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INVESTIGATION OF PHENOLS IN SOYBEAN SEEDS

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Introduction. *Recent investigations have revealed the therapeutic properties of biologically active substances of soybean seeds. The literature gives data on their content of flavonoids, vitamins, lipids; but soybean phenolic compounds have not been adequately investigated.*

Objective. *To investigate the accumulation of a number of phenolic compounds (tannins and phenolcarboxylic acids) in soybean seeds.*

Material and methods. *The investigation was concerned with the seeds of five soybean varieties: Soprosoy (Burundi), Okskaya (Russia), 740-1 (Sweden), Severnaya zvezda (Belarus), Gisa-111 (Iraq). The absorption spectra of aqueous extracts from soy seeds were recorded on a Lambda 950 spectrophotometer. The pH was established using an Aquilon-410 ionomer. The levels of tannins and simple phenols were determined by potentiometric titration; those of phenolcarboxylic acids were spectrophotometrically estimated in the ultraviolet region.*

Results. *The seeds of cultural soybean varieties, which were examined during experiments, did not vary widely. The pH range for all the extracts was 6.7-6.9. The content of tannin was low (0.20 to 0.41%). That of phenolcarboxylic acids varied over a wide range from 14.38 to 4.66%.*

Conclusion. *The levels of tannins and phenolcarboxyli acids in soybean seeds from different countries were investigated. The findings showed that all seeds contained a low amount of tannins (below 0.5%). The varieties differed in the content of phenolcarboxylic acids in the seeds.*

Key words: *soybean seeds, tannins, phenolcarboxylic acids, quantitative content.*

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INTRODUCTION

Soybean role in food industry is well known. It is the only vegetable food that contains all eight essential amino acids. It is also a good source of fibre, iron, calcium, zinc, and vitamins. In 2009, the world soybean production was 210.9 million metric tons, about 53% of the world oilseed production. Soybeans are made up of about 40% protein and 20% oil and are therefore considered to be a major source of proteins and oils. They are also an important source of three natural surfactants: soy lecithin, soy protein, and soy saponin [8].

In recent years, more and more attention has been given to the study of beneficial properties of soybean in pharmaceutical sciences, given that many of soybean biochemical compounds have shown themselves to have therapeutic properties [7]

Phenolic compounds are widespread in the plant kingdom. They have a broad spectrum of biological activity: antiinflammatory, antiviral, diuretic and others [4]. Plant polyphenols have drawn increasing attention due to their potent antioxidant properties and their marked effects in the prevention of various oxidative stress associated diseases such as cancer [3].

In many literature data, we can find several analysis of flavonoids, lipids, vitamins and other compounds in soybean seeds. However, there are quite small information about the content of the phenolic compounds in soybean seeds from different countries.

PURPOSE OF THE STUDY

The purpose of this study is to explore the accumulation of a number of phenolic compounds, including tannins and phenolcarbonic acids in soybean seeds from different countries.

OBJECTS AND METHODS

The objects of study were seeds of five soybean varieties: Soprosoy (Burundi), Окская –Okskaya (Russia), 740-1 (Sweden), Северная звезда - Severnaya zvezda (Belarus), Gisa-111 (Irak). Absorption spectrums of water soybean seeds extracts were recorded on a Lambda 950 spectrophotometer (Perkin Elmer, USA) against the back ground of a reference – water. Used samples were diluted 12.5 times. The amount of tannins and simple phenols was determined by potentiometric titration, phenolcarbonic acids - by spectrophotometery in the ultraviolet region. The pH value of water extracts was assessed by potentiometric method with ionometer Aquilon - 410 (Russia).

EXPERIMENTAL PART

Water extract of soybean seed was prepared by the following protocol. An exact weighed sample (about 2.0 g) of the divided raw materials was placed in conical flask of

100 ml capacity and was poured 100 ml of distilled water. The flask attached to a reflux condenser extraction and carried out an extraction within 1 hour on a hot plate with a closed helix [5].

Tannin content – The sum of tannins was determined by potentiometric [4] and titration indicator [1].

Phenolcarbonic acids content – Phenolcarbonic acids content was determined by ultraviolet spectra at wavelength 258±2 nm in terms of gallic acid. And according to the Beer–Lambert law

$$A = \varepsilon \cdot c \cdot l,$$

from that we deducted the following formula, to calculate phenolcarbonic acids (PCA) content in studied extracts:

$$X\,(\%) = \frac{A \cdot 25 \cdot 100 \cdot 100 \cdot 100}{\varepsilon \cdot l \cdot 2 \cdot m \cdot (100 - W)},$$

where A – the absorbance of the sample; ε – molar attenuation coefficient of that material; l – the pathlength; m – mass of sample extracted; W – lost of mass after sample drying; 100 – the total extract volume, mL.

