ORIGINAL ARTICLE

Peculiarities of Analytical Characteristics of Pectins Extracted from Sunflower Hearts

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Abstract

Aim: To present the results of the research of the analytical characteristics of pectins extracted from sunflower hearts. **Materials and Methods:** The object of the research is sunflower grades produced in Southern Russia. The research involved standard and modern methods of the physicochemical analysis. **Results:** The results showed that this raw material can be considered, first of all, as the future pectin industrial source. High pectin concentration in sunflower hearts proved the raw material technological importance for industrial processing. To assess pectin quality, the following analytical characteristics have been determined – polygalacturonic acid content, acetyl and methoxy components, extent of esterification, and complexing ability. **Conclusion:** High complexing ability of the sunflower pectin and high content of the polygalacturonic component provide for its possible use in the special and healthy food production. For that, sunflower heart pectins are low-esterified. It means that it is practical to use them as detoxicants.

Key words: Analytical characteristics, complexing ability, extent of esterification, pectins, sunflower hearts

INTRODUCTION

Pectin as a perfect natural detoxicant and radioprotector is the most competitive modern substance.[1-3]

The analysis of modern pectin technologies showed that scientists and specialists at leading companies, while developing pectin processes, pay special attention to the ones ensuring ecological cleanness and safety resulting in the high-quality end product.

It is worth noting that the success strategy of such companies as Herbstreith and Fox (Germany) and CP Kelco (USA) is in the expansion of the application of pectins in different industries based on the modification of their properties. At the same time, the problem of pectin production and its modification is far from practical solution in spite of the abundance of raw materials resources. The complexity in production of pectins with predictable structure, chemical composition, and properties is explained by a variety of pectin raw materials that require individual approach at processing. In turn, to develop high pectin technologies, it is necessary to study the analytical characteristics of pectins contained in these raw materials.

Thus, relevant and advanced research is to be focused on the development of the scientific bases for classifying pectin raw materials by the analytical characteristics of pectins, contained in them, to produce competitive pectin products with high food value. It should be noted that the study of secondary raw material resources, produced in the food and processing industry, arouses a special academic interest.

The urgency of such research is intensified by the environmental degradation in many parts of the world and practicability of mainstreaming the best available technologies.

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It is worthy of note that toxic metals are the main toxigenic compounds. Thus, based on the Corte-Dubinin scale, developed to assess contaminants toxicity and recommended by the World Health Organization, these compounds rank the first (135 points) having the highest adverse health effect.[4]

A healthy diet requires more pectins that have natural antitoxic properties.[5-8] Besides, pectin is a physiological component.[9,10] Thus, according to the regulations EU 432/2012, pectins are recommended to decrease blood cholesterol and glucose level in an amount of 4 and 10 g/day, respectively.[11-13]

This act determines a need in enlarging the range of functional food with pectins to ensure their radioprotective and detoxicative properties and to prevent socially significant diseases – atherosclerosis and diabetes.

Hence, these are important pectin properties: Complexing ability and solubility, which are determined by such analytical characteristics as free carboxyl group content, the extent of esterification and polyuronide component.

METHODS

We have chosen Krasnodar Kari as a testing site. Krasnodar Krai is located in Southern Russia, in the southwest of the North Caucasus. Sunflower is grown by almost all agricultural companies to produce seed oil, and the wastes of oil extracting factories – press cake and oil meal – are used to feed animals.

Sunflower hearts output per 1 ha amounts to approximately 60% of seed weight. Thus, 7-9 cm of sunflower hearts is produced at the sunflower seeds yielding 12-15 cm/ha. At present, sunflower hearts are used to produce feed flour.

As the objects of the research, we have chosen 10 sunflower grades in Krasnodar Krai being the most promising for future selection: Konditersky (SPK), VNIIMK 8883, Lider, Rodnik, Ataman, Kavkazets, Yubileiny-60, Berezansky, Flagman, Peredovik.

The experimental research involved standard and modern methods of the physicochemical analysis. The calcium pectate method that is the most widely used to assess industrial pectin raw materials was applied to determine total pectin content. Pectin analytical characteristics were determined by the conductometric titration method and complexing ability by trilonometric titration.

The research was conducted on 120 samples minimum in six replicates within 2013-2015. Industrially, mature sunflower hearts were sampled in their production areas. Then, we cut the segments of minimum 10 sunflower hearts. Segments were milled and average 100 g samples were taken. Pectin hydrolysis extraction was conducted by 0.2% hydrochloric acid solution at 80°C for 2 h. Then, pectin was extricated by 96% industrial ethyl alcohol. The obtained coagulant was dried at 40-45°C to 10-12% humidity.[8]

RESULTS

Figure 1 shows that Yubileiny-60 and Lider grades have the highest pectin content (43.08-43.89%). However, it should be noted that the other grades almost do not differ in pectin content. The quantitative pectin content ranges within 40.59-41.94%.

To assess the qualitative parameters of pectins in the test raw materials, we have studied their analytical characteristics – polygalacturonic acid content, acetyl and methoxy components, extent of esterification, complexing ability.

