Plant Archives Vol. 20, Supplement 2, 2020 pp. 385-388 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

BIOCHEMICAL COMPOSITION OF EGGPLANT AND ITS CHANGE DURING STORAGE

O.N. Shabetya[1]*, N.V. Kotsareva[1], Aldanyyen M. Nasser[1], A.G. Katskaya[2] and A.A.H. Al-Maidi[3]

[1]FSEBI HE Belgorod State Agricultural University, VJ Gorin, Belgorod, Russia

[2]FSBSI "Research Institute of Agriculture of Crimea", Simferopol, Russia.

[3]Plant Protection Department, College of Agriculture, University of Misan, Misan, Iraq.

*Corresponding author: shabetya14@yandex.ru

Abstract

We have conducted research to study the content of chemicals (dry matter and vitamin C) in the fruits of the eggplant. Based on the analysis of the content of dry matter and vitamin C in fruits of eggplant, the purpose of the present work was to determine the regularities of the formation of these substances depending on subspecies and genotypes under different climatic conditions and to establish the dynamics of these indicators at short-term storage. Chemical analysis of fruits of eggplant belonging to West Asian and East Asian subspecies has been performed. We used deep purple, purple, light lilac and white samples in the phase of the technical ripeness. The dry matter content depended not only on the subspecies but also on the colour of the fruits. The dry matter content of the samples of the East Asian subspecies is slightly higher (0.3-0.5%) than that of the West Asian. An increase in the dry matter content in fruits of genotypes both with a higher content of anthocyanins (a darker colour of the fruit) and with an increase in air temperature and drought during the growing season was also noted. In general, the indicator "dry matter content" is characterized by low variability. The stability of this indicator in the samples of the West Asian subspecies was slightly higher. The influence of the subspecies and varietal characteristics on the formation of dry matter in eggplant fruits ranges from 61 to 65%. The influence of the "weather conditions during the growing season" factor is about 20% and the interaction of factors is 15-18%. The stability of vitamin C in eggplant is higher than average and does not depend on the subspecies. Storage of purple-coloured eggplants in perforated plastic bags or crates in a refrigerator makes it possible to maintain their "marketability" without signs of withering and spoilage with minimal losses of chemical properties (dry matter) for 20 days. Varieties of white-skinned eggplants are absolutely unsuitable for storage in a refrigerator. Their short-term storage must be carried out indoors at a temperature of + 10 to + 15 °C.

Keywords **:** Eggplant; subspecies; variety; fruit coloration; dry matter, vitamin C; variability; stability; short-term storage.

Introduction

Eggplant is becoming more and more popular due to its taste and the content of useful chemicals, such as vitamins of group B, PP, C, potassium, calcium, phosphorus, magnesium, sodium (Voytsekhovskiy *et al.*, 2015). Eggplants also contain small amounts of copper, zinc, and aluminium. Due to the balanced content of salts of iron, manganese, and cobalt, they stimulate new blood and have a beneficial effect on the function of the spleen, bone marrow, contribute to the formation of red blood cells and hemoglobin, as well as normalize cholesterol and liver function. Eggplant is used in the treatment of anemia, atherosclerosis, and fatty degeneration (Dunaevskiy, Popik, 1990; Gorodniy *et al.*, 2002). In terms of quantity and availability of calcium, eggplant exceeds onion, carrot, cucumber, pepper, melon, pumpkin, and lettuce. Eggplant is also known for treating and preventing various diseases related to the heart and blood vessels. An eggplant has very few calories. In fact, 100 grams of raw eggplant will contain only 24 calories. This makes the product attractive for dietary nutrition (Sych, Sych, 2005; Shabetya, Kotsareva, 2015; Shabetya *et al.*, 2017).

One of the most important indicators is the content of dry matter in plant material. The quality of the processed products also largely depends on the content of dry matter in raw materials. The majority of vegetables has a relatively low dry matter content - 4 to 10 %. Such vegetables as carrots, green peas, and corn have a higher content of dry matter (14%, up to 20%, over 25%, respectfully). According to published data, the dry matter content in eggplant is 6-13% (Voytsekhovskiy *et al.*, 2015; Shabetya, Zinchenko, 20014; Shabetya, Mozgovska, 2017). The dry matter content depends on climatic conditions (Evdokimov, Yusov, 1990; Zhuchenko, 2001). Watering, especially before the collection of fruits and vegetables, increases the yield, but decreases the concentration of dry substances in raw materials, thus worsening its transportability and storage. For cooking side dishes, moderate dry matter content is desirable. It ensures the necessary elasticity and softness of the finished product. To produce high-quality canned foods, an increased dry matter content reduces fruit shrinkage in the jar and improves its appearance for a longer time (Zinchenko, 2018).

