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SHORT COMMUNICATION

STUDY OF POLYPHENOLS CONTENT IN EXTRUDED MIX

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Abstract: Vegetable foods are rich not only in vitamins, fiber, healthy fats, but also contain another class of useful substances - polyphenols. Once in the human body, the polyphenols have a positive effect on all organs and life processes. These compounds have antioxidant activity, protecting our body from harmful environmental factors. The study presents data on the polyphenols content in extruded grain products with the addition of by-products. The highest content of polyphenols is observed in extruded mix based on grains and 20 % grape pomace powder. Utilization of by-products improves the ecology of the country, and also allows the use of non-waste production.

Keywords: *extruded products, mix of grains, non-waste production, polyphenols, pomace powder*

INTRODUCTION

Scientists have long expressed the opinion that the weakening of public health in the world is directly related to the deterioration of the quality of nutrition. Most people don't bother to think about what they eat. Meanwhile, nutrition represents the factor that either worsens or improves human health every day [1 – 3].
In modern life, a person is constantly exposed to stress and unfavorable ecology, while not everyone eats properly and fully, which affects the functioning of the body [4]. Thus, in modern conditions of life, toxic compounds (free radicals) accumulate in the human body, which in large quantities can adversely affect the state of human health [5]. The most urgent solution to this problem is the use of antioxidants, which allow in a safe way to significantly slow down the oxidation processes in the body, as well as the formation of free radicals, thereby increasing the level of antioxidant protection of the body [6, 7].
The antioxidants category includes phenolic acids, flavonoids, coumarins, polyphenols, phytates, terpenes, carotenoids, tocopherols [8, 9].
Antioxidants from natural sources are received in the human body from food, primarily from vegetables and fruits [10].
Scientific studies have shown that the presence of polyphenols in food of vegetable origin makes them beneficial for the human body. Currently, there are more than 8,000 polyphenols [11].
Due to the wide variety of polyphenols and the plants that contain them, these compounds are divided according to the source of origin, the function of the polyphenols, and their chemical structure [11]. The main ones are flavonoids, phenolic acids, stilbenes and lignans.
Some scientists suggest that regular consumption of vegetable foods with high content of polyphenols, especially flavonoids, may reduce the risk of blood clots and plaques, reduce inflammation, reduce blood pressure and the risk of heart attacks, slow the development of cancer, and help control blood sugar levels [12]. Thus, for the prevention of these diseases, it is necessary to create new types of products with a high content of antioxidants [13].
One of the modern processes of the production of new generation products is extrusion, which makes it possible to obtain products enriched with biologically active components.
The purpose of this work is to determine the content of polyphenols in extruded products based on cereals with the addition of by-products such as grape, apple or tomato pomace powder [9, 13].

MATERIALS AND METHODS

Materials

The following materials were used to produce samples of extruded products:
- grains: wheat and corn, obtained under a contract with National Center for Research and Production of Seeds, Republic of Moldova;

- by-products: apple and tomato pomace provided by the Orhei-Vit SRL, Republic of Moldova; grape pomace varieties include Muscat, Cabernet, Codrinsky and Sauvignon provided by the Scientific and Practical Institute of Horticulture, Viticulture and Food Technologies, Republic of Moldova;
- reagents: ethanol, Folin-Ciocalteu reagent, tannin (Ecochimie SRL).

Obtaining extruded products

Samples of extruded products were obtained on an experimental extruder E-150 installed at the ”Polikom-Prim” enterprise.
Production scheme:
1. The pomace was subjected to convection drying at a temperature of 55 - 60 °C, then crushed to a size of 1 - 2 mm and 20 % of the main raw material was added to the mix for extrusion.
2. According to the technological process, a mix of grains and pomace powders was humidified to 15 - 16 % and then extruded under the following process parameters (Table 1).

