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STUDY TO DETERMINE SOME NUTRITIONAL COMPONENTS OF ONION CULTIVARS

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Abstract. Onions are widely grown in Vietnam, with many different varieties of onions. Each onion variety has different colour characteristics, and the ratio of nutritional ingredients is also different. The aim of this study is to determine some nutritional components of onions to serve as a scientific basis for the application of appropriate processing methods. The following was determined for each cultivar: the content of macro- and micronutrients, reducing and total sugar, and the vitamin C content. Significant differences in chemical composition between the analyzed cultivars were found. The cultivars of the same colour exhibited similar tendencies in terms of accumulating most of the analyzed elements. The greatest differences in the chemical content were found among yellow and red cultivars. Yellow cultivars accumulated significantly greater amounts of nitrogen, phosphorus, potassium, magnesium, iron, manganese, zinc, copper, and reducing sugar than red onion cultivars. Red onion cultivars contained significantly greater amounts of total sugar and vitamin C than yellow onion cultivars.

Keywords: nitrogen, onion cultivars, reducing sugars, total sugars, vitamin C.

1. Introduction

Onions are widely grown in Vietnam, with many different varieties of onions, especially in Lam Dong, Lao Cai, Son La, Hai Duong, Hung Yen, and Vinh Phuc provinces, with large areas and output. Each onion variety has different color characteristics, and the rates of nutrients are also different. The onion (*Allium cepa* L.) is one of the oldest cultivated vegetable crops. The nutritional and medicinal values, as well as the taste of the onion, make it a very popular vegetable all over the world, mostly due to various possible applications of the crop. Onions can be consumed raw, processed, and stored [1]-[3]. Antioxidants found in onions protect the human organism against free

radicals which are responsible for ageing and cardiovascular diseases. Fructans found in onions are considered prebiotics and stimulate the growth of intestinal microbiota decreasing the risk of diet-related diseases such as colorectal cancer [1]-[3]. Numerous studies have shown the differences in the chemical composition of onions depending on the cultivation conditions, such as nutrition, soil conditions, weather, and season. New onion cultivars of various colours, shapes, odours, and flavours are now available on the market. At the same time, customers are now more health-oriented and aware of healthy eating habits and pay attention not only to the appearance of onions but also to their nutritional prophylactic and medicinal values [1]-[3]. The aim of this study is to determine some nutritional components of onions to serve as a scientific basis for the application of appropriate processing methods.

2. Content

2.1. Materials and methods

2.1.1. Material

Six onion cultivars (*Allium cela* L.) samples reached technical maturity (harvest time is 120 days from planting) in Don Duong district, Lam Dong province. Six samples of onion albion, onion alibaba, onion grabowska, onion majka, onion scarlet, and onion wenta were used for analysis. Onion cultivars are packed in perforated foam boxes and transported by car to the laboratory to perform research. Onion cultivars used in the experiment must meet quality standards, be pest free, undamaged, and ensure food safety and hygiene.

2.1.2. Methods

- *Method for determining mineral content*

Mineral content was determined according to Vietnam's National Standard - TCVN 10641. This method was carried out on the principle that the test sample was decomposed in a nitric acid/perchloric acid mixture and determined by inductive plasma emission spectrometry [4].

- *Method for determining vitamin C content*

Vitamin C content was determined according to Vietnam's National Standard - TCVN 6427-2. This method was performed according to the principle of extracting ascorbic acid from the product using an oxalic acid solution or metaphosphoric acid/acetic acid solution. Titration was applied with 2,6 dichlorophenolindophenol until a pale pink color appeared [5].

- *Method for determining reducing sugars and total sugar content*

The reduced sugars and total sugar content of onion cultivars were determined according to Vietnam's National Standard - TCVN 4594. This method was carried out according to the principle of extracting total sugar from the sample with hot water, using hydrochloric acid to hydrolyze it into glucose; the amount of glucose was determined through reactions with pheling solution, $Fe_2(SO_4)_3$, $KMnO_4$ [6].

