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Study of the Physico-chemical Properties of Amaranth Grains Grown in the Kemerovo Region

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ABSTRACT

Amaranth seeds have excellent nutritional properties as they are rich in macronutrients, dietary fiber, vitamins, minerals and other phytochemicals : polyphenols and phytosterols. As a result of the research, the main physical and chemical characteristics of amaranth grains of the variety Yantar, grown in the Kemerovo region at natural humidity and dried in air, were established. It was found that the mass fraction of the crude protein of dried amaranth grains of the Yantar variety grown in the Kemerovo region, was higher by 11.6%, the mass fraction of fat in dried amaranth grains by 10.5%, the mass fraction of crude fiber of dried amaranth grains by 11.5%, the mass of the crude fiber proportion in dried amaranth grains by 11.6%, the mass fraction of calcium and phosphorus in dried grains of amaranth by 12 and 12.5%, respectively, the mass fraction of nitrogen-free extractive substances for dried grains by 11.5%, the content of exchange energy for dried grains amaranth by 11.5%, the number of feed units for dried amaranth grains by 11.8%, the amount of digestible protein for dried grains was higher by 11.5% comparing to amaranth grains at natural moisture. It was shown that all properties of amaranth grains at natural moisture content were 10.5-12% less than ones for grains dried in air.

Key words : Amaranth, crude protein, crude fat, crude fiber, digestible protein

INTRODUCTION

Consumption of amaranth seeds (Amaranthus sp.) as a food product has many health benefits, especially reducing the risk of cardiovascular disease. Amaranth seeds have excellent nutritional properties as they are rich in macronutrients (about 13-23% protein and about 6-13% fat), dietary fiber (about 9-14%), vitamins, minerals and other phytochemicals (polyphenols and phytosterols; Jimoh *et al.*, 2018). Compared to traditional cereals, it contains protein of higher quality and higher content of lysine and methionine. Amaranth has the ability to improve the nutritional quality of staple food, so it is especially suitable for people prone to food insecurity (e. g. urban consumers with low socio-economic status, smallholders and self-sufficient farmers).

Amaranth is considered to be highly resistant to pests, diseases and other environmental factors (e. g. drought stress). For small farmers living in harsh climates, this pseudo-wheat is considered to be a useful food source (Karamac *et al.*, 2019; Volkova *et al.*, 2020). However, it is unclear whether the nutritional properties of amaranth seeds are preserved under difficult climatic and agronomic conditions. The greatest attention is paid to research on the growth, yield and nutritional composition of amaranth, which is under pressure or environmental constraints. There are also reports of the influence of genotype on yield and grain quality. However, there are few studies of the influence of these factors or post-harvest processing on the bioavailability of nutrients (especially lipids) in the human gastrointestinal tract and the absorption of amaranth seeds (Alemayehu *et al.*, 2015; Dinssa *et al.*, 2016; Taniya *et al.*, 2020).

There are several studies on the amaranth seed treatment which affect its bioavailability and nutrient absorption. Typically, the processing of plant products affects the bioavailability and absorption of nutrients (Peiretti, 2018). In fact, the degree of malnutrition affects the release and absorption of nutrients, thereby greatly regulating the integrity of the cell wall, promoting lipid fusion and changes in protein structure and function. However, processing is not always beneficial and can lead to the

removal of food ingredients (such as dietary fiber and polyphenols), the formation of new networks (for example, the formation of proteins and lipids) and anti-nutrients (such as phytates, polyphenols and oxalates), can affect the absorption of macronutrients (Grundy *et al.*, 2016; Aguilera, 2018; Sarker *et al.*, 2020).

Despite the above benefits, amaranth is still underutilized, especially as a cereal (mainly as a leaf vegetable), but amaranth has a lot of potential. Amaranth comes from Mexico and Central America, but now it is also grown in Asia, USA, Canada, Africa and Europe (the latter is limited to ornamental varieties; Grundy *et al.*, 2016; Nardo *et al.*, 2020). Currently, amaranth is cultivated in Russia; in particular, amaranth growing in the Kemerovo region is of interest. Under current conditions, amaranth appears to be a promising solution to the problem of climate change and malnutrition (Coelho *et al.*, 2018; Capuano and Pellegrini, 2019; Cuadrado *et al.*, 2019). However, at present, the effect of grain sources (different genotypes of grain grown in different climatic and agronomic conditions) and processing on the nutritional value and digestibility of amaranth seed nutrients has not been fully studied (Grundy *et al.*, 2020). In this regard, the study of the physico-chemical composition of amaranth seeds grown in the Kemerovo region is of an urgent task. The purpose of this work was to study the physico-chemical characteristics of amaranth seeds grown in the Kemerovo region.