The Purpose of research

We studied the variability of the content of dry matter and vitamin C in eggplant depending on the subspecies and varieties, which were grown in the Belgorod region and the foothill zone of the Crimea. Based on the analysis of the content of dry matter and vitamin C in fruits of eggplant, the purpose of the present work was to determine the regularities of the formation of these substances depending on subspecies and genotypes under different climatic conditions and to establish the dynamics of these indicators at short-term storage.

Materials and Methods

Chemical analysis of fruits of eggplant belonging to West Asian and East Asian subspecies has been performed. We used dark deep purple, purple, light lilac and white samples in the phase of the technical ripeness. For the determination of soluble solids content, we used the refractometric method (GOST ISO 2173-2013). In production, the conventional method for determining solids using a refractometer is often applied. This method sets the percentage of only those substances that are dissolved in water. The experiments performed in research institutions showed that the readings of a refractometer depend on the chemical composition of the studied objects and may differ slightly compared to the method of determining dry substances by drying. The content of vitamin C was determined according to GOST 34151-2017.

Results and Discussion

According to the results of our studies, the dry matter content depended not only on the subspecies but also on the colour of the fruits. (Table 1).

Table 1 : Indicators of the content of dry matter and vitamin C in eggplants, 2018 (Belgorod region)

Genotype	Dry matter content using refractometer, %				Vitamin C content, mg per 100 g			
	I	II	III	IV	I	II	III	IV
West Asian subspecies								
No. 1 white-coloured fruits	8.0	7.8	7.9	7.9	4.0	3.9	3.9	3.8
mean value	7.9				3.9			
No. 2 deep purple fruits	8.0	8.1	7.9	8.0	3.8	3.9	3.9	4.0
mean value	8.0				3.9			
East Asian subspecies								
No. 3 purple-coloured fruits	8.0	8.3	8.2	8.7	3.9	3.9	4.1	4.3
mean value	8.4				4.1			
No. 4 lilac-coloured fruits	8.3	8.3	8.0	8.2	4,1	4.1	4.0	4.1
mean value	8.2				4.1			

The dry matter content of the studied samples of the West Asian subspecies averaged 7.9 - 8.0%. Five samples from each repetition were taken. Samples with fruits of deep purple colour accumulated more dry matter. The dry matter content of the samples of the East Asian subspecies was slightly higher and ranged from 8.2 to 8.4%. We also noted an increase in the dry matter content in fruits with a higher content of anthocyanins (a darker colour of the fruit). It was visually revealed that eggplant genotypes with a high dry matter content have a glossy surface, strong skin, dense pulp and are more suitable for transportation and storage. At the same time, we noted that higher air temperature and drought during the growing season contribute to the formation of high concentrations of dry matter.

The content of vitamin C ranged from 3.9 to 4.1 mg per 100 g. The accumulation of vitamin C depended on the subspecies and did not depend on the colour of the fruit.

We used only West Asian subspecies in the studies in the foothill zone of the Crimea because varieties of East Asian subspecies do not withstand the heat and are affected with vascular wilting (*Fusarium* sp., *Verticillium dahliae* Kleb.). The soluble dry matter content in the fruits of the West Asian subspecies varied greatly and depended on the colour of the eggplant (Table 2).

Table 2 : Indicators of the content of dry matter and vitamin C in eggplants, 2018 (foothill zone of the Crimea)

Genotype	Dry matter content using refractometer, %				Vitamin C content, mg per 100 g			
	I	II	III	IV	I	II	III	IV
West Asian subspecies								
No. 1 white-coloured fruits	7.3	7.7	7.5	7.5	4.5	4.9	4.8	4.9
mean value	7.5				4.8			
No. 2 deep purple fruits	8.5	8.7	8.8	8.8	4.8	4.9	4.9	5.0
mean value	8.7				4.9			

High air temperatures and drought during the growing season contribute to the formation of higher concentrations of dry matter in eggplants with deep purple skin. Vitamin C content in fruits of eggplant grown in the foothill zone of the Crimea was higher than that grown in the Belgorod region and varied from 4.8 to 4.9 mg/100 g. Vitamin C accumulation in eggplants of the West Asian subspecies almost did not depend on the colour of the fruit.

Scienties (Bashina, Ivanova, 2001; Kravchenko, etc., 2004; Pautova, 2004; Sych, 2005) have proven by their research the possibility of stability assessment of short variational series criteria using the Levis stability coefficients. The stability of dry matter was analyzed according to such indicators as maximum deviation, standard deviation and Levis coefficient (Table 3).