- *Method for determining nitrogen content*

The nitrogen content of onion cultivars was determined according to Vietnam's National Standard - TCVN 9936. Organic matter was decomposed with sulfuric acid,

alkalinize reaction products, liberated ammonium was distilled, and boric acid solution was collected, then titrated with standard sulfuric acid solution [7].

- *Method for determining sulfur content*

The sulfur content in onion samples was determined according to the method of Tran Thi Huong [8].

- *Data processing methods*

The statistical analysis of the results was conducted using Statistica 10 software. In order to determine the significance of the differences in the chemical composition of the analysed onion cultivars, one way analysis of variance (ANOVA) was conducted. For the purpose of determining homogenous subsets of means, the Newman-Keulus test was conducted for $p \leq 0.05$.

2.2. Results and discussion

2.2.1. The nutritional components of onion varieties

Nutrition is an important ingredient in food in general and in onions in particular. Each onion variety has a different nutritional content. The results of determining the nutritional content of each onion variety are shown in Table 1.

Table 1. The nutritional components of onion varieties

Analyzed component	**Onion varieties**						**Mean**
Macronutrients (g/kg)	***White***		***Yellow***		***Red***		
	Albion	Alibaba	Grabowska	Majka	Scarlet	Wenta	
N	18.16^{a}	23.29^{b}	26.92^{d}	25.31^{c}	18.47^{a}	18.74^{a}	21.92
P	3.52^{b}	4.73^{c}	5.56^{e}	5.06^{d}	3.76^{a}	3.82^{a}	4.43
K	14.03^{c}	14.91^{d}	16.12^{b}	16.38^{b}	11.42^{a}	11.53^{a}	14.08
Ca	0.65^{a}	0.84^{bc}	0.74^{a}	1.06^{d}	0.83^{b}	0.96^{c}	0.83
S	3.46^{a}	3.23^{a}	3.75^{c}	3.24^{a}	3.24^{a}	2.12^{b}	3.17
Micronutrients (mg/kg)							
Mg	543.76^{a}	649.62^{b}	672.08^{b}	658.16^{b}	509.12^{a}	552.04^{a}	597.46
Fe	25.34^{a}	25.04^{a}	30.65^{e}	29.83^{d}	18.07^{b}	21.32^{c}	25.21
Mn	11.42^{c}	12.82^{b}	14.59^{d}	12.81^{b}	10.64^{a}	10.96^{a}	12.27
Zn	19.73^{a}	23.64^{b}	25.32^{c}	26.34^{c}	19.57^{a}	24.17^{b}	23.16
Cu	4.52^{b}	5.93^{a}	5.65^{a}	5.79^{a}	3.93^{c}	4.82^{b}	5.14
Vitamin C (mg/100g)	*10.82^{b}*	*8.73^{a}*	*8.82^{a}*	*8.07^{a}*	*10.76^{b}*	*9.95^{c}*	*9.52*
Reducing sugars (g/kg)	*23.75^{e}*	*11.45^{b}*	*20.43^{d}*	*27.54^{f}*	*9.53^{a}*	*12.97^{c}*	*17.63*
Total sugars (g/kg)	*50.91^{d}*	*53.63^{e}*	*48.24^{c}*	*41.33^{b}*	*56.54*	*56.53^{a}*	*51.37*

Note: in horizontal rows, numbers with different exponents have statistically significant differences (with $p < 0.05$).

