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Scientific paper

Concentration of calcium and iron in collard green of conventional and organic agriculture

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Abstract

The vegetable *Brassica oleracea var.* acephala, popularly known as collard green is very consumed in Brazil and is important due of the presence of many nutrients. It can be grown both by conventional agriculture (CA), with the use of chemical inputs, and by organic agriculture (OA), characterized by the elimination of the use of artificial pesticides and other inputs. In regard to nutritional aspects related to food obtained through organic agriculture is evident the lack of compositional data, mainly in relation to minerals. So the object of this work is to determine and compare the calcium and iron concentration in collard green grown by CA and by OA, marketed in São Paulo. The mineral were determined by atomic absorption spectrometry with flame and the results for the collard green CA, in wet basis, were 76.95 ± 12.24 mg of Ca $100g^{-1}$ and 2.55 ± 1.15 mg of Fe $100g^{-1}$, and for collard green OA were: 60.64 ± 8.16 mg of Ca $100g^{-1}$ and 1.51 ± 0.26 mg of Fe $100g^{-1}$. The results indicate that the samples of collard green produced by organic agriculture the concentration of calcium and iron was lower ($p<0.05$) than the results for the collard green produced by conventional agriculture.

Keywords: *Brassica*, organic agriculture, minerals, nutritive value, vegetable.

Concentração de cálcio e ferro em couve-manteiga de cultivo convencional e orgânico

Resumo

A hortaliça *Brassica oleracea var.* acephala, popularmente conhecida como couve-manteiga é muito consumida no Brasil e é importante devido a presença de vários nutrientes. Pode ser cultivada tanto por agricultura convencional (AC), com a utilização de insumos químicos, quanto por agricultura orgânica (AO), sem emprego de agrotóxicos e outros insumos artificiais. Em relação aos aspectos nutricionais relativos aos alimentos obtidos por meio da agricultura orgânica há evidente escassez de dados de composição, principalmente em relação ao conteúdo de minerais. Deste modo, este trabalho teve como objetivo determinar e comparar as concentrações de cálcio e de ferro em couve-manteiga cultivada por AC e por AO, comercializadas no município de São Paulo. Os minerais foram determinados por espectrometria de absorção atômica com chama e os resultados obtidos, para a couve-manteiga AC, em base úmida, foram: 76,95 ± 12,24 mg de Ca $100g^{-1}$ e 2,55 ± 1,15 mg de Fe $100g^{-1}$; e para a couve-manteiga AO foram: 60,64 ± 8,16 mg de Ca $100g^{-1}$ e 1,51 ± 0,26 mg de Fe $100g^{-1}$. Os resultados indicam que nas amostras de couve-manteiga produzidas por agricultura orgânica a concentração de cálcio e de ferro foi inferior ($p<0,05$) aos resultados obtidos para a couve-manteiga produzida por agricultura convencional.

Palavras-chave: Agricultura orgânica, Brassica, hortaliças, minerais, valor nutritivo.

La concentración de calcio y de hierro en el cultivo convencional y ecológico de Col rizada

Resumen

Los vegetales Brassica oleracea var. acephala, popularmente conocida como la col rizada son muy populares en Brasil y muy importantes debido a la presencia de varios nutrientes. Se puede cultivar por la agricultura convencional (AC) con el uso de insumos químicos, así como por la agricultura orgánica (AO), sin utilizar pesticidas artificiales y otros insumos. En cuanto a los aspectos nutricionales relacionados con los alimentos obtenidos a través de la agricultura orgánica existe una evidente escasez de datos sobre la composición, sobre todo en relación con el contenido mineral. Por lo tanto, este

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estudio tuvo como objetivo determinar y comparar las concentraciones de calcio y hierro en la col rizada cultivadas para AC y AO, comercializada en São Paulo. Los minerales han sido determinados por espectrometría de absorción atómica con llama y los resultados obtenidos para la col rizada AC, base húmeda, fueron 76,95 ± 12,24 mg Ca $100g^{-1}$ y 2,55 ± 1,15 mg de Fe $100g^{-1}$, y para col rizada AO fueron: 60,64 ± 8,16 mg Ca $100g^{-1}$ y 1,51 ± 0,26 mg de Fe $100g^{-1}$. Los resultados indican que en las muestras de col rizada producidos por la agricultura orgánica la concentración de calcio y hierro fue menor ($p < 0,05$) a los resultados obtenidos para la col rizada producida por la agricultura convencional.

Palabras clave: Agricultura orgánica, Brassica, hortalizas, minerales, valor nutritivo.

Introduction

The *Brassica oleracea* var. *acephala*, popularly known as collard green, is a vegetable much consumed in Brazil and nutritionally important because of the presence of high levels of vitamins and minerals (SILVA, 2007).

This vegetable is the vegetable with higher calcium concentration (SANTOS et al. 2003), fact of great nutritional importance, since the only source of calcium available for the human body is derived from the diet, although considering that the bioavailability of minerals of plant origin is low, mainly because of the presence of other substances in plants, such as oxalic acid and phytic acid that decrease the absorption of minerals (COZZOLINO and SILVA, 2007; CASÉ et al., 2005).

