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(RESEARCH ARTICLE)

Some characteristics of pumpkins grown at different altitudes

Ekaterina Georgieva Petkova [1,*], Petya Stankova Kasnakova [1,2], Biynka Lubchova Tornyova [1,2], Tanya P. Packaleva-Stoycheva [1], Stoyan Iliev Papanov [3], Dobrin Ivanov Popov [4], Ivan Georgiev Ivanov [5] and Lefter Ynaki Nasto [6]

[1] *Medical College - Haskovo Branch, Trakian University, Bulgaria.*
[2] *Faculty of Public Health, Medical University - Plovdiv, Bulgaria.*
[3] *Faculty of Pharmacy, Medical University - Plovdiv, Bulgaria.*
[4] *Medical Faculty, Medical University - Plovdiv, Bulgaria.*
[5] *Technological Faculty, University of Food Technologies, Bulgaria.*
[6] *Medical Faculty, Trakian University, Bulgaria.*

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Abstract

According to the classification, the pumpkin belongs to the annual herbaceous, dicotyledonous, flowering plants of the Pumpkin family. Due to its unique taste and health properties, the pumpkin quickly spread throughout the continent.

The use of pumpkins is determined by people's desire to consume healthy foods.

Objective: Analysis of some characteristics of pumpkins grown at different altitudes. Research methods used: Systematic approach and critical analysis of the accessible scientific periodicals; Determination of moisture content, carotenoid content and total content carbohydrates, the total soluble solids, pectic substances and degree of esterification.

Conclusions: The data obtained show that dry weight content and carbohydrate composition does not depend on altitude.

Keywords: Pumpkin; Pectin; Carotene; Carbohydrate; Altitude

1. Introduction

Pumpkin (*Cucurbita*) are genus of fruit vegetables and belongs to Cucurbitaceae family, which includes also cucumber, cantaloupe, zucchini and watermelon. According to the classification, the pumpkin belongs to the annual herbaceous, dicotyledonous, flowering plants of the Cucurbita family [1].

It is said that the history of the pumpkin began 5000 years ago in distant Peru. It was the Indians who were the first people to grow and breed pumpkins. Archaeological excavations prove this statement.

The word pumpkin is of Greek origin and means “big melon” or “melon”. “Pepon” was changed by the French to “pompon”. The English changed “pompon” to “pumpion” and the American colonists changed “pumpion” to “pumpkin” [2].

First brought to Europe by Christopher Columbus in the 16th century, pumpkin quickly spread throughout the continent thanks to its unique taste and health properties.

* Corresponding author: Ekaterina Georgieva Petkova

Pumpkin is diverse in varieties, color, aroma and consistency. Its easy cultivation, which is also low in cost are prerequisite for mass production. As crops, ordinary hard-winged pumpkin (*Cucurbita pepo*), large-fruited pumpkin (*Cucurbita maxima*) and muscat pumpkin (*Cucurbita moschata*) are grown [3].

Large amounts of pectin, mineral salts, carotenes, vitamins and other substances have been identified in pumpkin with benefits to human health [4].

The use of pumpkins is determined by people's desire to consume healthy foods. The usefulness of pumpkin is due to:

the low energy value (calorie content 17g/100g);

the high content of carotenoids, vitamins from groups B, vitamin C, PP, A, E, K and T and pectin - some are very rarely found in plant food vitamins.

The content of vitamins per 100 g of pumpkin is present in Table 1. The average content is 1.565 mg/100g β-carotene (vitamin A provitamin) [5].

Table 1 Vitamins per 100g pumpkin according to USDA [6,7]

Vitamin	**Content**
Retinol equivalent (A)	250.072 (μg)
Ascorbic acid (C)	8.363 (mg)
Thiamine (B1)	0.058 (mg)
Riboflavin (B2)	0.065 (mg)
Pantothenic acid (B5)	409 (mg)
Pyridoxine (B6)	0.103 (mg)
Folic acid (B9)	14.794 (μg)
Tocopherol (E)	0.472 (mg)
Vitamin PP	0.567 (mg)
Niacin equivalent (PP)	0.782 (mg)

The content of macro- and microelements which have detoxifying and slightly dehydrating effect on the body is presented in Table 2 [8,9].

