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A F N S ARCHIVE OF FOOD AND NUTRITIONAL SCIENCE
ISSN 2575-0194

Mini Review

Multipurpose Antioxidants based on Food Industry Waste: Production and Properties Evaluation

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More Information

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Submitted: June 04, 2025
Approved: June 19, 2025
Published: June 20, 2025

How to cite this article: Toshkhodjaev. Multipurpose Antioxidants based on Food Industry Waste: Production and Properties Evaluation. Arch Food Nutr Sci. 2025; 9(1):001-003. Available from: https://dx.doi.org/10.29328/journal.afns.1001062

Keywords: Coffee; Silver Skin (SS); Extraction; Antioxidants

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Abstract

Some preliminary results of studies on the assessment of the possibilities and prospects for obtaining products with a high Antioxidant Activity Index (AOA) from the waste of the coffee beverage production industry - "silver skin" (SC, silverskin, CS) are presented.

The obtained data on the extraction of SC with aqueous-alcoholic extractants, the effect of extraction conditions on the yield of extracts, and extractive substances are discussed. It is reported on the production of dry powders of extracts that retain their properties during long-term storage.

Data on the antioxidant properties of both liquid and dry forms of extracts are presented and good AOA of the studied objects is noted in comparison with the "standard" antioxidant - rosemary extract, and it is also shown that the AOA of dry forms of extracts can be increased by doping with synergists - polyphenols of natural genesis. The antioxidant activity of the obtained compositions was studied on real objects - animal fats and natural dyes, the results of which confirmed the prospects of the studied antioxidants (AO) for practical purposes.

Introduction

It is known that coffee is second only to oil in terms of sales in the world. According to the International Coffee Organization (ICO), coffee consumption is growing by an average of more than 2.5% per year [1]. With the growth of coffee consumption, environmental problems associated with its production and waste disposal are also increasing. Among the various by-products (waste) of coffee production as a drink, namely coffee grounds, roasting waste - silver skin (SS, silverskin), coffee pulp, coffee parchment and others, SS stands out for several technological qualities: ease of transportation and processing, low (up to 5%) moisture content, which ensures long-term storage, etc. It has been established that SC contains various organic products, among which a complex of compounds with antioxidant properties stands out: phenolic acids, caffeine. The isolation of the above compounds from SC and their use to protect various products from oxidative destruction can become a source of additional economic benefit, and qualified SC processing will reduce the level of negative impact of the coffee production industry on the environment. It should be noted that the volume of SC formed during the roasting of coffee beans in the Russian Federation is estimated at approximately 12 thousand tons annually.

An analysis of literary sources showed that there are practically no works by domestic scientists on the problem under discussion; there are only a few articles or abstracts of reports devoted to other areas of SC processing [2-7].

The Present studies were conducted using SC obtained from the Moscow Coffee House on Shares enterprise (Moscow, Russia), formed during roasting of Arabica coffee beans from Guinea and Brazil. The moisture content of silver peel was determined using the OFS 1.5.3.0007.15 method and was 0.16 ± 0.01%. Under such humidity conditions, the formation of microorganisms, such as bacteria, fungi, and mold, is impossible, and there is no deterioration of the raw material itself or a change in its appearance and odor [8].

The following conditions were used in the process of studying the extraction of SC: dry raw materials with a particle size of up to 10 mm, the raw material: extractant ratio is 1:10, the extraction temperature is the boiling point of the extractant and the extraction time is 60 minutes, the

extractant is C_2H_5OH: H_2O in a ratio of 0:100; 30:70; 50:50; 70:30; 100:0.

The content of extractive substances was estimated using the pharmacopoeial method OFS 1.5.3.0006.15 [8]. The obtained results are presented in Table 1.

Since certain limitations in the practical use of alcohol-containing extracts are well known, and we also recorded (spectrophotometric analysis) changes in extract compositions during storage for 60 days, a dry extract powder was obtained.

The extract powder was obtained by spray drying the E1 extract (extractant - 100% distilled H_2O) at a temperature of 150 °C on a Buchi Mini Spray-Dryer B-290 [9]. The yield of dry powder SESK-1 from 500 g of extract was 5.4 g. The humidity of SESK-1 was 6.65% (Axus AG-S analyzer). Dry powder of the extract (SESK-2) was obtained in parallel without using a drying unit by evaporation on a rotary evaporator. The yield of dry powder SESK-2 from 270 g of extract was 7.09 g. The humidity of SESK-2 was 4.01% (Axus AG-S analyzer). Studies conducted according to the method [10] showed that all samples of the obtained extracts are non-toxic, which confirms previously obtained data [11].

The antioxidant activity of the obtained extracts E1-E5 was assessed using the method [12]; the results are presented in Table 2.