The polyuronide component content ranged from 81.9% to 90%. The extent of esterification of extracted pectins ranged from 44.4% ± 1.5% (Yubileiny-60) to 53.4% ± 1.5% (Lider). With such extent of esterification and polyuronide content, pectins are rapidly soluble and belong to the low-esterified group.

The free carboxyl group content that determines the detoxicative properties of pectins extracted from the test raw materials is presented in Figure 2.

The results of the research showed that sunflower pectins are characterized by a high-free carboxyl group content that ranges from 11.28% to 14.80%. These data are consistent with the extent of esterification of pectins contained in the test raw materials.

It is known that the extent of esterification of a molecule with a metal determines linear macromolecule charge density and thus cation strength and bond. The increasing number of carboxyl groups in pectins results in a rapid formation of larger floccules and thus increasing complexing ability.

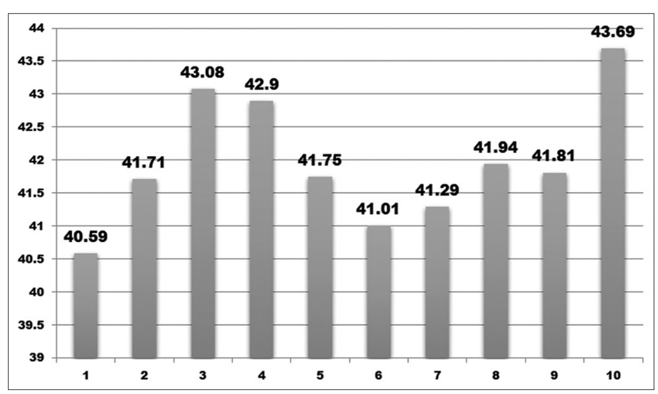

Figure 1: Pectin content in different sunflower grades, % of oven-dry substance: 1 – Konditersky (SPK); 2 – VNIIMK 8883; 3 – Lider; 4 – Berezansky; 5 – Rodnik; 6 – Flagman; 7 – Ataman; 8 – Kavkazets; 9 – Peredovik; 10 – Yubileiny-60

To confirm these assumptions, we defined the complexing ability of pectins, extracted from Konditersky (SPK) and Flagman grades, with Cd, Sr, Zn, Hg, Pb due to their high human toxic effect. The experimental data are shown in Figure 3.

The obtained data prove a relatively high complexing ability of sunflower pectins.

Not least important property of pectins is gelling power that determines their wide application in the food industry. Gelling depends on the polyuronide component, the extent of esterification of its molecule, and the content of functional groups – acetyl and methoxy components.

We have determined the methoxy group content to assess the gelling mechanism [Figure 4]. At 40-50% pectin methoxylation, the methoxy component test content amounted to 9.2-12.8% versus theoretical one 6.83-8.47%.

The test data showed a high experimental value of the pectin methoxy component in the test raw materials. It enables us to forecast a high gelling power of pectins and their applicability at manufacturing jelly confectionery.

However, the acetyl group content is one of the most important parameters characterizing the ability and mechanism of forming strong jellies.

The data on the pectin acetyl component are shown in Figure 5.

Pectins of different origin contain more or less acetyl groups (CH_3CO) connected with hydroxyl groups of galacturonic acids. Hence, the lemon pectin contains 0.37% acetyl groups, the apple pectin 0.45%, and the beetroot pectin 6-13%.

The data above show that the acetyl component in all pectin samples is high enough and ranges within 0.87-1.51%. From that, its highest content was found in pectins extracted from Konditersky (SPK)and Yubileiny-60 grades and the lowest from Lider, Flagman, Ataman, Peredovik, and Berezansky grades. In the other grades, this parameter falls in between.

However, it is worth noting that sunflower pectins contain a significant quantity of acetyl groups. It has an adverse effect on pectin gelling power in spite of a high content of polyuronide and acetyl components. The gelling power is increasing when the acetyl group content is decreasing. That is why the sunflower pectin production process is to have a "hard" treatment, resulting in a lower content of acetyl groups.

DISCUSSION

The results of the research of secondary raw materials produced at sunflower processing showed that the pectin

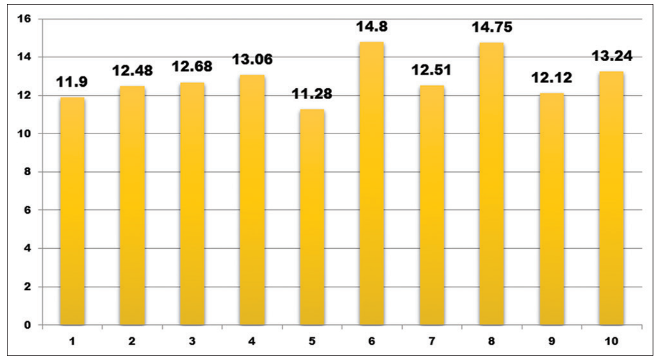

Figure 2: Free carboxyl group content in pectins extracted from different sunflower grades, %: 1 – Konditersky (SPK); 2 – VNIIMK 8883; 3 – Lider; 4 – Berezansky; 5 – Rodnik; 6 – Flagman; 7 – Ataman; 8 – Kavkazets; 9 – Peredovik; 10 – Yubileiny-60

