenya) and use morphological descriptors (such as colour of the leaf, petiole, stem and flower; stem shape; growth habit, leaf length and width) to differentiate between different morphotypes.

## Materials and Methods

Vines of morphotypes were obtained from farmers in Kisii County in the month of August 2018. The vines were used because no seeds could be obtained from the farmers in the study area. Seed samples of *Basella alba* were also obtained from the Gene Bank at Mugaga, Kenya in December 2017. They were stored in cool and dry place. Seeds from the Gene Bank exhibited dormancy which was broken by gently rubbing the seeds between 2 sand paper for 3 minutes. Seed obtained from the Gene Bank used for comparison with the ecotypes from Kisii.

The vines or seeds from each morphotype were planted in separate pots in a randomized complete design (RCD) with 3 replicates for each morphotype. The pots were filled soil from the University of Eldoret compound. Soil type was identified as oxisols with a PH of 5.5. Farm yard manures at the rate of 2.5 g/m3 was mixed with the soil. Watering was done three times a week. Weeding was done 3 times during the growing season to keep the plants weed free. Spraying against spider mites was carried out twice, at 3 weeks and 6 weeks using Dictator plus 250 (active ingredient 21.2% propargite and 75% tetraddefon) at a rate of 1.5ml/ha. No leaf defoliation was done.

Measurements of leaf length and width were done 3 times during the growth period (30 days after planting, 40 days after planting and 55 days after planting) using string and ruler. Other factors such as leaf and flower colour were identified with the help of Munsell® colour chart (Munsell, 1977). Seeds from morphotype 5 were harvested periodically as they ripen from 55 days after planting.

Data on measurements of leaf length and width were analyzed using Analysis of variance (ANOVA) and means were separated using Least Significant Difference (LSD). Statistical analysis software GENSTAT package was used.

## Results

The morphotypes were coded 1-5. Their general characteristics of are shown in Table 1 and Plate 1. The stem colour of the morphotypes varied from dark red to red, pink and green. Stem shape was round for morphotypes 1-4 but angular for morphotype 5. The leaf node and petiole colour among the morphotypes was either red, pink or green. Leaf colour ranged from dark green to light green. Leaf margin was ovate for morphotypes 1-4 and oval for morphotype 5. Morphotype 5 had determinate growth at first and later started twinning. Morphotype 1-4 had indeterminate growth right from establishment stage.

Table 1

*Summary of General Characteristics of Vine Spinach Morphotypes from Western Kenya*

| **Character** | **1** | 2 | 3 | **4** | 5 |
|---|---|---|---|---|---|
| Growth Habit | Twining | Twining | Twining | Twining | Twining (Initially Bushy) |
| Stem color | Red | Dark Red | Green | Pink | Green |
| Stem Shape | Round | Round | Round | Round | Angular |
| Stem Node | Red | Green | Green | Pink | Green |
| Leaf Color | Dark Green | Dark Green | Dark Green | Light Green | Glossy Green |
| Leaf Margin | Entire | Entire | Entire | Entire | Entire |
| Leaf Shape | Ovate | Ovate | Ovate | Ovate | Oval |
| Petiole Color | Red | Red | Green | Red | Green |

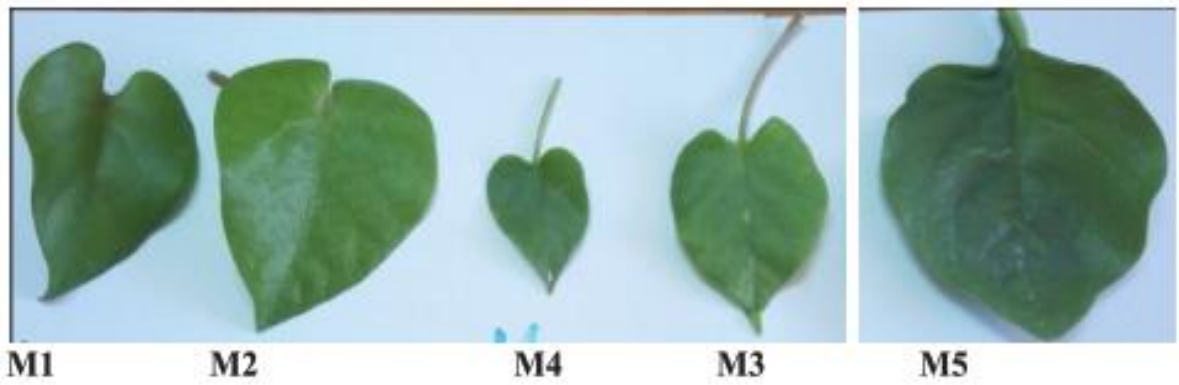


*Figure 1*: Plate 1 – Morphological characteristics of vine spinach morphotypes

Morphotype 1-4 formed white-pink flowers which aborted and therefore did not form seeds. Morphotype 5 formed white flowers which formed purple fruits with one seed.