Table 2 Macro- and microelements per 100g pumpkin according USDA [6,7]

Macroelements		**Microelements**	
25.485 (mg)	Calcium (Ca)	0.398 (mg)	Iron (Fe)
204.477 (mg)	Potassium (K)	0.245 (mg)	Zinc (Zn)
14.337 (mg)	Magnesium (Mg)	1.095 (μg)	Iodine (I)
25.723 (mg)	Phosphorus (P)	180.396 (μg)	Copper (Cu)
4.453 (mg)	Sodium (Na)	0.048 (mg)	Manganese (Mn)
19.938 (mg)	Chlorine (C1)	86.564 (μg)	Fluorine (F)
18.094 (mg)	Sulfur (S)	1.084 (μg)	Cobalt (Co)

M. Javaheraghti, et al. [10] analyze Total soluble Solids

Interest in raw materials of plant origin that contain high levels of carotenoids with provitamin A activity has increased significantly in recent years. Some varieties of pumpkin coloring intensely yellow to orange, revealed high levels of carotenoids, mainly β- and α-carotene. The deep orange color of the pumpkin comes from the antioxidant's carotenoids and especially β-carotene [11,12,13] A study evaluating twenty-two varieties of *Cucurbita moschata* eported total carotenoid contents ranging from 7.02 μg/g to 138.56 μg/g [14].

Pumpkin seeds are also highly valued for their protein content, linoleic acid, phytosterols (antioxidants), vitamins A, B, C, E and K, as well as minerals such as chromium, sodium, magnesium, zinc, copper, iron, phosphorus and selenium [15].

Objective: Analysis of some characteristics of pumpkins grown at different altitudes.

2. Materials and methods

All data were reported as mean ± standard error of triplicate determinations, analyzed using one-way analysis of variance (ANOVA) with significant differences between means determined at $p < 0.05$ and measured by Duncan's multiple range tests using the Statistical Package for Social Sciences version 14 (SPSS) [16]

The researched material is the juice of the corresponding types of pumpkin.

The following factors were taken into account during the selection of the vegetable raw material (types of pumpkins): market distribution, accessibility for the user, price.

The pumpkin of the "Danka Polka" variety (genus *Cucurbita maxima*) is grown in the vicinity of the city of Batak (a city in Southern Bulgaria), altitude 1.036 m. Pumpkins of the "Zhemchuzhina" variety, "Tahitian melon" (genus *Cucurbita moschata*) and "Argentina" (genus *Cucurbita maxima*) are grown in the vicinity of the town of Bogdanci (a town in North Macedonia), altitude 85 m.

2.1. Research methods used

- Systematic approach and critical analysis of the accessible scientific periodicals;
- Determination of moisture content;
- The total soluble solids (TSS);
- Carotenoids extraction and total content;
- Carbohydrates;
- Pectic substances and degree of esterification.

Time of the study: 09.2020 - 01.2021.

Place of the study: Laboratory of the University of Food Technology Plovdiv and Laboratory of Pharmaceutical Analysis of the Medical University of Plovdiv.

Determination of moisture content. The moisture content was determined by a moisture analyzer KERNDAB 100-3 (Kern, Germany).

The Total Soluble Solids (TSS) content was determined by hand refractrometer ATC (Aichose, China) and expressed as °Brix. The samples were preliminary homogenized by a blender MSM 14200 (Bosch, Germany), a few drops of juice were put on the prism glass, and the TSS value was immediately read [10].

Carotenoids extraction and total content. To determine the total amount of carotenoids, approximately 15 g of the samples for the carotenoid extraction, successive additions of 25 mL of acetone were made to obtain a paste, which was transferred to a 250 mL Buchner flask and filtered under vacuum. This procedure was repeated three times or until the sample became colorless. The extract obtained was transferred to a 500 mL separatory funnel containing 40 mL of petroleum ether. The acetone was removed through the slow addition of ultrapure water to prevent emulsion formation. The aqueous phase was discarded. This procedure was repeated four times until no residual solvent remained. Then, the extract was transferred through a funnel to a 50 mL volumetric flask containing 5g of anhydrous sodium sulfate. The volume was made up of petroleum ether, and the samples were read at 450 nm. The total carotenoid content was calculated using the following formula:

$$Carotenoids\ content\ (\mu g/g) = \frac{A.V.10^4}{A^{1\%}.P}$$

where: A - Absorbance; V - Total extract volume (mL); P - sample weight (g);

$A^{1\%}$ = 2592 (β-carotene extinction coefficient in petroleum ether) [17].

Carbohydrates. The total soluble carbohydrate content was analyzed by the phenol-sulfuric acid method [18]. Water extracts (0.1 mL) were mixed with 1 mL 5% phenol and 5 mL concentrated H_2SO_4. The samples were heated in a water bath at 30°C for 20 min, and then the absorbance was measured at 490 nm against a blank comprised of distilled water. The content of carbohydrates was determined from the calibration curve for glucose and the results were calculated as g/100g FW (fresh weight) [19,20,21].

Pectic substances and degree of esterification were analyzed by the titration method described by Owens *et al*. and the results were calculated as g/100 g FW [22].

