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TOTAL PROTEIN AND AMINO ACID COMPOSITION IN SELECTED FRUITS OF RUSSIA

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ABSTRACT

This article attempts to identify specific features of some commonly used Russian fruit and berry raw materials (raspberry, dewberry, gooseberry, dogrose, strawberry, cherry, kiwi, bananas) by estimating the content of total protein, its fractional and amino acid composition. It has been proven that among the studied fruit and berry raw materials, the most protein-rich fruit is banana (0.92%), while the lowest mass fraction of protein is observed in kiwifruit and cherries (0.49 and 0.51%, respectively). Further, in the rest of the fruit and berries, the mass fraction of protein is in the range between 0.53 and 0.81%. Studying the generic peculiarities showed that out of the studied raw materials, raspberries and gooseberries were rich in albumin (the mass fraction was 0.24 and 0.25%); the maximum number of glutelins was observed in gooseberry and banana (the mass fraction was 0.52 and 0.63%, respectively). In cherry and kiwi, the lowest albumin content was observed (0.09 and 0.07%, respectively). Despite the low mass fraction of globulins in the samples of raw materials, it was maximum in banana (0.09%), which, together with the high content of glutelins, ensured high enough contents of total protein (0.9%) in it. The experimental data obtained during analysis of protein in fruit and berry raw materials revealed that these fruits contain both nonessential (valine, leucine, isoleucine, lysine, methionine, threonine, tryptophan, phenylalanine) as well as essential (alanine, arginine, aspartic acid, glutamic acid, glycine, histidine, proline, serine, tyrosine, cysteine) amino acids, and the content of these are varies as per the fruits types.

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1 Introduction

Vegetable proteins are an integral part of many food products. Most of the fruits, berries and vegetables contain little amount of protein (0.5–1.5%) and it has been reported that amino acid composition of these are poorer than that of proteins of animal origin (Subacius 1998; Asyakina et al., 2015). But it has been well established that the use of fruits, berries, vegetables significantly improves digestibility of food products especially in case of meat, bread and cereals. In addition, low content of proteins allows extensive use of vegetables and fruits in diets with restricted amounts of protein (Melnikova et al., 2012; Moshe et al., 2013, Ostroumov et al., 2013).

Further, plants enzymes play a significant role in the development of human body. Fresh fruits and vegetables contain highly active enzymes that preserve their activity in the intestine, and are involved in the process of hydrolysis and synthesis of organic substances (Ostroumov et al., 2013; Dzhakhangirova, 2016). This greatly facilitates the work of intestine and contributes to better absorption of cereals flower, confectionery, fat, meat and fish products. Nitrogenous substances in vegetables, fruits and berries are essential for the formation of consumer properties of these products, in particular in the formation of taste and aroma (Vogelstein, 1979; Dzhakhangirova, 2016).

Merchandising as a science is continually evolving, resulting in development of new science based commodity research indicators which may be used for assessing quality and authenticity of the components used for food products (Wakefield 2002; Watts 2003; Dzhakhangirova, 2016).

Various researches have been conducted for the assessment of proteins and amino acids characteristics in vegetable and natural products (Wakefield, 2002; Watts, 2003; Woolfe, 2004). Further, researcher have developed a new objective as commodity research indicator of vegetable proteins' quality i.e. the molecular weight, which is listed as the main criterion in regulatory documentation – Specifications TU-9143-022-56529037-13(Russian Federation) (Winnepeninckx, 1996; Xu, 2002; Watts, 2003), and may be used as a valid criterion for determining the degree of counterfeiting of herbal raw materials and products of processing. The modified method of thin-layer gel-chromatography (TLGC) has been developed for determining the molecular weight as an integral part of the set of methods intended for commodity research and assessment of vegetable proteins, which is simple, economical, and affordable (Winnepeninckx, 1996; Zhang, 2000). Based on the modified TLGC method, a method of determining of the MM (molecular mass) of selected 21 cereals

proteins have been developed and file patent RU 1793372. Further, this method has been used for monitoring the naturalness of tangerine juices by the value of mass concentration of total and amine nitrogen (formal number) (Dzhakhangirova, 2016), proline, mass fraction of ash, its alkalinity and chloramine number. If at least one of the above indicators is not included into the limits of variation, it is identified as the violation of naturalness (Golubtsova, 2017).

The aim of this work was to identify the specific features of the studied fruit and berry raw materials by fractional and amino acid composition by spectral methods using nitrogen vapors.