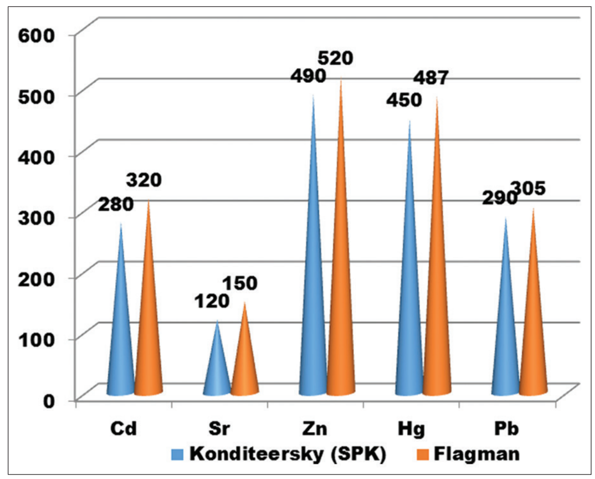

Figure 3: Complexing ability of pectins extracted from different sunflower grades with regard to the main toxic metals, mg/100 g dry pectin

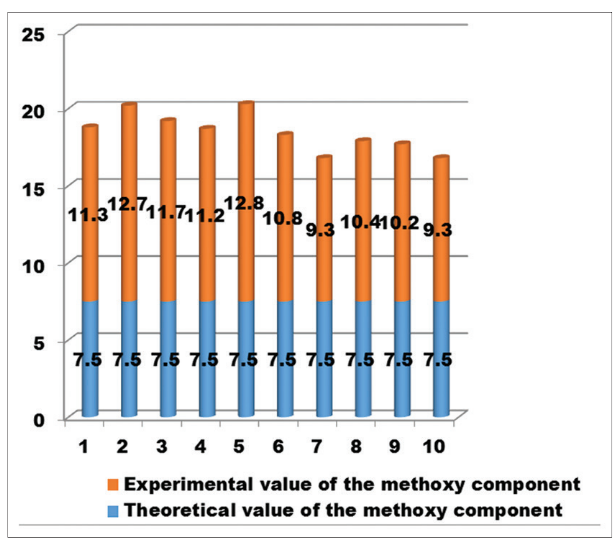

Figure 4: Methoxy component content in pectins extracted from different sunflower grades, %: 1 – Konditersky (SPK); 2 – VNIIMK 8883; 3 – Lider; 4 – Berezansky; 5 – Rodnik; 6 – Flagman; 7 – Ataman; 8 – Kavkazets; 9 – Peredovik; 10 – Yubileiny-60

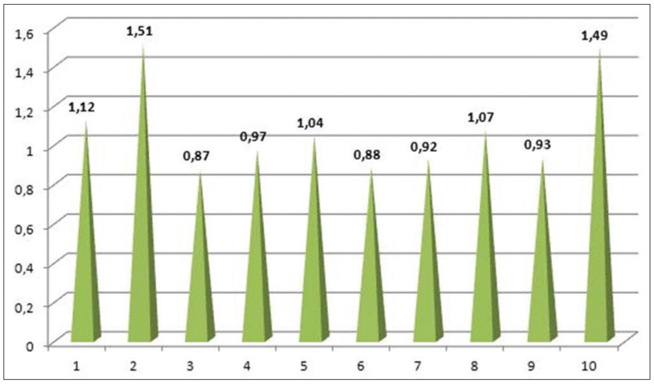

Figure 5: Acetyl component content in pectins extracted from different sunflower grades, %: 1 – Konditersky (SPK); 2 – VNIIMK 8883; 3 – Lider; 4 – Berezansky; 5 – Rodnik; 6 – Flagman; 7 – Ataman; 8 – Kavkazets; 9 – Peredovik; 10 – Yubileiny-60

content in sunflower hearts is high enough (43.08-43.89%). At that, Yubileiny-60 and Lider grades have the highest content. In the other grades, pectins range within 40.59-41.94%.

Besides, extracted pectins are characterized by a high content of the polyuronide component (81.9-90%)with the lowest content in Ataman grade and the highest in Kavkazets grade.

It was found out that the extent of esterification of extracted pectins depends on the sunflower grade and ranges from 44.4% ± 1.5% (Yubileiny-60)to 53.4% ± 1.5% (Lider).

CONCLUSIONS

The high content of the polyuronide component and the low extent of esterification of the sunflower pectin provide for its rational use in the special and healthy food production.

The complexing ability of the sunflower pectin changes with regard to the main toxic metals depending on the extent of esterification.

We have determined that the sunflower pectin, in spite of the low extent of esterification, can have high gelling power. This is related to the low content of ballast substances, high methoxy component, and practicability of sunflower pectin deacetylation at its production. Acetyl groups, connected with the hydroxy groups of pectins, deteriorate their gelling power.

Thus, having studied the analytical characteristics of pectins, extracted from 10 sunflower grades, one may conclude on the potential of the secondary sunflower raw material as the industrial one to produce pectins with high antitoxic properties.

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