

EVALUATION OF FIVE LEAFY GREEN VEGETABLES

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ABSTRACT

Five leafy green vegetables were evaluated for their marketable yield at the Gladstone Road Agricultural Centre from November 2011 to February 2012. Single leaves of each of the five types of leafy vegetables were harvested on six occasions over a period of five weeks. Results indicate that under local conditions, during the cooler months of the year, these leafy green vegetables show good potential for adaptability and increased productivity. The study also gives a partial assessment of the nutritional composition of the leafy greens. Moisture contents were above 90% for the evaluated greens. Sodium and potassium contents were very high, particularly for the two Swiss chards.



Mustard Greens



Red Mustard Greens



Russian Kale



Leafy green vegetables in the field at the Gladstone Road Agricultural Centre, January 2012.

Introduction:

The term 'greens' refers to the leaf and stem portions of plants that are cut while the plant is still young and tender and used as a fresh food item. These vegetable greens are rapidly

growing plants and are ready for market in a short period of time. The outer leaves are harvested over an extended period, without any adverse effects to the plant. These leaves are usually used in salads in various combinations, making an attractive display of colour and texture.

Leafy green vegetables are an important component of the human diet, providing fibre, minerals and vitamins (Acikgoz, 2011; Emebu and Anyika, 2011; Gupta and Prakash, 2011; Sikora and Bodziarczyk, 2012) and are low in calories. They are also a very good source of antioxidants (Velioglu, *et al.*, 1998; Bunning and Kendall, 2007; Acikgoz, 2011; Gupta and Prakash, 2011).

Leafy green vegetables are not grown on as wide a scale as some of the more popular vegetable crops like, tomato, sweet pepper and cucumber, and may be considered a minor crop in The Bahamas. Greens grow best during the cool winter season experienced locally between October and March. Several of these crops have been introduced and are grown in The Bahamas.



Leafy vegetable greens of red and yellow Swiss chard, harvested singly for use in fresh salads

Swiss chard (*Beta vulgaris* ssp. *cicla* L.) is not a commonly used vegetable crop in The Bahamas. It is a relative of the red beet root and is cultivated for its fleshy stem portion and succulent leaves. It is a salt-tolerant plant, accumulating high levels of sodium within its leaves (Pokluda and Kuben, 2002). Russian kale (*Brassica napus* ssp. *Pabularia*) is a member of the cabbage family. It is a cool season vegetable green, but is heat tolerant and can be grown during the summer months. Mustard greens [*Brassica juncea* (L.) Czern.], also known as Chinese mustard, are rich in vitamins and minerals, such as calcium, iron and phosphorus. They grow well on a wide range of soils and can be harvested at a very early stage.

There is an increasing demand by the Bahamian consumer for fresh vegetable produce. With the rising cost of imported food items, consumers look for ways to reduce their household's food bill. With the initiation of the Department of Agriculture's 'Backyard Gardening' programme, the cultivation of these leafy vegetables is a means by which families can reduce their food bill and supplement their incomes.

Very little research has been done by the Department of Agriculture on these leafy green vegetable crops. With proper cultivation practices, several harvests can be obtained from a single planting of leafy green vegetables.

Objectives:

The main purpose of this study was to evaluate several leafy green vegetables for yield, quality, and adaptation to local conditions. Another objective was to show farmers some alternative crops that can be successfully grown during the cool season. It will also provide farmers with practical information on the growing of these crops. These include red and yellow Swiss chard, red and green mustard greens and red Russian kale.

Materials and Methods:

Five leafy green vegetable crops were evaluated for their leaf yield and quality at the Gladstone Road Agricultural Centre during February of 2012. The 5 x 6 factorial experiment was established in a completely randomised design, using five types of leafy green vegetables harvested at six different dates. The leafy greens included red Russian kale, red and green mustard and red and yellow Swiss chard. The seeds were set out in a seed bed during November of 2011. After about six weeks, when the plants achieved at least four mature leaves and a well developed root system, they were transplanted in double rows to raised beds of 100 ft length. Plant spacing was 8 in (20 cm) between plants within the rows. The rows were 5 ft (1.5 m) apart. The rows were irrigated using a drip irrigation system which supplied water throughout the short growing season. The leaves were sprayed weekly, using a combination of Xentari[®] and Bravo[®] with Nutrileaf[®] liquid fertiliser in a 20-20-20 formulation, as a preventative measure against insect pests and diseases. Weeds were controlled by hand weeding.