Table 1

THE RESULTS OF DETERMINATION OF PHENOLIC COMPOUNDS IN SOYBEAN SEEDS (n=3, p=0,95)

Cultivars	Value of the designated parameter				
	pH of water extract	Content of tannins, %		wavelength in maximum, nm	Content of PCA*, %
		Indicator titration	Potentiometric titration		
Soprosoy	6,92	0,261±0,006	0,240±0,003	259,43	5,35±0,12
Okskaya	6,85	0,262±0,005	0,252±0,004	259,27	4,66±0,09
740-1	6,85	0,208±0,004	0,191±0,002	258,27	12,12±0,21
Severnaya zvezda	6,87	0,413±0,008	0,424±0,004	258,88	14,38±0,24
Gisa-111	6,73	0,334±0,004	0,303±0,004	260,70	6,96±0,13

* PCA – phenolcarbonic acids

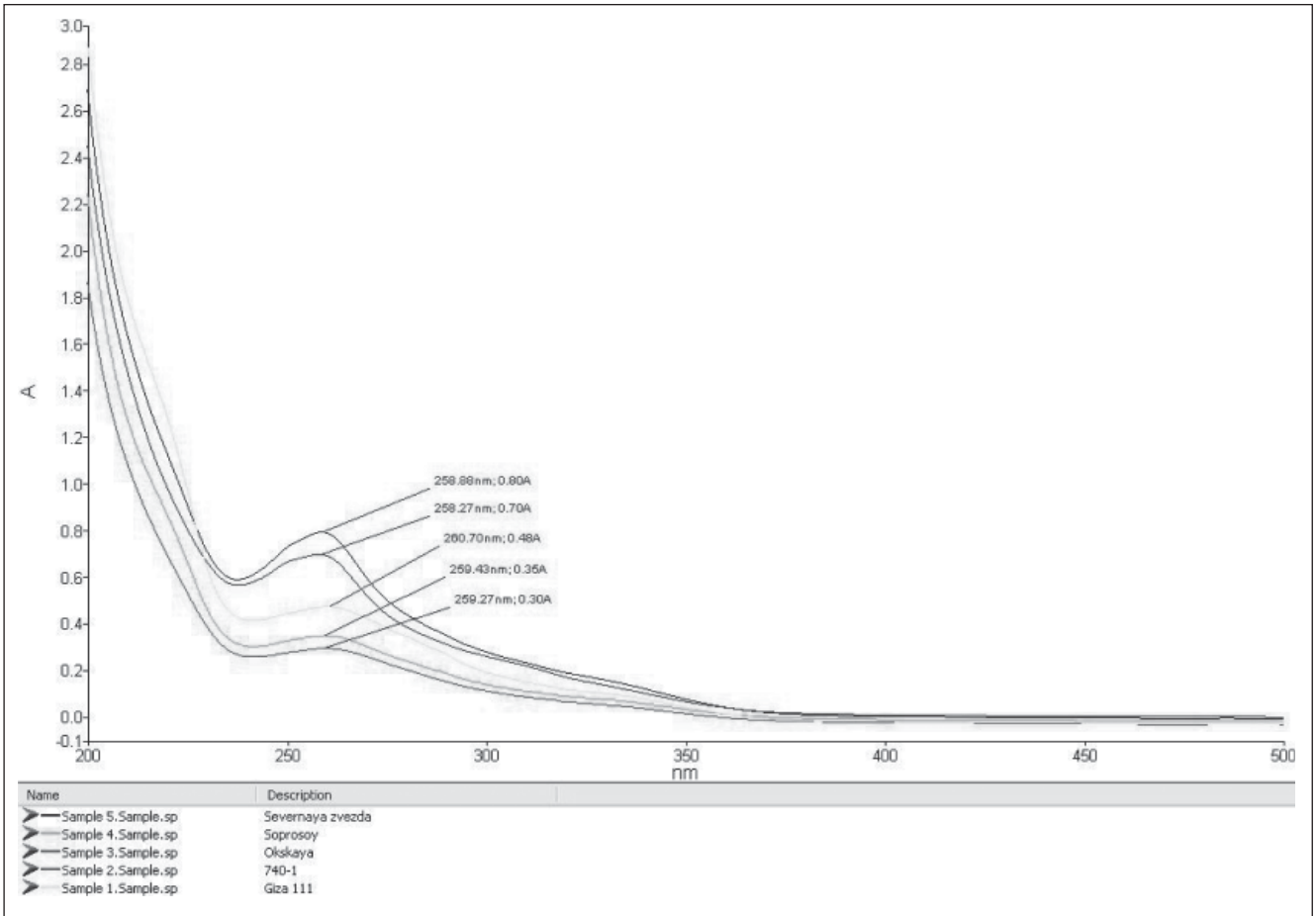

Figure 1. Absorption spectra of water extracts of different soybean cultivars

RESULTS

Studied soybean cultivars seeds do not significantly differ in pH extracts/ The pH value for all of the extracts are in the range of 6,7-6,9 (Table 1).