Table 1. *Parameters of the technological process for the production of polycomponent extruded products*

Raw material	Temperature, [ºC]	Pressure, [atm.]	Time, [s]	Humidity of mixture, [%]
Grains of corn + 20 % apple pomace powder	110-115	26-30	14-16	15.6
Grains of wheat + 20 % apple pomace powder	90-100	24-26	13-16	15.7
Grains of corn + 20 % Muscat grape pomace powder	95-105	25-27	16-18	15.4
Grains of wheat + 20 % Muscat grape pomace powder	100-110	25-27	15-18	15.3
Grains of corn + 20 % Sauvignon grape pomace powder	110-120	28-30	17-20	15.6
Grains of wheat + 20 % Sauvignon grape pomace powder	100-105	25-27	15-17	15.1
Grains of corn + 20 % Cabernet grape pomace powder	100-110	26-28	15-18	15.8
Grains of wheat + 20 % Cabernet grape pomace powder	100-105	25-27	15-17	15.1
Grains of corn + 20 % Codrinsky grape pomace powder	105-115	27-30	17-20	15.7
Grains of wheat + 20 % Codrinsky grape pomace powder	90-100	25-27	16-18	15.3

In the production of an experimental lot 5 kg of each mix was used. First, the extruder was heated to a temperature of 140 - 150 ºC.

The temperature of raw material processing in the extruder varies from 90 ºC to 120 ºC. The production time for extruded products is from 13 sec to 20 sec. The pressure was 24 - 30 atm. depending on the composition of the mix.

Determination of total polyphenols content (TPC)

Polyphenols were determined both in raw materials and in extruded products. TPC in raw materials and extruded products was determined using the Folin-Ciocalteu reagent.
The Folin-Ciocalteu reagent, which is a mixture of phosphotungstic and phosphomolybdenic acids, reduces to a mixture of tungsten and molybdenum oxides when it is used to oxidize the phenols extracted from pomace powder. This reaction results in a solution that has a blue color with maximum absorption at 750 nm. The amount of this blue color is proportional to the number of phenolic compounds present in the sample being analyzed. The result is expressed as an index, which is obtained by multiplying the absorbance by 100 for extracts from red powders and by 20 for extracts from light-colored powders.
TPC, expressed as tannins, was determined using the Folin-Ciocalteu method. Tannin in this study is used to construct a calibration graph (Figure 1).

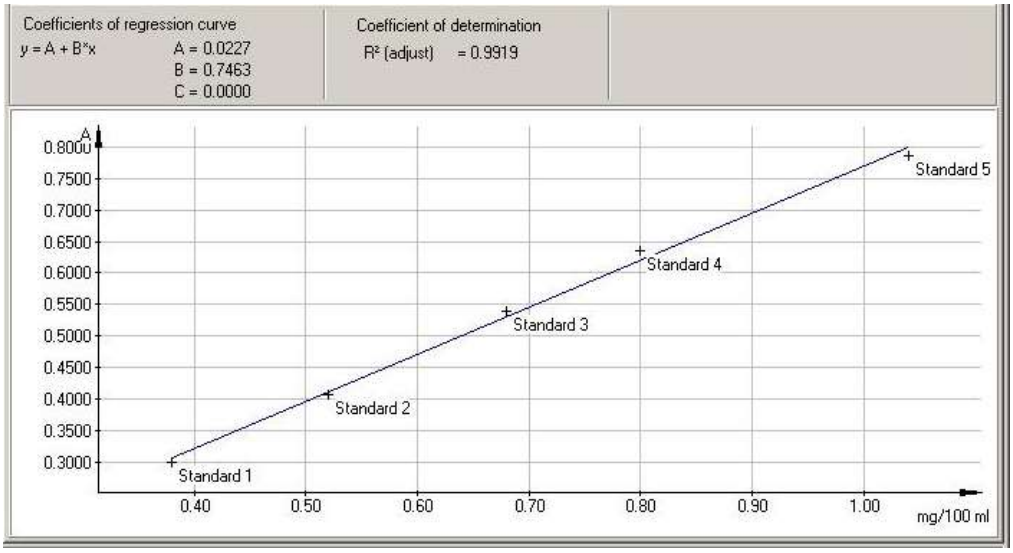

Figure 1. *Calibration curve for the determination of TPC equivalent to tannins*

Determination of polyphenols in grains and pomace powders was carried out in their extracts.
First, the extraction solution was chosen. For this 30 % and 70 % ethyl alcohol solution, water 90 °C, 30 % ethyl alcohol solution + 1 g citric acid were used.
For analysis, the product was extracted with a 70 % alcohol solution. The weight of the sample of the product is 2 - 5 g with 100 mL of a 70 % alcohol solution, thoroughly triturated and left for 10 minutes. Then take 1 - 5 mL of the extract, combine with 1 - 5 mL of Folin-Ciocalteu, add 10 mL of 20 % Na_2CO_3, mix the mixture and incubate for

30 minutes in the dark. After this time, the sample is analyzed in a spectrophotometer UV/Vis Spekol 1500, Zeiss Jena at a wavelength of $\lambda = 630$ nm.