Non-destructive harvesting of single leaves of the Swiss chards, kale and mustard greens commenced 58 days after planting, when the leaves were of a marketable size. Leaves were harvested over a five-week period, as they grew to size. Six non-destructive harvests were conducted on the 19th, 27th and 31st of January and the 9th, 17th and 21st of February.

This study also examined the proximate and mineral composition of the Russian kale and red and yellow Swiss chards. Randomly selected leaf samples were cleaned to remove dirt and submitted to the Food Safety and Technology Laboratories of the Department of Marine Resources for analyses. The leaves were processed, then analysed for nutrient and mineral composition and the values expressed on a dry matter basis. Quality characteristics measured included, moisture, dry matter, ash, sodium, potassium and total salt.

Methods Used in Analysis of leafy greens (Based on A.O.A.C., 1995):

Moisture/Dry Matter – leaves were wiped and chopped into small pieces. Triplicate 2g samples were accurately weighed into pre-labelled, pre-weighed dishes and were dried at 130°C to constant weight. Dried samples/dishes were weighed. Moisture content (%) was calculated. Dry matter (%) was calculated by 100 – Moisture content (%).

Other Analyses - Samples were wiped, chopped and dried in oven. The dried samples were subsequently powdered in a high-speed blender and used for the remainder of the tests.

Ash - Triplicate prepared samples were weighed into pre-weighed, porcelain crucibles. The samples were transferred to a muffle furnace and ashed at 550°C for 8 hours. The crucibles were allowed to cool in desiccators and then weighed. Percentage ash content was calculated.

Salt - Determination using the Volhard method where sample was treated with AgNO₃, wet ashed and the excess AgNO₃ back titrated with KSCN using FeNH₄(SO₄)₂ as indicator.

Sodium and Potassium - Aqueous solutions of ashed samples were aspirated directly into a Cole-Parmer Model 2655-00 flame analyzer. Intensity was compared against a prepared standard curve.

The mean daily maximum and minimum temperatures for the trial period were 27.1°C (80.8°F) and 19.6°C (67.3°F), respectively. The total rainfall for the period was 93.8 mm (3.69 in). Mean monthly sunshine duration for the period was 7.8 h. Weather information (Table 1) was obtained from the Meteorological Department of The Bahamas.

Table 1. Weather data on rainfall, hours of sunshine and mean maximum and minimum temperatures for New Providence for the period of November 2011 to February 2012, courtesy of the Meteorological Department of The Bahamas.

Month	Total rainfall (mm/inches)	Mean monthly radiation (h)	Mean maximum temperature (°C/°F)	Mean minimum temperature (°C/°F)
November 2011	20.1/0.79	8.1	28.2/82.7	21.6/70.8
December 2011	22.9/0.9	7.0	26.9/80.4	19.8/67.6
January 2012	6.6/0.26	8.0	26.1/78.9	17.8/64.0
February 2012	44.2/1.74	8.1	27.2/81.0	19.2/66.6

Note: Monthly mean values have been rounded up to the nearest tenth.

Results:

The analysis of variance (ANOVA) of the total leaf weights per plant and number of marketable leaves per plant among five leafy green vegetables varieties are summarised in Table 2. The table showed a statistical significance for both of these yield responses at a 1.0 % level of confidence, among the five leafy greens. There was a significant interaction of harvest date with variety, indicating different responses of the five leafy greens to the different harvest dates. There was no significant effect of harvest date on the yield responses.

Table 2. Analysis of variance (ANOVA) for total leaf weights per plant and number of marketable leaves per plant, among five leafy green vegetables varieties harvested at different times. Std Err is for each treatment mean. Error mean square has 299 df. *, ** and *** denote statistical significance at 5, 1 and 0.1% level of confidence, respectively. df, degrees of freedom; std err, standard error; ns indicates differences between means not significant.

Source	df	-----Significance levels-----	
		Leaf Weights/Plant (g)	No. of Marketable Leaves/Plant
Variety	4	**	**
Harvest Date	5	ns	ns
Harvest Date x Variety	20	**	**
Error	270		
Std Err		0.9	0.2

The leafy greens generally performed well. Leaves were uniformly shaped and free of pests or diseases. The yield contributing characteristics of the five leafy greens are shown in Table 3.

The red Russian kale gave heavier leaf weights and larger number of leaves than any of the other leafy greens. Of the two mustard greens, the green mustard gave higher weights than the red mustard, though leaf numbers were significantly lower. These numbers are consistent with those reported by Pokluda (2007) for several mustard cultivars, under hydroponic growing conditions. The Swiss chards gave the lowest weights of all the leafy greens, with the red Swiss chard producing a significantly larger number of leaves than the yellow.