The collard green can be grown either by conventional agriculture, it is a production system in which is no use of chemical inputs, such as fertilizers, pesticides and herbicides (CORSON, 1996), as for organic agriculture, characterized by the elimination of the use of agrochemicals and other artificial inputs at any stage of the production process and storage, favoring the preservation of environmental and human health (BRASIL, 1999).

It is estimated that organic foods have, on average, the price of 150% to 240% higher than those grown by conventional farming, which ends up generating the gentrification of their consumption (MARTINS et al., 2006). Yet, it is noteworthy that the production of organic foods allows the recovery of soil and water sources and its consumption is related to to improving the quality of life and health of the farmer and the consumer (EMBRAPA, 2009; DAROLT, 2002).

There are various food composition tables showing the values of the concentration of minerals in conventional collard green. However, none of the consulted shows the composition of food grown by organic farming, data of great relevance, since, according TOASSA et al. (2009), the consumption of organic food is continually increasing.

Still according to this author, organic foods, in relation to nutritional value and taste, have superior sensory attributes to the cultivated by the conventional system. However, there are still scarce studies that evaluate the nutritional aspects of these foods comparing them with the ones obtained by conventional agriculture.

Given the above, the objective of this study was to determine and compare the concentrations of calcium and iron in collard green grown by conventional farming and by organic farming in the State of São Paulo.

Materials and Methods

We acquired six packs of collard green grown in Vargem Grande Paulista (SP) by conventional agriculture and six packs of organic collard green grown in the region of Atibaia (SP). The samples were collected during the period January to February 2009, and kept in original container, stored in refrigerator for up to 1 day, until subsequent analysis.

All packs of collard green, conventional and organic were washed in running water, chopped and dried in a greenhouse 70 °C for 24 hours until obtaining of a constant mass. Only the part of the petiole, traditionally not consumed, was discarded. It was determined previously the moisture and ash of the samples (IAL, 1985).

For the determination of minerals, was made up standard solutions, stock of calcium and iron, according to Association of Official Analytical Chemists (AOAC, 2000a), diluting them later to compose the analytical curve, whose concentrations were similar to concentrations of minerals present in the sample (IAL, 2008).

The opening of the sample of collard green was performed by dry digestion in duplicate and determination of minerals was performed by atomic absorption spectrometry (Varian ® Model 50B) with flame of air / acetylene, in triplicate. For both procedures, was adopted the methodology described by the Institute Adolfo Lutz (IAL, 2008).

In the diluted standards solutions, on the white and in the samples reserved for the analysis of calcium was added 1% solution of lanthanum chloride (AOAC, 2000a).

The lamps used were adjusted to 10 mA, and the conditions of use of equipment made in accordance with the recommendations by the Analytical Methods. For determination of calcium the wavelength (λ) was of 422.7 nm and the opening of the slit of 0.5 nm; and λ = 372.0 nm opening of slit of 0.2 nm for the determination of iron (VARIAN, 1989).

The analytical curves were constructed with assistance from the Origin 6.0 software and the data of probability were obtained through the software Graph Pad Prism 5.0, Values expressed in mean and standard error. We used the Student t test, considering $p < 0.05$ as significant difference.

Results and Discussion

There is a great quantity of tables of food composition tables showing the values of the concentration of minerals in collard green, however, between the tables consulted we did not find data on the composition of minerals in food grown by organic agriculture. The table at the University of São Paulo (USP, 2004) does not have the mineral composition of collard green of organic crop, neither the conventional cultivation. Nevertheless, it is interesting to compare the results obtained in this study concerning the conventional collard green, with the data of food composition presented in the literature. Therefore, the values related to moisture, ash, concentrations of calcium and iron obtained in this work and presented in some tables of food composition are shown in Table 1.

The concentration of calcium found in conventional collard green presented value between 43 and 77% lower than those presented in the tables of food composition specified in Table 1, considering the minimum and maximum values presented, respectively. This may be due to calcium constitute an element of hard determination by atomic absorption spectrometry, with the flame of air / acetylene whose temperature of the flame is approximately 2300 °C. In this condition undesirable chemical reactions may occur, since in the flame can happen combinations before the volatilization of the mineral studied. These combinations, usually containing oxygen in their structures, have different volatilities of the salt of origin of the element to be determined, resulting in a compromise of precision and accuracy of the results. This would not occur if the flame was of nitrous oxide, which has a temperature of about 2850 °C, and is able to volatilize those oxides formed (HARRIS, 2005; SKOOG et al. 2002).

As the flame more suitable for the determination of calcium (nitrous oxide) was not available, we used a known chemical modifier that is the lanthanum chloride added in excess to samples, to the white and the standard solutions. According to HARRIS (2005) and SKOOG et al. (2002), lanthanum binds to the interferer and has the ability to form a more stable compound. This technique can totally eliminate, as partially eliminate the interferences. Due to the result of calcium in Conventional collard green being lower than those published in the literature can be assumed that the analytical interferences were eliminated only partially.