RESULTS AND DISCUSSIONS

Total polyphenols content in raw materials and extruded products

The content of polyphenols in raw materials (grains and pomace powders) in different extraction solutions is shown in Table 2.

Table 2. *The content of polyphenols in raw materials in different extraction solutions*

Raw material	Content of polyphenols, mg/100 g			
	70 % ethyl alcohol solution	30 % ethyl alcohol solution	30 % ethyl alcohol solution + 1 g. citric acid	Water, 90 °C
Tomato pomace powder	680	680	760	680
Apple pomace powder	252	246	248	200
Cabernet grape pomace powder	5662	5416	5380	4200
Grains of wheat	330	80	-	100
Grains of corn	294	77	-	97

As can be seen from Table 2, the extraction of polyphenols takes place more intensively in a 70 % ethyl alcohol solution. Further extraction of all products was carried out in this solution. It should be noted that, in 70 % ethyl alcohol solution, the highest content of polyphenols was observed in the sample containing grape pomace powder, with a value of 5662 mg/100 g, while the lowest amount of polyphenols was noted in the sample with apple pomace powder, at 252 mg/100 g. Extraction of polyphenols from grape pomace powder in 70 % ethyl alcohol solution was increased compared to water extraction by 35 %; extraction from tomato pomace powders showed similar results in both alcohol and water extractions.
The content of polyphenols in raw materials is presented in Table 3.

Table 3. *Content of polyphenols in raw materials*

Raw material	Content of polyphenols, mg/100 g of extract
Grains of wheat	330 ± 7
Grains of corn	294 ± 6
Tomatoes pomace powder	680 ± 8
Apples pomace powder	252 ± 2
Muscat grape pomace powder	5340 ± 10
Codrinsky grape pomace powder	5100 ± 10
Cabernet grape pomace powder	5662 ± 12
Sauvignon grape pomace powder	3440 ± 11

As shown in Table 3, the pomace powder from Cabernet grape variety presents the highest content in polyphenols (5662 mg/100 g extract), followed by Muscat, Codrinsky and Sauvignon grape pomace powder.
The content of polyphenols in grains is only 294 - 330 mg/100 g.

The content of polyphenols in extruded products is shown in Table 4.

Table 4. *Content of polyphenols in extruded products*

Raw material	Content of polyphenols, mg/100 g of extract
Grains of corn + 20 % apples pomace powder	286 ± 2
Grains of corn + 20 % Sauvignon grape pomace powder	923 ± 8
Grains of corn + 20 % Muscat grape pomace powder	1303 ± 9
Grains of corn + 20 % Cabernet grape pomace powder	1367 ± 9
Grains of corn + 20 % Codrinsky grape pomace powder	1255 ± 8
Grains of wheat + 20 % apples pomace powder	314 ± 3
Grains of wheat + 20 % Sauvignon pomace powder	952 ± 7
Grains of wheat + 20 % Muscat grape pomace powder	1332 ± 8

As shown in Table 4, addition of 20 % pomace powder to grains increases the content of polyphenols in extruded grain mix up to 300 %. For example, when adding Muscat grape pomace powders, both extruded wheat mix and extruded corn mix, the content of polyphenols was 1332 mg/100 g and 1303 mg/100 g respectively.

CONCLUSION

Expanded the range of extruded products with the addition of apples, grapes and tomatoes pomace powder, which allows the use of by-products of the canning and wine industry. New types of products with increased biological value have been obtained, namely with a high content of polyphenols, which classifies them as preventive products. The highest content of polyphenols is observed in extruded mix based on grains and 20 % Muscat grape pomace powder and Codrinsky grape pomace powder.
Utilization of by-products improves the ecology of the country, and also allows the use of non-waste production.

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