The greatest significant differences were recorded for reducing sugar content while the magnesium accumulation exhibited the least differences between onion cultivars. The highest content of nitrogen (26.92 g/kg) and phosphorus (5.56 g/kg), respectively 25% and 27% above the average, was recorded in the yellow onion cultivar Grabowska. The lowest content of the elements in question (18.16 g N/kg and 3.52 g P/kg) respectively 17% and 20% below average was recorded in the white cultivar Albion. The difference of N in the samples of Albion, Scarlet, and Wenta is not significant. The highest potassium content (16.38 g/kg), as well as calcium content (1.06 g/kg), were found in yellow cultivar Majka, respectively 16% and 27% above the average. The lowest content of potassium (11.42 g/kg, 17% below average) was determined in the red cultivar Scarlet, and the lowest content of calcium (0.65 g/kg, 18% below average) was determined in the white cultivar Albion. Most of the analysed cultivars did not exhibit significant differences for sulfur accumulation and formed a homogenous subset with a mean content of 3.24 g S/kg. Significant differences in the content of this element were recorded only in two cultivars: the highest content of sulfur was determined in the yellow cultivar Grabowska (3.75 g/ kg, 19% above average), and the lowest content of sulfur in the red cultivar Wenta (2.12 g/kg, 30% below average). The literature on the subject indicates a slightly higher mean content of sulfur in onions (4.5 - 5.5 g S/kg) [2, 3]. According to data included in Table 1, the red cultivar Scarlet accumulated the least of the analysed micronutrients from all the cultivars under study. This cultivar showed the lowest content of magnesium (509.12 mg/kg, 14% below average), iron (18.07 mg/kg, 27% below average), manganese (10.64 mg/kg, 12% below average), zinc (19.59 mg/kg, 14% below average) and copper (3.92 mg/kg, 22% below average). The highest content of all the micronutrients was determined in yellow cultivar Grabowska - magnesium (672.08 mg/kg), iron (30.65 mg/kg, 25% above average), and manganese (14.59 mg/kg, 20% above average), as well as higher than average content of zinc (25.32 mg/kg) and copper (5.65 mg/kg). The highest content of zinc was determined in the yellow cultivar Majka (26.34 mg/kg), and the highest content of copper in the white cultivar Alibaba (5.93 mg/kg). The analysed onion cultivars showed significant differences in terms of the content of reducing sugars which ranged from 9.53 g/kg to 27.54 g/kg. The mean total sugar content is 50.91 g/kg. The highest content of total sugars was determined in the red cultivar Wenta 56.53 g/kg and the lowest in the yellow cultivar Majka 41.33 g/kg. The vitamin C content determined in fresh mass ranged from 8.07 mg/100g (cultivar Majka) to 10.82 mg/100g (cultivar Albion). This research result is also consistent with the research results of Jurgiel M.G et al. [1], Rodrigues G. B et al. [2], and Rodrigues G.B et al. [3].

2.2.2. The color of the onion and its chemical composition

In order to determine the effect of the colour of the onion on its chemical composition, the statistical analysis of the results was repeated and the colour was a variable factor Table 2. The amount of accumulated nitrogen, phosphorus, potassium, magnesium, iron, manganese, and zinc was significantly higher ($p \leq 0.05$) in yellow cultivars than in red and white cultivars. The lowest content of total macro and micronutrients was found in red cultivars (37.51 g/kg and 590.48 mg/kg respectively). Table 2 confirms this correlation. Moreover, onion with higher sulfur content is characterized by a more pungent flavour and intensive odour [8]. The higher content of reducing sugar in yellow

onion cultivars indicates the presence of a greater amount of active formyl groups taking part in Maillard reactions during food processing such as baking, frying, and cooking. The products of the Maillard reaction are partly responsible for the flavour and colour of a dish [9]. Since yellow onion cultivars contain more macro- and micronutrients than white and red cultivars, they would constitute a better source of nutrients as far as the use of onion as a pot herb and in food processing is concerned. Red onion cultivars exhibit significantly higher content of vitamin C than yellow cultivars (on average 10.32 mg/100 g and 8.45 mg/100 g). Red onion cultivars have a milder taste and odour than yellow onion due to their high content of total sugar and lower content of sulfur. Consequently, red onions are more likely to be consumed raw in salads. The obtained result is also consistent with the research result of Jurgiel MG et al. [1], Rodrigues GB et al. [2], and Rodrigues GB et al. [3].

