

## Horticultural value of kale crops grown in Northwestern of Spain

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### Introduction

The *Brassica oleracea* L. crops are used extensively in Europe and Central Asia being an important source of vegetables in many countries. In European countries, such as France or England, kale (*B. oleracea acephala* group) is exploited mainly as fodder crop, and research about its potential as a vegetable crop is scarce. Kales are an important crop in the traditional farming system of Galicia (Northwestern of Spain) where they are used both as vegetables and fodder. Farmers often use the tender leaves for human consumption and the oldest ones for feed (Cartea et al, 2003).

A collection of 250 landraces of *B. oleracea* crops is maintained at the Misión Biológica de Galicia (MBG). Kale is by far the most well-represented *B. oleracea* crop with 214 accessions. The objectives of this work were (i) to make an agronomic and nutritional characterization of the MBG core collection to know the potential ability of kale as a vegetable crop, and (ii) to select the two most promising varieties to be included in future breeding programs.

### Material and methods

Sixty kale landraces and four commercial kale varieties checks were evaluated at two locations in NW Spain. Data on five nutritional and two agronomical traits were recorded. Quality data were crude protein and fiber (given as dry weight percentages), Calcium ( $\text{Ca}^+$ ) and Potassium ( $\text{K}^+$ ) (given as percentage of dry weight) (Table 1). Dried leaves samples were ground in order to determine the  $\text{Ca}^+$  and  $\text{K}^+$  concentration and crude fiber and protein content, following the standard methods. The traits early vigor and vegetable yield were recorded according to previous characterizations of kale crops (Cartea et al., 2003). Glucosinolate composition was determined by HPLC. Landraces were evaluated following an 8 × 8 simple lattice design. Landraces were considered as fixed factor, while locations, replications and blocks were considered as random factors. Comparisons of means among landraces were performed using the Fisher's protected least significant difference (LSD) at  $p = 0.05$  (Steel et al., 1997). These analyses were made using the GLM procedure from SAS (SAS Institute, 2000).

### Results and discussion

#### *Agronomic traits*

The analysis of variance showed significant differences among locations and landraces for early vigor and vegetable yield. The landrace × location interaction was not significant (data not shown). However, in Galicia, leaves are used both for animal and human consumption. Two landraces, namely MBG-BRS0468 and MBG-BRS0476, having 1326 g and 1184 g, respectively, showed the highest vegetable yield and were

significantly better than the best commercial varieties. Early vigor represents the ability of a plant to compete with weeds, which are abundant in Galician agriculture. The landraces MBG-BRS0468 and MBG-BRS0476, showed acceptable values for this trait (Table 1), good enough to overcome weed competition.

### *Nutritional traits*

Related to mineral content, the combined analysis of variance over locations did not show significant differences between locations concerning to  $K^+$  and  $Ca^{2+}$ . Landraces differed significantly in  $Ca^{2+}$  content, while landrace  $\times$  location interaction was not significant regarding both minerals. The landraces MBG-BRS0468 and MBG-BRS0476 showed the highest content in  $K^+$ , mineral that increases energy and muscle strength, and reduces hypertension in human. Galician landraces showed higher  $Ca^{2+}$  and  $K^+$  content than broccoli, cauliflower, Brussels sprouts, kale, red and white cabbage, and Savoy cabbage, and lower than Tronchuda kale (Padilla et al., 2007a; Rosa, 1999). In particular, MBG-BRS0468 and MBG-BRS0476 had acceptable values of  $Ca^{2+}$  considering the high availability of this mineral due to the low level of oxalates, compounds that inhibit its absorption (Heaney y otros, 1993). MBG-BRS0468 and MBG-BRS0476 showed 12.3 % dry weight (dw) and 10 % dw of crude fiber and 17.9 % dw and 18 % dw of protein in their leaves, respectively. These protein and fiber contents would be considered as appropriate for fodder and they were similar to values found by Rosa (1999) in different *B. oleracea* crops.