2 Materials and Methods

The organoleptic evaluation method (Subacius, 1998) was used with an objective of quality control in mass-produced products. It associated with the rating of products quality 'samples as a whole and/or some of the main organoleptic characteristics'. To assess the appearance, texture (consistency), smell and taste, 5 points scale was used "5 points was assigned to - excellent quality fruit, 4 points to good quality, 3 points to satisfactory quality and 2 points to poor quality fruit.

Unlike organoleptic characteristics, physical and chemical parameters are specific and are important for homogeneous groups. These indicators are therefore more numerous, which requires the use of various measurement methods for their determination. During this study, physico-chemical characteristics have been estimated by the method given by Golubtsova (2017) with some modification.

Chromatographic methods were used for determining the amino acid and fatty acid composition of raw fruit materials. The composition and the degree of moisture in plant tissues was estimated by using nuclear magnetic resonance (NMR).

Physical and chemical methods are also used to determine the moisture content of fruit and berry raw materials. The accuracy of the determination results and the duration of the analysis depend on the temperature conditions of drying and sample preparation. Usually drying is carried out at temperature not exceeding than 105 °C, until reaching a constant mass of samples. Tissues containing native (non-denatured) proteins should be dried under vacuum at temperatures below the temperature of protein denaturation. When drying products with low mass fraction of the fat and high moisture content, drying temperature should be adjusted to 150 C and the duration of drying should not exceed 1 h (Bazarnova, 2013).

To determine the protein in fruit and berry raw materials, Kjeldahl method was used in present study. This method consisted in the determination of nitrogen with the subsequent recalculation on protein. The essence of the method consisted in the mineralization of the food samples with concentrated sulfuric acid heated for the ammonium salts' formation, transferring the ammonium cations into ammonia, ammonia stripping in a sulfuric acid solution; quantification by reverse titration with alkali solution; calculation of the nitrogen content in the test food facility; the conversion of nitrogen to protein by using protein ratios.

Microbiological methods are used to determine the degree of contamination in various food products. In present study, isolation, characterization and identification of fruit and berry contaminating microorganisms was carried out by following the guideline proposed by Dzhakhangirova (2016). Calculation of all grown visible colonies of mesophilic aerobic and facultative anaerobic microorganisms and their quantity per 1 g (cm²) of the product was estimated by the procedure given by "The microbiological control Instruction of quick-frozen fruits and vegetables (2011)".

For theoretical analysis of the data, methods of recording, organizing, grouping, classification, comparative analysis and generalization of materials of scientific and methodical publications, regulatory documents, periodicals and Internet resources were used for analysis (Wakefield, 2002). The analysis of the world literature on this subject was also carried out, and a patent search with the patent report preparation in accordance with GOST 15.01-96 was conducted.

For assessing the quality of the fruits and raspberries (*Rubus idaeus*), strawberries (*Fragaria ananassa*), gooseberries (*Ribes úvacrísipa*), cherries (*Prunus frutícosa*), rose hips (*Rosa majalis Hermm*), banana (*Músa Paradísiaca*), Kiwi (*Actinidia*

deliciosa), the organoleptic and physico-chemical parameters were determined according to the requirements of the relevant normative documents (Vogelstein, 1979):

- GOST R 54691-2011 "Fresh raspberries and blackberries. Specifications";
- GOST 33485-2015 "Fresh gooseberries. Specifications";
- GOST 1994-93 "Rosehip fruit. Specifications";
- GOST R 53884-2010 (UNECE FFV-35:2002) "Strawberries for retail. Specifications."
- GOST 21921-76 "Fresh cherries. Specifications";
- GOST R 51603-2000 "Fresh bananas. Specifications";
- GOST 31823-2012 "Kiwifruit for retail. Specifications";
- TR CU 021/2011 "Technical regulations of the Customs Union "Food products safety".

Samples were taken according to the requirements of GOST 26313-2014 "Products of processing fruits and vegetables. Rules of incoming inspection, methods of sampling" and based on the rules of fruit examination.

3. Results and Discussion

Present study has been carried out to identify specific features of the studied fruit and berry raw materials by the content of total protein, its fractional and amino acid composition.