3. Result and discussion

The moisture content in the varieties studied by us is from 7.05 ± 0.10% in the variety "Zhemchuzhina", Republic of North Macedonia to 12.54 ± 0.10% in the variety "Argentina", Republic of North Macedonia (Table 3). We cannot explain this result with the climatic features of the places where the pumpkins were grown.

Table 3 Determination of moisture content

Pumpkin`s variety	**"Danka Polka"**	**"Zhemchuzhina"**	**"Tahitian melon"**	**"Argentina"**
Moisture content, (%)	11.74 ±0.10	7.05 ±0.10	8.53±0.10	12.54 ±0.10

Extraction is the process of extracting one or more components from a mixture in a solid or liquid state by treatment with a solvent (extractant). Depending on the aggregate state of the mixture, a distinction is made between liquid-liquid extraction (e.g. extraction of heavy metal salts from wastewater using an organic solvent) and solid-liquid extraction (e.g. brewing tea or coffee, extraction of sunflower oil seeds with petroleum ether).The industrial devices in which the extraction is carried out are called extractors (often: extraction columns).

The total soluble solids in the considered samples are presented in Table 4.

Table 4 The Total Soluble Solids (TSS)

Pumpkin`s variety	**"Danka Polka"**	**"Zhemchuzhina"**	**"Tahitian melon"**	**"Argentina"**
TSS (^{0}Brix)	10.00 ±0.01	6.99	8.00 ±0.01	13.10 ±0.02

The difference in the values of moister content and total soluble solids are small, i.e. the values of these characteristics are approximately the same. We observe a difference between these characteristics in a sample of "Danka Polka" pumpkin. Moisture content is 11.74 ± 0.10%. The results show that the considered indicator does not depend on the altitude.

It can be seen from Figure 1 that there is a linear correlation between Dry substance and Total extractable substances.

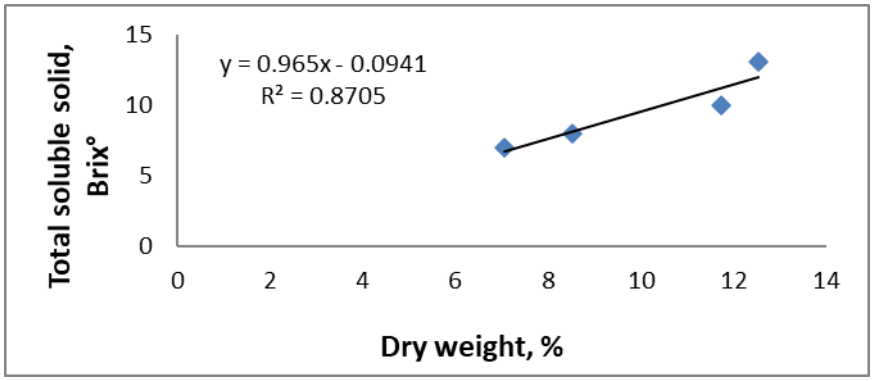

Figure 1 Dry weight / Total extractable substances

The obtained correlation value shows that as the "Dry substance" array increases, the "Total soluble solids" array also increases [19,20,21]...

Vitamin A deficiency constitutes a public health problem and affects mainly children and women. Interest in raw materials of vegetal origin that contain high levels of carotenoids with provitamin A activity, has increased substantially in recent years. Some cultivars of pumpkin (*Cucurbita*) staining intense yellow to orange have revealed high levels of carotenoids, mainly and α-carotene .

Table 5 β-carotene content in 100 g juice

Pumpkin`s variety	"Danka Polka"	"Zhemchuzhina"	"Tahitian melon"	"Argentina"
β-carotene, mg/100g	1.248±0.01	0.243	0.440	0.721

The results of the conducted experiments show β-carotene content from 0.243mg/100g in a sample of "Zhemchuzhina" pumpkin to 1.248 mg/100g in a sample of "Danka Polka" pumpkin. In all probability this fact can be explained by the altitude.

A study evaluating twenty-two cultivars of *Cucurbita moschata* reported total carotenoid contents rating from 7.02 µg/gto 138.56 µg/g [14].