The landraces MBG-BRS0468 and MBG-BRS0476 showed a total glucosinolate content higher than the content found in other *B. oleracea* crops (Nilsson et al., 2006). Sinigrin represented on average 34% of the total glucosinolate content, followed by glucoiberin (28%) and glucobrassicin (25%). The rest of glucosinolates were found in less than 3% of total glucosinolate content (data not shown). MBG-BRS0468 and MBG-BRS0476 had the highest glucobrassicin content, one of the most potent anticancer compound found in cruciferous vegetables (Nilsson et al., 2006).

### **Conclusions**

The MBG core collection has been studied based on agronomical traits and on the Calcium, Potassium, fiber, protein and glucosinolate content. Galician kale have high contents in fiber, proteins, vitamins and minerals, particularly Potassium ( $K^+$ ) and Calcium ( $Ca^{2+}$ ) and moreover, they have anticarcinogenic properties due to some glucosinolates. Those investigations allowed us to emphasize two local populations with the highest vegetable yield and the best nutritional qualities for human consumption: MBG-BRS0468 and MBG-BRS0476.

### **References**

- Cartea, ME, Picoaga A, Soengas P, Ordás A, 2003. Morphological characterization of kale populations from northwestern Spain. *Euphytica* 129, 25-32.
- Heaney RP, Weaver CM, Hinders SM, Martin B, Packard PT. Absorbability of calcium from *brassica* vegetables: broccoli, bok choy, and kale. *J Food Sci* 1993;58:1378–80.
- Nilsson J, Olsson K, Engqvist G, Ekvall J, Olsson M, Nyman M, Akesson B, 2006. Variation in the content of glucosinolates, hydroxycinnamic acids, carotenoids, total antioxidant capacity and low-molecular-weight carbohydrates in *Brassica* vegetables. *J. Sci. Food Agric.* 86, 528-538.
- Padilla G, Cartea ME, Ordás A. 2007a. Comparison of several clustering methods in grouping *Brassica oleracea acephala* group landraces. *J. Am. Soc. Hort. Sci.* 132, 1-9.
- Rosa EAS (1999) Chemical composition. In: C Gómez-Campo (ed.), *Biology of Brassica coenospecies*, pp, 315-357. Elsevier Science B.V., Amsterdam, Netherlands.
- SAS Institute Inc., 2000. SAS OnlineDoc, version 8. SAS Institute. Inc., Cary, North Carolina, USA.
- Steel RDG, Torrie JH, Dickey DA. 1997. *Principles and Procedures in Statistics: A Biometrical Approach*, 3rd Ed. Mc Graw Hill, New York.

**Table 1. Agronomical and nutritional traits evaluated in kales from Northwestern of Spain**

Traits	MBG-BRS0468	MBG-BRS0476	Mean and range of 60 local varieties
<b>Agronomic</b>			
Vegetable yield (g)	1325.90	1183.5	720.7 (367.2 - 1325.9)
Early vigor (1-5) <sup>a</sup>	3.0	2.5	2.84 (1.75 - 4.0)
<b>Nutritive</b>			
Calcium (% dw) <sup>b</sup>	0.87	1.02	1.49 (0.87 - 2.12)
Potassium (% dw) <sup>b</sup>	3.16	3.35	2.72 (2.01 - 3.35)
Fiber (% dw) <sup>b</sup>	12.3	10.0	13.4 (8.8 - 17.7)
Protein (% dw) <sup>b</sup>	17.9	18.0	17.4 (11.0 - 24.5)
Total glucosinolates ( $\mu\text{mol g}^{-1}$ dw) <sup>c</sup>	37.55	35.55	26.97 (11.00 - 52.8)
Glucobrassicin ( $\mu\text{mol g}^{-1}$ dw) <sup>c</sup>	16.52	16.76	7.12 (1.75 - 16.76)

<sup>a</sup> Early vigor: Subjective scale from 1 (very poor) to 5 (excellent);<sup>b</sup> Percentage of dry weight;

<sup>c</sup>  $\mu\text{mol per g}$  of dry weight.

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