Table 3. Mean values for marketable leaf weights per plant and number of marketable leaves per plant among five leafy green vegetables.

	RED RUSSIAN KALE	RED MUSTARD	GREEN MUSTARD	RED SWISS CHARD	YELLOW SWISS CHARD
Wt. of marketable leaves/plant (g)	38.6a	34.3bc	35.1b	32.6bc	32.1c
Number of marketable leaves/plant	6.7a	6.3ab	5.8c	6.3abc	5.9bc

The t-test at a level of 5% probability was applied. Means with different letters differ significantly.

Table 4 presents a summary of measurements for the proximate analyses of the leaves of three of the leafy green vegetables evaluated. These results showed high moisture contents for all the leafy greens, which ranged from 90.0% in 'Russian Kale' to 92.9% in 'Red Swiss Chard'. The mean values for sodium (Na⁺) and potassium (K⁺) were markedly high, with much variation in the sodium contents of the three leafy green vegetables. This may be attributed to several factors such as fertilisation, soil conditions and variety. The mean values of sodium, per 100g of dry weight, were 1,245 mg, 6,258 mg and 9,938 mg, respectively, for red Russian kale, red Swiss chard and yellow Swiss chard. The potassium contents for the two Swiss chards were slightly lower than those values reported by Pokluda and Kuben (2002), but the sodium values were extremely high. The red Russian kale accumulated higher amounts of potassium and sodium within its leaves than reported in several studies (Ayaz, *et al.*, 2006; Acikgoz, 2011; Emebu and Anyika, 2011; Sikora and Bodziarczyk, 2012).

Table 4. Proximate analyses of the leaves of three of the leafy green vegetables.

	RED RUSSIAN KALE	RED SWISS CHARD	YELLOW SWISS CHARD
Moisture (%)	90.00	92.9	91.1
Ash (%)	2.4	2.2	2.0
Na⁺ (mg/100g) Dry weight	1245	6258	9938
K⁺ (mg/100g) Dry weight	2168	3124	3748

Discussion:

Yield responses for the five leafy vegetables were consistent over the harvesting period. The varieties displayed foliages that were uniform and attractive in appearance, with large, upright leaves. Leaves were free of diseases and insect pests, the result of pesticide spraying to avert any potential problems. The cool season may have also contributed to the low insect pest populations. The leaf texture was appealing and the taste mild and pleasant, according to

those individuals selected to assess the food qualities of the leafy greens. These leaves can contribute significantly to the nutrient requirements of the Bahamian diet.

The red Russian kale was the most outstanding of the five leafy greens. It yielded more leaf weight per plant and had the largest number of leaves per plant. From the experimental results, the significant variations among the five leafy green vegetables for the yield responses may be attributed to the different growth characteristics of the different varieties of leafy greens.

The moisture contents of the three leafy greens evaluated were very high. The red Swiss chard had the highest value for moisture content, making it more susceptible to deterioration. As reported by Emebu and Anyika (2011), microorganisms that promote spoilage in foods thrive well in foods with high moisture contents, resulting in a reduced shelf life. Though they were not evaluated for fat content, the high moisture content, according to Emebu and Anyika (2011), is indicative of low fat values.

The three leafy greens were very similar in their actual ash content, around 2.0%, though the kale presented a slightly higher percentage of ash than the others. This value is higher than that reported for kale (1.33%) by Emebu and Anyika (2011), but is in keeping with the results of Sikora and Bodziarczyk (2012), who reported ash contents of between 2.0 and 2.18%. These results are well below those of Mariga *et al.* (2012), whose data showed 17.6% ash for Swiss chard. The ash content is indicative of the mineral content of foods (Nnamani *et al.*, 2009); the low ash content of these leaves suggests that the mineral content is low. The higher ash content of kale suggests a higher mineral content in this leafy vegetable than in the Swiss chard varieties.

These results show extremely high sodium and potassium contents. The kale leaves displayed a lower ratio of sodium to potassium content. Kale is considered to be a low potassium food, while Swiss chard is noted to be a high potassium food. A diet high in potassium and low in sodium is beneficial for the reduction of high blood pressure (Andzouana and Mombouli, 2012).

This report gives only a partial assessment of the nutritional composition of several of the leafy greens under study. Additional studies on the fibre, protein and fatty acid composition and other mineral constituents will assist in the selection of leafy green vegetable varieties with improved nutritional values.

This study demonstrates that the leafy green vegetables can become viable horticultural crops for local production. These varieties can be recommended to farmers for inclusion in their winter vegetable cropping systems. More studies need to be done however, to determine whether the cultivation of these, or similar leafy greens, could be extended into the warmer months of the year.

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