Table 3 : Dry matter content in the fruits of eggplant and its stability, 2018 (Belgorod region)

Cultivar	%					Levis coefficient
	Mean value	Max value	Min value	Max deviation	Standard deviation	
1	7.9	8.0	7.8	0.1	0.05	1.03
2	8.0	8.1	7.9	0.1	0.05	1.03
3	8.4	8.7	8.0	0.4	0.25	1.09
4	8,2	8.3	8.0	0.2	0.10	1.05
mean value	8.1	8.3	7.9	0.2	0.12	-
Levis coefficient	1.06	1.09	1.03	-	-	-

In general, the indicator “dry matter content” is characterized by low variability. The stability of this indicator in the samples of the West Asian subspecies was slightly higher (Levis coefficient 1.03).

Also, we made calculations to identify the relationship between the indicators “dry matter content”, subspecies, variety and weather conditions during the growing season (Sych, 2001). The key insight that emerged from the results of the analysis of variance (ANOVA) (Dospekhov, 1979; Gromyko, 2000), was that the influence of the subspecies and varietal characteristics on the formation of dry matter in eggplant fruits ranges from 61% to 65%. The influence of the “weather conditions during the growing season” factor was about 20% and the interaction of factors was 15-18%.

The stability of the content of vitamin C in the fruits of eggplant was also analyzed (Table 4).

Table 4 : Vitamin C content in the fruits of eggplant and its stability, 2018 (Belgorod region)

Variety	%					Levis coefficient
	Mean value	Max value	Min value	Max deviation	Standard deviation	
1	3.9	4.0	3.8	0.2	0.1	1.05
2	3.9	4.0	3.8	0.2	0.1	1.05
3	4.1	4.3	3.9	0.4	0.2	1.10
4	4.1	4.1	4.0	0.1	0.05	1.03
Mean value	4.0	4.1	3.9	0.2	0.1	-
Levis coefficient	1.05	1.08	1.05	-	-	-

The stability of vitamin C in eggplant was higher than average and did not depend on the subspecies. This indicator was more stable for lilac-coloured samples of the East Asian subspecies (0.03).

During storage, the chemical composition of eggplants changes (Zinchenko, 2012). The fruits of all samples were put for short-term storage under different conditions (indoors and refrigerator), in different types of containers (crates and perforated plastic bags) for 10 and 20 days.

At the end of each storage period, the dry matter content of the studied eggplants was determined.

Our studies showed that there is a certain relationship between the dynamics of the dry matter content in the fruits of eggplants and the conditions of storage (Table 5).

Table 5 : Dynamics of dry matter content during short-term storage of eggplants under various conditions and types of packaging

Conditions and types of containers		Indoors		Refrigerator	
		Crate	Perforated plastic bags	Crate	Perforated plastic bags
West Asian subspecies, No. 1 white-skinned fruits					
10 days	Dry matter content, %	7.9	7.9	8.0	8.1
20 days	Dry matter content, %	8.0	8.0	-	-
West Asian subspecies, No. 2 deep purple fruits					
10 days	Dry matter content, %	7.8	7.9	7.9	8.0
20 days	Dry matter content, %	7.8	7.9	8.0	8.1
East Asian subspecies, No. 3 purple-coloured fruits					
10 days	Dry matter content,%	8.1	8.2	8.5	8.4
20 days	Dry matter content,%	8.3	8.3	8.5	8.5
East Asian subspecies, No. 4 lilac-coloured fruits					
10 days	Dry matter content,%	8.1	8.1	8.2	8.2
20 days	Dry matter content,%	8.2	8.2	8.3	8.3

It was noted that sample No. 1 (white-skinned fruit of West Asian subspecies) had a non-significant increase in the dry matter content after 10 days of storage in a refrigerator. After storage in a perforated plastic bag, the dry matter content was 8.1%. However, longer storage under these conditions led to a massive deterioration of the fruit. So, this sample was not studied any more under refrigeration conditions. Therefore, we concluded that white coloured eggplants are not suitable for storage at temperatures below 7-10˚C. For short-term storage of fruits without anthocyanin, it is necessary to use the room conditions, regardless of the type of container (crates or perforated plastic bags).

The greatest loss of dry matter content in fruits of the West Asian subspecies (sample No. 2, deep purple fruits) was noted in the first 10 days (stored indoors, temperature + 15 + 20 °C in a box). Its value reached 7.8 %. At the end of 20-day storage, an increase in the dry matter content was noted under the conditions of the refrigerator in perforated plastic bags. Under these conditions, the fruits visually had no signs of spoilage and preserved turgor. The conditions of the refrigerator and the perforated plastic bag are optimal both for preserving the dry matter content and for short-term storage of samples of purple-coloured fruits of the West Asian subspecies.

The high preservation of dry matter content in the purple coloured and lilac-skinned fruits of the East Asian subspecies was noted in the variant “refrigerator”. Storage of these fruits in perforated plastic bags or crates in a refrigerator made it possible to maintain their "marketability" without signs of withering and spoilage, as well as with minimal losses of chemical properties (dry matter) for twenty days (Table 4).