The results of determination of iron in conventional collard green, as well as the values obtained in different tables of food composition are also presented in Table 1. The result of the iron content obtained is between 14 and 93% higher than the maximum and minimum values presented in the tables of food composition consulted, respectively. However, also according to Table 1 it can be seen that even among different composition tables there are differences in the levels of minerals presented. According to RIBEIRO et al. (1995) there is the need to update the tables of chemical composition of foods, because there are incomplete data for foods and nutrients, besides the lack of clarity in the description of methods of chemical analysis, this are some of the factors that make the use of these tables not reliable.

Table 1. Concentration of moisture, ash and minerals in collard green obtained by conventional agriculture, presented by different authors.

Variables	Results of this Study	Pinheiro (2008)	NEPA (2006)	Philippi (2002)	Franco (2001)	UNIFESP (2001)
Moisture (%)	89.49	-	90.90	-	-	90.55
Ashes (%)	1.56	-	1.30	-	-	0.89
Calcium (mg $100g^{-1}$)	76.95	203.00	-	135.00	330.00	145.00
Iron (mg $100g^{-1}$)	2.55	1.00	-	1.70	2.20	0.19

The content of moisture and ash, besides the concentrations of the minerals studied in collard green under conventional and organic cultivation are presented in Table 2.

Table 2. Moisture, ash and minerals contents in conventional and organic collard green [(1)].

Variables	Collard Green	
	Convencional	Organic
Moisture (%)[(2)]	89.49 ± 1.30a [ns]	88.63 ± 0.93a [ns]
Ashes (%)[(2)]	1.56 ± 0.09a [*]	1.37 ± 0.13b [*]
Calcium (mg $100g^{-1}$)[(3)]	76.95 ± 12.24a [**]	60.64 ± 8.16b [**]
Iron (mg $100g^{-1}$)[(3)]	2.55 ± 1.15a [*]	1.51 ± 0.26b [*]

*[(1)] Values expressed as averages and standard deviation followed by the same letters on the lines, do not differ by t test and at 5% probability; [(2)] (n = 18) [(3)] (n = 12) , [(NS)] Non significant, * and ** Significant at 5 and 1% probability, respectively.*

The calcium content ($R_{\text{analytical curve}}$ = 0, 9940), and iron ($R_{\text{analytical curve}}$ = 0, 9978) and of ashes presented more elevated in conventional collard green ($p < 0.05$). The moisture content is similar in the collard green obtained by the two types of culture ($p > 0.05$).

The fact of calcium, iron and ash present higher levels in collard green of conventional tillage may be due to chemical fertilization that the soils of conventional agriculture receive, providing greater amounts of some minerals to the plant (FERNANDES et al. 2004). After all, plants absorb of the environment all inorganic substances required for essential biochemical processes, where the soil is the most important source of nutrients for vegetables (ZSÖGÖ, 2007). In general, they use fertilizers with formulations containing various minerals, both macro and micro minerals, besides the fact that the plants planted in fertile soil absorb more nutrients (FERNANDES et al., 2004).

It is believed that the high concentration of calcium and iron in collard green grown by conventional agriculture contributed to the increase in the ash content in these samples.

It is valid to argue that in natural situations, the elements present in the soil are recycled becoming available again for plant growth, without the need for chemical fertilizer. This fact contributes to the success of the organic agriculture. However, with time, when a number of crops are made in a given field, fact of high occurrence in conventional agriculture, the nutrients are continuously removed of the cycle by the occasion of the harvest, some of these minerals may be present in minor amounts or in an unavailable form for plants (ZSÖGÖ, 2007).

With this, we can infer that the tendency of a soil in which it is practiced the agriculture is losing its nutrients throughout time (D'ANDREA et al., 2004), reason why the chemical fertilization is so practiced in conventional agriculture. In this sense, the advantage of the organic agriculture over the conventional is that the first encourages crop rotation, the planting of legumes species, green manure, the use of animal manure and maintenance of vegetation on the surface of the earth, to promote the nutrients cycling (CUNHA et al., 2007).

The results of the determinations of ash, calcium and iron demonstrate that the plants obtained by conventional agriculture have higher levels of these nutrients, possibly because the chemical fertilization provides higher concentrations of minerals in the soil. However, according to GOBBO-NETO and LOPES (2007) the stress by which plants cultivated in organic agriculture are more likely to pass that plants grown by conventional agriculture, since they are not chemically fertilized nor protected from insects by pesticides, despite ensuring smaller biomass for the vegetable, provides greater production of products derived from the secondary metabolism of plants. According to CASTRO et al. (2005) these compounds are not necessary for all plants, for carrying out an important role in interaction of the plants with the environment, besides being a considerable part of the plant substances which prevent disease, constituting a group of foods denominated as functional.

Plants excessively protected by the man with the use of pesticides or produced in fertilized soils, characteristic of conventional agriculture, will have the secondary metabolism less activated and therefore produce less of these important metabolites, constituting as food sources less interesting from a nutritional standpoint (FERNANDES et al. 2004). With this, it follows that foods with increased biomass are not necessarily the most appropriate or more healthy for human consumption.

Conclusion

There is a statistically significant difference ($p < 0.05$) between the collard green of conventional and organic farming, as the ash content, concentration of calcium and iron, whose values were higher in conventional collard green.

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