From the results obtained at this exploratory stage of the research, we can make a preliminary but quite definite conclusion that the SC extracts obtained by the methods used without any optimization and containing, according to the data of [13], as well as our results of HPLC studies, along with components with antioxidant properties, also "ballast" components, and in quantities from 20% to 40%, exhibit quite satisfactory antioxidant properties in comparison with the standard - the standard antioxidant rosemary extract (GOST ISO 1342-2017).

The results of assessing the AOA index of the objects we studied were confirmed and somewhat developed when using the method [14] to assess the AOA. Some of the series of results obtained are shown in Table 3.

Table 1: Yields of extracts and extractive substances in SC extracts at different C_2H_5OH: H_2O ratios.

Item Ratio C_2H_5OH:H_2O, % vol.	Extract designation	Yield of finished extract, %	Amount of extractive substances X, %
0:100	Э1	76.23 ± 0.62	12.97 ± 1.19
30:70	Э2	69.33 ± 3.79	9.61 ± 1.55
50:50	Э3	66.50 ± 1.24	8.24 ± 0.53
70:30	Э4	64.00 ± 2.48	7.07 ± 0.42
100:0	Э5	62.77 ± 2.17	5.65 ± 0.75

Table 2: Results of the study of the antioxidant activity (AOA) level of the obtained extracts E1-E5.

No.	Extract	R, %	No.	Extract	R*, %
1	E1	46.8	4	E4	60.3
2	E2	47.1	5	E5	64.4
3	E3	60.6	6	ER**	75.6

R* - Degree of radical capture, %; ER** - Rosemary extract (standard).

Table 3: Results of assessing the AOA indices obtained by the method [14].

№	Item Sample	AOA Index, mg/g	№	Item Sample	AOA Index, mg/g
1	SESK-1	156.3	4	TGB*	24.8
2	SESK-2	364.9	5	SESK-1+TGB**	326.7
3	ER	279.3			

*TGB – 1,3,5-trihydroxybenzene
**SESK-1+TGB – a composition of SESK-1 (80%) + TGB (20%)

From the results presented in Table 3 it follows, firstly, that (by the methodology used) the AOA of SESK-2 exceeds the AOA level of the reference (standard) antioxidant – rosemary extract, and, secondly, the AOA of the SK extract can be significantly increased by doping with a small amount of a natural synergist.

The difference in the AOA index levels between SESC-1 and SESC-2 is probably due to the transformation of the extract components at elevated temperatures. A special experimental verification of this hypothesis is currently underway.

Natural fats were used as real objects for search and evaluation experiments on antioxidant activity: milk and chicken (rendering), as well as natural carotenoid dyes.

Dry extract of SESC-1, as well as SESC-1 with the addition of 40% (by weight) TGB and SESC-1 with the addition of 40% ascorbic acid, were selected for testing on fats. Rosemary extract (RE) was used as a reference sample.

Antioxidants were added to the fat samples in an amount of 0.25% of the fat weight. The samples were stored in a sealed container at 25 °C. The mass fraction of free fatty acids (in terms of the percentage of oleic acid) according to GOST R 50457-92 (ISO 660-83) in the studied samples and the peroxide value (meq/kg) according to GOST ISO 3960-2013 were determined on days 1, 10 and 21. It was found that the dry extract of SC is capable of preventing natural oxidative destruction of animal fats at a satisfactory and good level relative to the reference "standard" antioxidant, while the ESC powder can be used as a kind of "platform" for obtaining compositions with a high level of AOA (in some cases exceeding the level of the standard AO), doping with minimal amounts of natural, available and inexpensive synergists. In the second series of experiments, the optical density was determined, and the content of beta-carotene and canthaxanthin in the samples of aqueous solutions was calculated after exposure of the samples to sunlight for 7 days at room temperature.

It was found that the introduction of 10% SESC-1 from the mass of the dye, capable of preventing the degradation of natural carotenoids at a level of 92% - 93%, i.e., comparable to the commercial rosemary extract (Naturex company).

Conclusion

1. The results obtained during the study and presented in the text of the article indicate the prospects for the development of highly effective, natural multi-purpose antioxidants based on coffee bean roasting waste (silver skin, CS).

2. Obviously, further, in-depth chemical-technical and assessment-ecological development of the multi-stage process of creating, in fact, composite antioxidants based on SC is required.

3. It should also be borne in mind that the feedstock - SC is essentially a natural "chemical container" containing components of various structures and biological properties, and the method for obtaining antioxidants based on SC should take into account the possibility of the most efficient use of these components and constituents, i.e. should be included as a component in the process of complex processing of coffee production waste [2].

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