It can be seen from Fig. 2 that there is a linear correlation between Dry weight and β-carotene

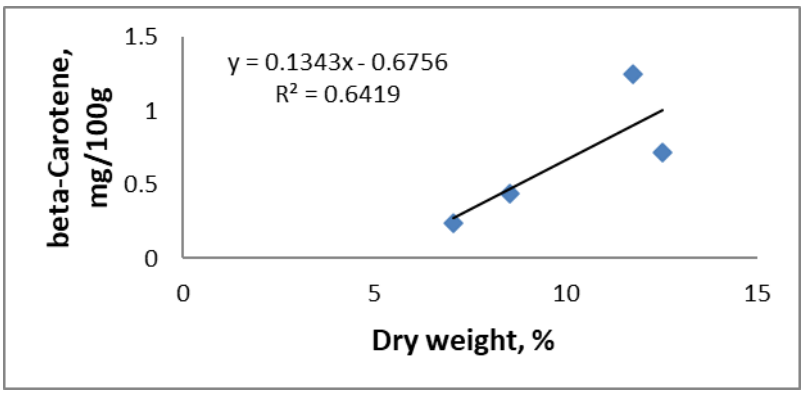

Figure 2 Correlation Dry weight/ β-carotene

The obtained correlation value shows that with an increase in the mass of dry substance, the mass of β-carotene increases.

Raw pumpkin contains 22 kcal/100 g, boiled pumpkin contains 24 kcal/100 g., baked pumpkin contains 27 kcal/100 g., and pumpkin stew contains 24 kcal/100 g.

The content of carbohydrates in raw pumpkin and thermally processed in different ways is from 22 to 27 kcal/100g [1,7].

The carbohydrate composition of the considered samples is presented in the Table 6.

Table 6 Carbohydrates in 100 g juice

Pumpkin`s variety	**"Danka Polka"**	**"Zhemchuzhina"**	**"Tahitian melon"**	**"Argentina"**
Carbohydrates (%)	3.06 ±0.01	2.05 ±0.01	3.06 ±0.01	4.26 ±0.01

The "Argentina" pumpkin has the highest carbohydrate content: 4.26 ± 0.01%, and the least (2.05 ± 0.01%) has "Zhemchuzhina". The varieties "Danka Polka" and "Tahitian melon" have the same values of total carbohydrates – 3.06 ±0.01%. The obtained results give reason to assume that the altitude is not a determining factor for the carbohydrate composition of the samples.

It can be seen from Fig.3 that there was a linear correlation dependence between Dry weight and Total carbohydrate content.

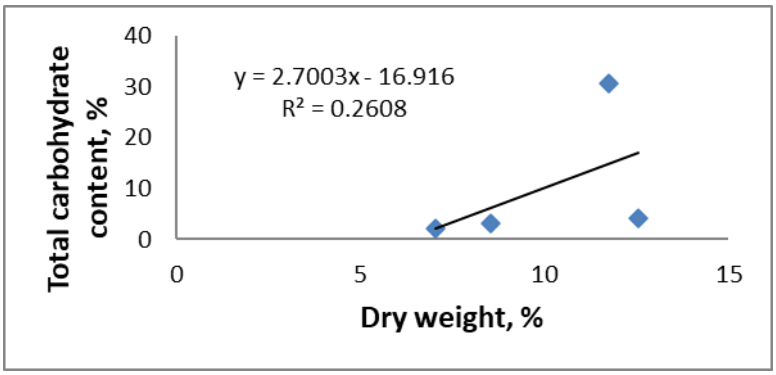

Figure 3 Correlation dependence Dry weight/ Total carbohydrate content

The obtained correlation value shows that as the mass of dry matter increases, the mass of total carbohydrate content also increases.

In plant cells, pectin is a complex of polysaccharides found in most primary cell walls, the non-woody parts of land plants being particularly rich. Pectin is present not only in the primary cell wall, but also in the intermediate lamella, where it helps to make intercellular contacts. The structure and chemical composition of pectin differs from plant to plant, as well as from the same plant in its different parts and depending on the stage of development.

The obtained results for the content of pectin and degree of esterification of pectin are presented in Table 7.

Table 7 Pectin substances and degree of esterification of pectin

Pumpkin`s variety	**"Danka polka"**	**"Zhemchuzhina"**	**"Tahitian melon"**	**"Argentina"**
Pectin substances (anhydrouronic content), %	0.151 ± 0.01	0.209 ± 0.01	0.265 ± 0.01	0.265 ± 0.01
Degree of esterification of pectin, %	65.00 ± 0.10	50.00 ± 0.10	67.50 ± 0.10	65.20 ± 0.01

The pectin content is from 0.151±0.01% in the "Danka Polka" sample to 0.265 ± 0.01% in the "Tahitian Melon" and "Argentina" samples. An intermediate value is occupied by the sample "Zhemchuzhina"- 0.209 ± 0.01%.

4. Conclusions

For the considered varieties:

- Dry matter content does not depend on altitude.
- Carbohydrate composition does not depend on altitude.
- β-carotene content depends on altitude.
- As the dry matter increases, the degree of pectin esterification increases.

The correlation between Dry substance and Total soluble solids, Dry weight and β-carotene, Dry weight and Total carbohydrate content is rectilinear.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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