Conclusion

The dry matter content depended not only on the subspecies but also on the colour of the fruits. The dry matter content of the samples of the East Asian subspecies is slightly higher (0.3-0.5%) than that of the West Asian. We also noted an increase in the dry matter content in fruits with a higher content of anthocyanins (a darker colour of the fruit). In general, the indicator "dry matter content" is characterized by low variability. The stability of this indicator in the samples of the West Asian subspecies was slightly higher. The influence of the subspecies and varietal characteristics on the formation of dry matter in eggplant fruits ranges from 61 to 65%. The influence of the “weather conditions during the growing season” factor is about 20% and the interaction of factors is 15-18%. The stability of vitamin C in eggplant is higher than average and does not depend on the subspecies. Storage of purple-coloured eggplants in perforated plastic bags or crates in a refrigerator makes it possible to maintain their “marketability” without signs of withering and spoilage with minimal loss of chemical properties (dry matter) for 20 days. Varieties of white-coloured eggplants are absolutely unsuitable for storage in a refrigerator. Their short-term storage must be carried out indoors at a temperature of + 10 to + 15 °C

Appreciations. This work was supported by the selection program for the creation of scientific and technical products by the Federal State Budgetary Educational Institution of Higher Education "Belgorod State Agricultural University named after V. Gorin". Conflict of interest. The authors have declareв there is not any conflict of interest.

References

Bashina, O.E. and Ivanova, N.Yu. (2001). Multidimensional statistical groups: Training Manual. Moscow: Moscow State University of Commerce.

Dospekhov, B.A. (1979). Methods of field research (with the basics of statistical processing of research results). - 4th edition, revised and added. Moscow: Kolos.

Dunaevskiy, G.A. and Popik, S.Ya. (1990). Vegetables and fruits in the nutrition of a healthy and sick person. Kiev: Zdorovye.

Evdokimov, M.G. and Yusov B.S. (2004). Comparative analysis of methods for assessing spring durum wheat for adaptability: Breeding and seed production, 2: 31-33.

Gromyko, G.L.; Krysina, M.V. and Vorobiev, A.N. (2000). Theory of statistics. Textbook for high schools. Moscow: Infra-M.

Gorodniy, N.M. (2002). Fruit and vegetable resources and their biomedical assessment. Kiev: LLC “Alepha”.

Kravchenko, P.A.; Kleiman, A.S. and Usenko, T.A. (2004). Processing the results of observations, errors of which are distributed according to laws other than normal. Bulletin of the Kharkiv Petro Vasylenko National Technical University of Agriculture. Kharkiv, 27: 215-220.

Pautova, L.A. (2004). Everyday view of stability. - Omsk: Omsk State University.

Sych, Z.D. and Sych, I.M. (2005). The harmony of vegetable beauty and benefit. Kiev: Aristey.

Sych, Z.D. (2005). Characteristics of the coefficients stability signs in the dynamical series with different duration. Plant Varieties Studying and Protection, 2: 5-21.

Sych, Z.D. (2001). Synchronization of studies with the rhythms of abiotic climatic factors: Vegetable and melon growing. Kharkiv, 45: 317-320.

Shabetia, O.N. and Kotsareva N.V. (2015). Assessment of the source material of Solanaceae for resistance to abiotic factors: International scientific Institute "Educato". Novosibirsk, 5(12) 3:119-122.

Shabetia, O.N.; Kotsareva, N.V.; Al-Denia Muad, N.M. and Sheenko, D.A. (2017). Express-assessment methods initial breeding material. Innovations in Agricultural Complex: problems and perspectives. Belgorod, 3(15): 126-137.

Shabetia, O.M. and Mozgovskay, G.V. (2017). Varieties of eggplant. Vegetables and fruits. Kiev, 3: 34-37.

Shabetya, O.M. and Zinchenko, E.V. (2014). The composition and value breeding of genetic fund of eggplant: Vegetable and melon growing. - Kharkiv, 60: 274-283.

Voytsekhovskiy, V.I.; Slobodyanik, G.Ya.; Rebezov, M.B.; Voytsekhovskaya, E.V. and Smetanskaya, I.N. (2015). Nutritional value and safety of eggplants. Young Scientist, 19(99): 115-118.

Zhuchenko, A.A. (2001). Adaptive plant breeding system [ecological and genetic basis]; Moscow.

Zinchenko, E.V. (2012). Keeping quality of the eggplant fruits depending on the storage conditions. Bulletin of Poltava State Agrarian Academy. Poltava, 1: 74-76.

Zinchenko, E.V. (2018). Biological model of eggplants suitable for processing. Ukrainian Black Sea region agrarian science, 3(99): 21-29.