Figure 1 and 2 showed the spectral curves of nitrogen vapor after burning samples. The total protein content in the studied fruit and

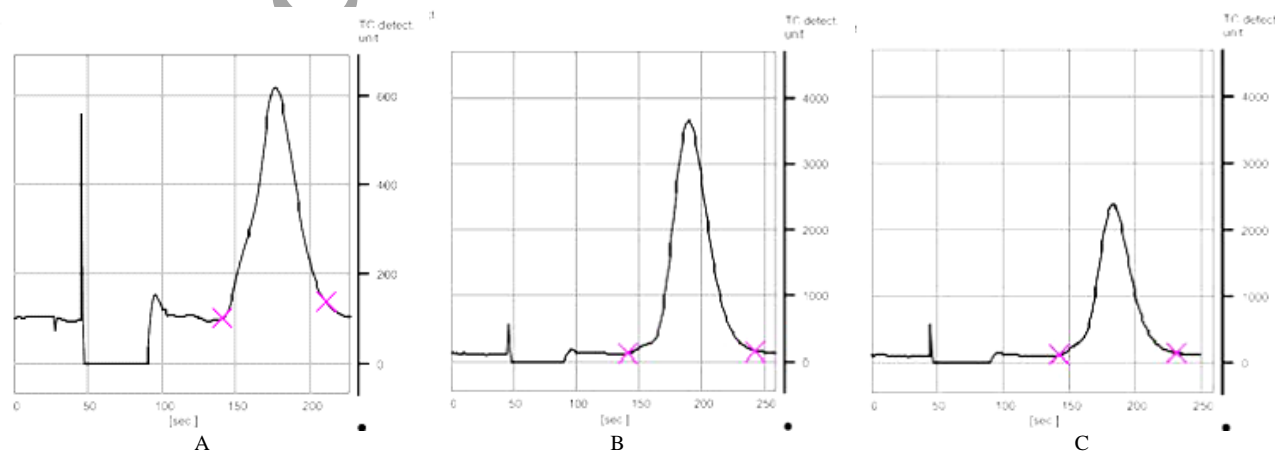


Figure 1 Spectral curves of nitrogen vapor after burning samples of raspberries (A) strawberries (B), rose hips (C)

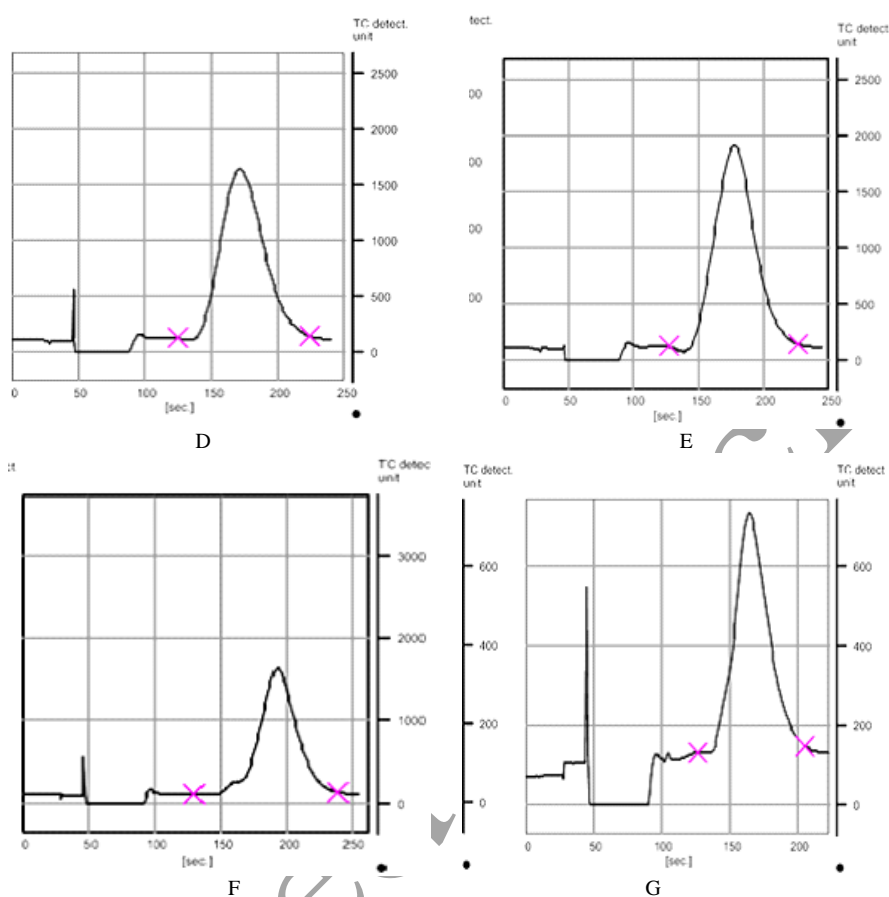


Figure 2 Spectral curves of nitrogen vapor after burning samples of gooseberries (D) cherries (E) bananas (F), kiwifruits (G)