Table 2. The colour of the onion and its chemical composition

Analyzed component	**Onion colour**			**Mean**
Macronutrients (g/kg)	***White***	***Yellow***	***Red***	
N	20.73^{a}	26.42^{b}	18.64^{a}	21.92
P	4.17^{a}	5.36^{b}	3.76^{a}	4.43
K	14.43^{b}	16.27^{c}	11.53^{a}	14.07
Ca	0.76^{a}	0.92^{a}	0.86^{a}	0.83
S	3.34^{a}	3.51^{a}	2.74^{a}	3.18
Micronutrients (mg/kg)				
Mg	598.72^{b}	664.13^{c}	532.59^{a}	597.43
Fe	25.16^{b}	30.76^{c}	19.72^{a}	25.24
Mn	12.14^{a}	13.73^{b}	10.84^{a}	12.21
Zn	21.67^{a}	25.92^{b}	21.91^{a}	23.17
Cu	5.28^{ab}	5.78^{b}	4.39^{a}	5.12
Vitamin C (mg/100g)	*9.83^{a}*	*8.45^{b}*	*10.32^{a}*	*9.53*
Reducing sugars (g/kg)	*17.54^{ab}*	*24.19^{b}*	*11.26^{a}*	*17.66*
Total sugars (g/kg)	*52.52^{b}*	*44.94^{a}*	*56.73^{c}*	*51.34*

Note: in horizontal rows, numbers with different exponents have statistically significant differences (with $p < 0.05$)

3. Conclusions

Significant differences in chemical composition between the analyzed cultivars were found. The cultivars of the same colour exhibited similar tendencies in terms of accumulating most of the analysed elements. The greatest differences in the chemical content were found among yellow and red cultivars. Yellow cultivars accumulated significantly greater amounts of nitrogen, phosphorus, potassium, magnesium, iron,

manganese, zinc, copper, and reducing sugar than red onion cultivars. Red onion cultivars contained significantly greater amounts of total sugar and vitamin C than yellow onion cultivars.

REFERENCES

[1] Jurgiel MG, Suchorska O, (2008). The effect of nitrogen fertilization on the content of microelements in selected onions. *Journal of Elementology,* (13), 227-234.

[2] Rodrigues GB, Gonzalez RO, Rodrigues ER, Diaz Romero C, (2008). Comparison of mineral and trace element contents in onion cultivars (*Allium cepa* L.). *Journal of the Science of Food and Agriculture,* (88), 1554-1561.

[3] Rodrigues GB, Rodrigues CT, Rodrigues EM, Diaz Romero C, (2009). Fructans and major compounds in onion cultivars (*Allium cepa*). *Journal of Food Composition and Analysis,* (22), 25-32.

[4] Vietnam's National Standard - TCVN 10916, (2015). *Food - Determination of minerals in food and special nutritional foods - Atomic absorption spectroscopy method*, p. 1-7.

[5] Vietnam's National Standard - TCVN 6427-2, (1998). *Vegetables and fruit and vegetable products. Determination of ascorbic acid content*, p. 1-6.

[6] Vietnam's National standard - TCVN 4594, (1988). *Canned foods- Determination of total sugar, reducing sugar and starch content,* p. 1-4.

[7] Vietnam's National standard - TCVN 9936, (2013). *Starches and derived products- Determination of nitrogen content by the Kjeldahl method - Titrimetric method*, p. 1-6.

[8] Tran TH, (2014). Research determines the concentration of sulfur in some medicines that grow and process herbal in Binh Minh commune, Khoai Chau district, Hung Yen province. *Journal of Agricultural Science and Technology*, (4), 61-70.

[9] Hamilton BK, Yoo KS, Pike LM, (1998). Changes in the pungency of the onion by soil type, sulfur nutrition, and bulb maturity. *Scientia Horticulturae,* (74), 249-256.

[10] Elhassaneen YA, Sanad MI, **(**2009). Phenolics, selenium, vitamin C, amino acids pungency levels, and antioxidant activities of two Egyptian onion varieties. *American Journal of Food Technology,* (4), 241-254.