Study Of Amaranth Seeds As The Raw Material For The Extraction Of Biologically Active Additives

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ANNOTATION

The composition of nutrients in the fruits of amaranth with different color coat was studied. The protein composition of amaranth seeds was defined. The lipid complex of various types of amaranth has been determined. The oil from amaranth seeds by the method of raw material extraction was obtained. It has been established that amaranth oil approximates to cotton oil interms of unsaturated fatty acids content.

Keywords: amaranth seeds, chemical composition, type of coloring, oil extraction, fatty acid content, biochemical parameters.

1. INTRODUCTION

The search for alternative solutions in technology of food products determines the necessity to create modern nutritional structure based on the use of functional products obtained from natural sources, which contain unique in chemical structure lipid components, capable of exerting effective biological effect on the human body, correcting the negative anthropogenic environmental impact (Artemov, 1998; Wagenfeld, 1994; Oaxtepec, 1991; Inform. Bulletin of RAAS, 1994; Bogomolov, 2001).

As a promising source for the creation of functional food products and biologically active additives (BAA), amaranth seeds are of particular interest, the lipid complex of which contains a high amount of squalene belonging to the terpene class (Buldakov, 1996; Kazakov, 1983; Kretovich, 1986; Kazakov, 1980; Klyuchkin, 1999).

The research aimed at substantiating and developing technologies and formulations of specialized products with high biological activity based on amaranth seeds are relevant.

2. RESEARCH METHODS

Standard and modern methods of physical-chemical analysis have been used during research: gas-liquid and thin-layer chromatography, colorimetry, spectrophotometry, as well as special methods of research of biological properties of raw materials(Poznyakovsky, 2005; Mikulovich, 1991; Braudo, 2000).

Diversity of component composition of amaranth seeds, which have unique properties, is the basis for development of technological complex for selective extraction of these components and their effective use (Khaziev, 1993; Skurikhin, 1984). Development of technologies, determination of areas of use of amaranth oil and possibility of obtaining products with increased physiological value are urgent.

Following dependence of decrease in content of free fatty acids in oil extracted from the crushed seeds of amaranth was determined comparing with seeds treated with acute saturated steam (τ=10 min, t=100-105°C, w=10-12%) in the series of extraction agents; diethyl ether, hexane, Freon II, liquid carbon dioxide, refined deodorized vegetable oil.

Property of refined deodorized vegetable oil and liquid carbon dioxide to selectively remove non-polar components of amaranth oil (triglycerides, squalene, tocopherols, sterols) from seeds, leaving more polar compounds (phospholipids, free fatty acids in products) in the extracted material has been established.

Technology of direct extraction of amaranth seeds, aimed at preserving biomedical properties of amaranth oil and increasing nutritional value of amaranth meal has been developed.

Based on experimental data has been shown that amount of oil phase in formulations of hard margarines can be doubled compared to sunflower oil if it is replaced by CO_2-extract, meanwhile increasing the stability of margarines to oxidation during storage.

While carrying out experimental research, we used standard methods of analysis generally accepted in oil and fat industry, as well as modern instrumental methods of analysis: gas-liquid, high-effective liquid and thin-layer chromatographs, UV- and IR-spectroscopy and spectroscopy in visible areas. Ultrastructure of amaranth seeds was studied by electron scanning microscopy. For studies on determining the quality and chemical composition, oil was extracted from amaranth seeds according to the method of Folch by exhaustive extraction with mixture of chloroform and 80% ethanol in ratio of 2:1. Direct scanning on densitometer carried out quantitative assessment of lipid fractions. Their density in 60% aqueous alcohol in mercury calculated the porosity coefficient of petals from amaranth seeds.

We studied the physical-mechanical properties of three types of amaranth seeds differing in color: white-seeded, pink-seeded and black-seeded. It was determined that light-colored seeds are larger, have larger equivalent diameter and bigger mass of 1000 pieces of seeds. In addition, they crush more easily, which indicates higher technological properties and the possibility of processing with separation of the shell. Amaranth seeds are characterized by low speed of soaring (2.8-3.1 m/s) in comparison with other small-seeded oily crops.

Chemical composition of amaranth seeds was studied in order to identify the possibility of industrial processing and development of technological requirements. Results are in table 1.

Table 1.

Type of seeds	**Mass fraction, %**						
	Moisture	**Anti-nutrients**	**Lipids**	**Protein**	**Cellulose**	**Ash**	**Starch**
White seed	9.9	0.043	7.50	15.7	5.3	3.2	61.6
Pink seed	10.1	0.049	6.10	16.8	6.9	3.2	60.6
Black seed	10.3	0.058	5.80	13.9	9.8	3.4	61.7

Results of research showed that starch content exceeded 60%, level of anti-nutrients, including tannin did not exceed 0.06% in seeds of amaranth of the studied types, and in light-colored seeds amount was lower comparing to dark-colored. Light-colored seeds had high oil content, which, however, did not exceed 8.37% in individual studied samples, provided by the Botanical Garden of Bukhara region.