Table 1 Total protein content in samples of fruit and berry raw materials

The mass fraction of total protein in the studied object (%)						
Rasp berries	Straw berries	Rose hips	Goose berries	Cherries	Bananas	Kiwifruits
0.66±0.03	0.53±0.03	0.78±0.04	0.81±0.04	0.51±0.03	0.92±0.05	0.49±0.02

Value given after ± represent standard error mean

berries have been calculated based on interpretation of the spectra of nitrogen vapors and has been shown in Table 1.

Analysis of the experimental data revealed that among the studied fruit and berry raw materials, the most protein-rich fruit is banana (0.92%), while the lowest mass fraction of protein is observed in kiwifruit and cherries (0.49 and 0.51%, respectively). In rest of the fruit and berries, the mass fraction of protein is in the range between 0.53 and 0.81% (Table 1).

Studying the fractional composition of proteins in the analyzed raw materials revealed both general patterns in the quantitative ratio of fractions, and specific features in protein fractions (Table 2). The general pattern of the fractional composition of proteins of the studied raw materials includes the predominance of albumin and glutelins in their mass. It is commonly known that seeds of evolutionarily old and young plants differ significantly in the composition of the protein complex. The former mostly contain insoluble proteins is glutelins while the latter one mainly contain albumins (Dzhakhangirova, 2016; Golubtsova, 2017).

Table 2 Fractional composition of proteins in samples of fruit and berry raw materials

Sample	Weight percentage of the fraction (%)			Total
	Albumins	Globulins	Glutelins	
Raspberries	0.24±0.01	0.03±0.001	0.33±0.02	0.60±0.03
Strawberries	0.19±0.01	0.02±0.001	0.30±0.02	0.51±0.03
Rosehips	0.17±0.01	0.02±0.001	0.34±0.02	0.72±0.03
Gooseberries	0.25±0.01	0.04±0.002	0.52±0.03	0.80±0.04
Cherries	0.09±0.005	0.05±0.003	0.25±0.02	0.39±0.02
Bananas	0.18±0.01	0.09±0.005	0.63±0.03	0.90±0.05
Kiwifruits	0.07±0.004	0.05±0.003	0.29±0.01	0.41±0.02

Value given after ±represent standard error mean

Table 3: Amino acid composition of protein in fruit and berry raw materials

Amino acids	Mass fraction of amino acids (%)						
	Rasp berries	Straw berries	Rose hips	Goose berries	Cherries	Bananas	Kiwifruits
1	2	3	4	5	6	7	8
Valine	0.087±0.004	0.004±0.0002	0.046±0.002	0.095±0.005	0.007±0.0004	0.022±0.001	0.005±0.0003
Isoleucine	0.029±0.001	0.004±0.0002	0.005±0.0003	0.009±0.0005	0.001±0.0001	0.021±0.001	0.028±0.001
Leucine	0.108±0.005	0.007±0.0004	0.010±0.001	0.016±0.001	0.003±0.0002	0.039±0.002	0.031±0.002
Lysine	0.065±0.003	0.005±0.0003	0.250±0.01	0.021±0.001	0.03±0.002	0.009±0.0005	0.001±0.0001
Methionine	0.033±0.002	0.001±0.0001	0.002±0.0001	0.030±0.001	0.014±0.001	0.046±0.002	0.021±0.001
Threonine	0.005±0.003	0.003±0.0002	0.014±0.001	0.183±0.009	0.085±0.004	0.034±0.002	0.023±0.001
Tryptophan	0.009±0.0005	-	-	0.004±0.0002	-	0.072±0.004	0.080±0.004
Fenilalanin	0.024±0.001	-	-	0.002±0.0001	0.001±0.0001	0.037±0.002	0.040±0.002
Alanine	0.017±0.001	0.005±0.0003	0.005±0.0003	0.040±0.002	-	0.040±0.002	-
Arginine	-	0.074±0.004	-	0.223±0.01	0.013±0.001	0.047±0.002	0.078±0.004
Aspartic acid	-	0.301±0.02	0.011±0.001	0.007±0.0004	0.058±0.003	0.072±0.004	0.044±0.022
Histidine	0.005±0.003	0.001±0.0001	0.038±0.002	0.012±0.001	0.029±0.001	0.018±0.001	0.005±0.0003
Glycine	0.018±0.001	0.015±0.001	0.015±0.001	0.004±0.0002	-	0.150±0.008	-
Glutamic acid	0.100±0.005	0.075±0.004	0.27±0.01	0.080±0.004	0.119±0.006	0.036±0.002	0.029±0.001
Proline	-	0.002±0.0001	0.012±0.001	0.007±0.0004	0.022±0.001	0.164±0.01	-
Serine	0.024±0.001	-	-	0.030±0.002	0.012±0.001	0.053±0.003	-
Tyrosine	0.020±0.001	0.003±0.0002	0.023±0.001	0.023±0.001	-	0.001±0.0001	-
Cysteine	0.046±0.002	-	-	-	-	0.001±0.0001	0.015±0.001
Total	0.59±0.03	0.50±0.03	0.70±0.04	0.78±0.04	0.39±0.02	0.86±0.04	0.40±0.02