The leaf length of morphotypes significantly differed at $P \leq 0.00$. Morphotype 5 had the longest leaf length while morphotype 4 has shortest leaf length compared to others (Table 2).

The leaf width of the morphotypes significantly differed at $P \leq 0.00$. Morphotype 5 had the longest leaf width while morphotype 4 has shortest leaf width compared to others (Table 2).

*Table 2*

Means of Leaf Length and Width of Vine Spinach Morphotypes

| Morphotype | Mean Leaf Length (cm) | Mean Leaf Width (cm) |
|---|---|---|
| 1 | 7.23±0.19b | 6.25±0.25bc |
| 2 | 7.04±0.24b | 6.64±0.20c |
| 3 | 6.39±0.17ab | 5.48±0.21ab |
| 4 | 5.05±0.41a | 4.53±0.40a |
| 5 | 10.75±050c | 7.84±0.34d |

Means having the same letters within the same column are not significantly different at

$P \leq 0.01$

## Discussion

Five morphotypes were identified using leaf, stem and flower color, size of the leaf, color at the stem node and formation of seeds. These morphotypes fell into the category of *Basella alba* L or *Basella rubra L*. Morphotype 3 and 5 were identified as *Basella alba* L. as they lack the red coloration. Morphotype 1, 2 and 4 were identified *as Basella rubra L*. due the red coloration either on the stem or the stem nodes. This is in line with studies that have shown that the *Basella* sp. grown in Africa falls in these 2 categories (Grubben and Denton, 2004). Another study in India also found great variability among vine spinach landraces (Medagam et al, 2014). A summary on cultivated crops by Elzebroek and Wind (2008) describe three types of vine spinach: (i) the most common type with dark green, ovate or almost round leaves; (ii) with red stems and reddish, ovate to almost round leaves, often planted as an ornamental; and (iii) with heart-shaped, dark green leaves). This concurs to some extent to the findings of present study.

Colouration on stem and leaves is due to the presence of anthocyanins which accumulate in certain plant tissues and are responsible for a morphotype of colours like red, blue and purple.

The accumulation is controlled by environmental factors such as light, temperatures, nutrients and stress as well as genetic factors (Beggs & Wellman, 1994). These pigments belong to the general class of flavonoids, which have many functions that include pre-infection mechanisms of disease resistance, increase in osmotic pressure of the cell sap hence enhancing absorption of water by the root hairs from the soil and water movement within the plant, assistance in respiratory and photosynthetic processes as well as protection of chlorophyll from being decomposed by strong lights (Kochlar & Krishnamoorthy, 1992). These roles of anthocyanins may also be applicable to vine spinach morphotypes and gives them the ability to survive dry spells. Flavoids are also associated with medicinal properties.

All the morphotypes except morphotype 5 formed white flowers which aborted and failed to form seed. This can been attributed to genetic and environmental factors. Environmental factors like insects and mites, insufficient light, unsuitable photoperiod, high temperature, nutrient deficiency (Calcium and boron), drought stress have been associated with flower abortion (Runkle, 2018). In this study environment stresses mitigated through provision adequate moisture, application of fertilizers and control of pests. The plants were also trellised to ensure proper growth. It has been noted that *Basella* sp. are short day plants whose flowering is inhibited at day lengths longer than 13 hours (PROTA, 2018). This was not an issue in the experimental site which has 12 hours of day length. This may then point to genetic factors being responsible for the abortion of the flowers. This should be investigated further.

Morphotype 5 formed seed under the prevailing environmental conditions. The seeds of this morphotype were sourced from the Gene Bank at Mugaga, Kenya and they were obtained from Asia. More investigations may be required to assess the adaptability of this morphotypes to different agroecological zones in Kenya and possible introduction to farmers after more studies on agronomic and nutritional traits.

## Conclusion

In conclusion this study identified 5 morphotypes of vine spinach. Parameters used to identify the morphotypes included leaf color, stem color, flower color, color at the stem node and size of the leaf. Leaf length and width, varied significantly among the morphotypes but there was some considerable overlap in these parameters. This study forms the preliminary step in understanding and improving the vine spinach types in the study area. Molecular characterization can further be avenue to explore the exact identity of the vine spinach morphotypes in Kisii County.

## Recommendation

This study therefore recommends that more research attention be given to vine spinach as crop in order to understand its diversity as well as genetically enhance it through plant breeding.

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