This work addresses the following interrelated problems:

- identification of biochemical and physical-mechanical features of amaranth seeds of various types in order to select raw materials for production of vegetable oil of food products of functional purpose and BAA;
- research of nutritional and physiological value of modern varieties of amaranth seeds as a source of BAS (squalene, tocopherols, polyunsaturated fatty acids, pectin, etc.);

The composition of nutrients in the fruits of amaranth with different shell color was studied, and the task of the feasibility of its separation in the development of new products was solved (Table 2).

Table 2
Composition of nutrients in amaranth seeds, % per dry substance

Name of the indicator	**Type of the seeds**		
	White seed	Pink seed	Black seed
Protein (Nx6.25)	16.0-18.50	15.50-18.10	13.54-16.30
Lipids	6.05-8.05	5.97-8.23	5.80-6.80
Starch	59.6-63.2	59.9-63.3	60.0-63.4
Dietary fiber	6.10-8.62	6.90-8.90	8.70-10.90
Mono- and disaccharides	2.08-4.58	2.16-4.64	2.09-4.69
Ash	3.11-4.05	2.80-3.60	3.0-3.82

The amaranth seeds, regardless of the color of the fruit, contain mainly carbohydrates (over 72%), and the content of dietary fibers, mono- and disaccharides, minerals and starch is at the same level. Light-painted seeds are characterized by higher protein concentration at increased oil content (5.97-8.23%) compared to dark-painted seeds. By evaluating the biological efficacy, the lipid complex of various types was studied by comparing the composition of biologically active components (Table 3).

Table 3
Biologically active components of lipids of amaranth seed

Type of the seeds	**Mass fraction, %**				
	unsaponifiablesubstances	tocopherol	phospholipid	squalen	sterol
White seed	10.90-12.70	0.10-0.18	2.70-2.85	8.30-8.70	4.60
Pink seed	8.90-9.30	0.14-0.16	3.14-3.64	6.14-6.60	3.70
Black seed	9.60-10.80	0.11-0.15	3.87-4.28	6.84-7.04	4.00

Due to the presence of a natural immunomodulator of squalene in the amaranth seeds of lipids, products containing amaranth oil and, as a result, squalene in physiologically significant amount, can effect on organism, for example anticancerogenic, anti-inflammatory, antitumor, etc. (16-20). White seed types are superior to pink seed and black seed types in terms of squalene content (8.30-8.70%), sterols (4.40-4.80%) and tocopherols (0.10-0.18%).

3. RESULTS AND DISCUSSION

Evaluating the prospects of using seeds to obtain oil as an independent product enriched with biologically active components, the quantitative and qualitative composition of tocopherols extracted from white seed amaranth lipids, in comparison with refined oils was studied (Table 4).

Table 4
Tocopherol content in amaranth lipids and refined oils

Oil	**Total mg/100 g**	**α- tocopherol**		**β+ γ- tocopherol**		**β-tocopherol**	
		mg/100g	% from total	mg/100g	% from total	mg/100g	% from total
amaranth	106	8	7	75	71	23	22
soybean	114	10	9	67	59	37	32
cottonseed	99	50	51	47	47	2	2
sunflower-seed	42	39	93	1	2	2	5

Amaranth oil in terms of the total content of tocopherols approaches soybean oil and exceeds sunflower oil (by 8.2, 3.0 and 2.5 times, respectively). The predominance of tocopherols with antioxidant activity (93% of the total) in it increases the protective potential of the organism, preventing the oxidation of lipids.

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The fatty acid composition of amaranth lipids of various types differs not so appreciably (Table 5).

Table 5
The fatty acid composition of amaranth oil

Name of fatty acids	**Code**	**Content,% to the total of fatty acids**		
		White seed	**Pink seed**	**Black seed**
Palmitic	$C_{16:0}$	19.2	20.0	21.2
Stearin	$C_{18:0}$	3.6	4.1	3.2
Arachic	$C_{20:0}$	0.8	0.9	1.0
∑ S		**23.6**	**25.0**	**25.4**
Oleic	$C_{18:1}$	24.7	25.4	25.4
Linoleic	$C_{18:2}$	50.5	48.6	48.4
Linolenic	$C_{18:3}$	1.2	1.0	0.8
∑US		**76.4**	**75.0**	**74.6**

In terms of unsaturated fatty acid content (74.6-76.4%), amaranth oil approaches cotton oil (76.5%), being lower only for oleic acid (1.3 times), with increased content of linoleic acid (4.4-6.5%) and linolenic acid.

4. CONCLUSION

The results of studies of the biochemical characteristics of amaranth seeds allow identifying the influence of species characteristics of seeds on a number of indicators, which are taken into account when choosing the direction of their use. It has been established that white-colored seeds are characterized by the highest biological potential compared to black-colored, due to the increased concentration of proteins and lipids containing polyunsaturated fatty acids, tocopherols with antioxidant activity, phospholipids, sterols, and, most importantly, squalene in a physiologically more significant amount.

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