Value given after ±represent standard error mean

Studying the generic peculiarities showed that among the studied raw materials, raspberries and gooseberries are rich in albumin (the mass fraction was 0.24 and 0.25%) while maximum glutelins concentration was observed in gooseberry and banana (the mass fraction was 0.52 and 0.63%, respectively). In cherry and kiwi, the lowest albumin content was observed (0.09 and 0.07%, respectively). Despite the low mass fraction of globulins in raw materials samples of fruits and berries, maximum fraction of globulins was reported in banana (0.09%), which, together with the high content of glutelins ensures enough contents of total protein (0.9 per cent, Table 2).

The experimental data obtained during analysis of protein in fruit and berry raw materials showed that they contain both nonessential (valine, leucine, isoleucine, lysine, methionine, threonine, tryptophan, phenylalanine) and essential (alanine, arginine, aspartic acid, glutamic acid, glycine, histidine, proline, serine, tyrosine, cysteine) amino acids in various concentrations (Table 3). Further, raw materials such as raspberries, gooseberries, kiwifruit and banana contain all essential amino acids. The maximum amount of essential amino acids was reported in

raspberries and gooseberries (mass fraction 0.36%). It is known that all amino acids (both nonessential and essential) in human body perform specific functions, and are involved in various metabolic processes (Vogelstein, 1979).

Maximum concentration of essential amino acid valine, which is required for metabolism in muscles, maintaining nitrogen content in the human body, repairing damaged tissues, has been noted in raspberries and rosehips (Golubtsova, 2017). Further, raspberries, kiwifruit and banana are rich in isoleucine, which is absolutely essential for synthesis of hemoglobin (Golubtsova, 2017).

The unique ability of leucine is to reduce the level of blood sugar; maximum concentration of this was observed in raspberries. Further, Rosehips also have high concentration of amino acid lysine, which supports nitrogen exchange in adults, contributes to growth in children, and helps to recover after injuries and surgery (Golubtsova, 2017).

Higher concentration of methionine was reported from the bananas fruit, it is amazingly necessary amino acid for normal functioning of the human body, it is beneficial for the digestive system, essential for treating osteoporosis, chemical and allergic reactions, protects from radiation, prevents negative deposits in the liver and on the walls of arteries (Vogelstein, 1979). Threonine content in gooseberries is more than 3 times higher than the other fruit and berry raw materials. This amino acid is essential for synthesis of elastin, collagen and is involved in fats metabolism, efficiently stimulates the immune system. As the experimental data shown, in the studied fruit and berry raw

materials, bananas and kiwifruit are particularly rich in essential amino acid tryptophan; dietologists call these fruits "the fruits of joy" (Vogelstein, 1979) and recommend using them for improving the mood. This is due to the fact that tryptophan promotes serotonin formation in the brain which helps in treating insomnia, depression. Kiwifruit are rich in the last essential amino acid (Table 3), phenylalanine; this amino acid acts as a painkiller (Dzhakhangirova, 2016; Golubtsova, 2017).

Conclusion

Thus, new data have been obtained about fractional and amino acid composition in the proteins of raw materials. Analyzing the data by the qualitative and quantitative composition of amino acids, it may be noted that gooseberries are rich in arginine; strawberries in aspartic acid; rose hips in glutamic acid; bananas in proline and raspberries in cysteine.

Conflict of Interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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