The content amount of tannin found in the seeds of different soybean cultivars were low, from 0,20% to 0,41% (Table 1) and there was no significant difference between the cultivars although the highest content was determined in severnaya zvezda (Belarus) – 0,41%, and the lowest in 740-1 (Sweden) – 0,20%.

An absorption spectra of water extracts from studied soybean cultivars was produced in the wavelength range of 250-500 nm (Figure 1).

In figure 1 we can see that the absorption spectra of extracts present maximum at a wavelength around 260 nm. This indicates the presence of phenolic compounds, presumably phenolcarbonic acids. The optical density at given wavelength is different, which hints at different amounts of phenolcarbonic acids in these cultivars. The highest optical density was observed in the spectrum of soybean seed extract from severnaya zvezda (Belarus), the lowest – okskaya (Russia).

In order to determine phenol content in these samples, we used a study that shows, that with pH≈7, an absorption spectra of gallic acid has two maximums at 212 nm and 260 nm [2]. So given that the pH of our extracts was around pH≈7, we wanted to calculate the phenol content of our studied samples in terms of gallic acid, so we verified if there was a maximum in our extract at 212 nm. An example of the spectra of Soprosoy is given in figure 2.

In the study (Evsyuhina et al., 1998) it was determined that at 260 nm the molar attenuation coefficient – ε of gallic acid is $7{,}1 \cdot 10^{-3}$ l.mol^{-1}.cm^{-1}.

The phenolcarbonic acids content (%) calculated is given in table 1, and it shows that there are differences phenolcarbonic acids in content in studied cultivars, with the highest content found in Severnaya zvezda (Belarus) – 14,38% and the lowest in Okskaya (Russia) – 4,66%.

CONCLUSION

Our study of tannins in soybean seeds showed that there are a little amount of tannins (less than 0,5%), which means that for these substances there was almost no significant differences between studied cultivars from different regions. But concerning phenolcarbonic acids content there were differences between the cultivars. The lowest content found in Okskaya soybean seeds – 4,66% and the highest in Severnaya zvezda – 14,38%.

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ИЗУЧЕНИЕ ФЕНОЛЬНЫХ СОЕДИНЕНИЙ В СЕМЕНАХ СОИ

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РЕЗЮМЕ

Введение. В ходе последних исследований выявлены терапевтические свойства биологически активных веществ семян сои. В литературе представлены данные по содержанию в них флавоноидов, витаминов, липидов, но фенольные соединения сои изучены недостаточно.

Цель исследования – изучить накопление ряда фенольных соединений (дубильных веществ и фенолкарбоновых кислот) в семенах сои.

Материал и методы. Объект исследования – семена 5 сортов сои: «Soprosoy» (Бурунди), «Окская» (Россия), «740-1» (Швеция), «Северная звезда» (Беларусь) и «Гиса-111» (Ирак). Спектры поглощения водных экстрактов семян сои регистрировали на спектрофотометре Lambda 950. Значение pH устанавливали с помощью ионометра Аквилон-410. Содержание дубильных веществ и простых фенолов определяли потенциометрическим титрованием, фенолкарбоновых кислот – спектрофотометрически в ультрафиолетовой области.

Результаты. Семена культурных сортов сои, изученные в ходе эксперимента, не имели существенных различий. Значение pH для всех экстрактов находилось в диапазоне 6,7–6,9. Содержание танина было низким – от 0,20 до 0,41%. Содержание фенолкарбоновых кислот колебалось в более широком диапазоне – от 14,38 до 4,66%.

Заключение. Изучено содержание танинов и фенолкарбоновых кислот в семенах сои из разных стран. Согласно полученным результатам, во всех семенах содержание дубильных веществ незначительно (менее 0,5%). Сорта отличаются по содержанию в семенах фенолкарбоновых кислот.

Ключевые слова: семена сои, танины, фенолкарбоновые кислоты, количественное содержание.