MATERIALS AND METHODS

Amaranth seeds of the variety Yantar cultivated in the Kemerovo region in 2020 were selected as the object of the research. The grains were used at natural moisture content and grains dried in air at room temperature for 55% moisture for seven days.

Moisture content was determined according to GOST 31640-2012.

The mass fraction of dry protein was determined according to GOST 13496.4-93.

The mass fraction of crude fat was determined according to GOST 13496.15-97.

The mass fraction of crude ash was determined according to GOST 26226-95.

The mass fraction of crude fiber was determined according to GOST 31675-2012.

The mass fraction of calcium was determined according to GOST 26570-95.

The mass fraction of phosphorus was determined according to GOST 26657-97.

The mass fraction of non-extractive substances (NES), the content of exchange energy (EE), digestible protein (DP) and the number of feed units (FU) were determined according to the Methodological Guidelines for Evaluating the Quality and Nutritional Value of Feed CINAO.

All experiments were carried out in triplicate.

RESULTS AND DISCUSSION

The results of determining the physico-chemical properties of amaranth grains of the variety Yantar grown in the Kemerovo region in 2020 were performed at natural humidity (NH) and dried in air (DA), they are presented in Table 1.

Analysis of the tabular data allowed concluding that the mass fraction of the crude protein of amaranth grains of the variety Yantar grown in the Kemerovo region at natural moisture content was 11.6% less than the mass fraction of the crude protein of the amaranth grains of the variety Yantar dried in air. The mass fraction of fat of amaranth grains of the variety Yantar at natural moisture content was 10.5% less than the mass fraction of fat of amaranth grains dried in air. Mass fraction of crude fiber of amaranth grains at natural moisture content was 11.5% less than for dried grains. Mass fraction of crude fiber of amaranth grains at natural moisture content was 11.6% less than for dried grains. The mass fraction of calcium and phosphorus for amaranth grains at natural moisture content was 12 and 12.5%, respectively, less than for dried grains. The mass fraction of NES for grains at natural moisture content was 11.5% less than for dried grains. The content of exchange energy, which was important for the conversion of feed in poultry farming, for amaranth grains at natural moisture content was 11.5% less than for dried amaranth grains. The number of feed units for amaranth grains at natural moisture content was 11.8% less than for dried grains. The amount of digestible protein for grains at natural moisture content was 11.5% less than for dried amaranth grains.

Such a proportional increase in the main physico-chemical parameters of amaranth

Table 1. Physical and chemical properties of amaranth grains of the variety Yantar grown in the Kemerovo region in 2020

S. No.	Indicator	Units	Indicator value	
			NH	DA
1.	Mass fraction of natural moisture	%	11.53	-
2.	Mass fraction of dry matter	%	-	88.47
3.	Mass fraction of dry protein	%	14.31	16.18
4.	Mass fraction of crude fat	%	7.89	7.06
5.	Mass fraction of crude ash	%	4.47	5.05
6.	Mass fraction of crude fiber	%	7.26	8.21
7.	Mass fraction of calcium	%	0.66	0.75
8.	Mass fraction of phosphorus	%	0.56	0.64
9.	Mass fraction of NES	%	55.45	62.67
10*	Content of EE	MJ/kg	12.39	14.0
11*	Amount of FU	Unit/kg	1.42	1.61
12*	Amount of PP	%	11.45	12.94

*Indicators 10-12 are presented per bird.

grains of the variety Yantar grown in the Kemerovo region dried in air for seven days was explained by removal of moisture during drying, weight loss by the grains, as a result of which it was necessary to take more dried grains for grinding and conducting analysis. In addition, when removing excess moisture, the main substances contained in amaranth were concentrated.

CONCLUSION

The main physico-chemical characteristics of amaranth grains of the variety Yantar grown in the Kemerovo region at natural humidity and dried in air were established. It was shown that all parameters for amaranth grains at natural moisture content were 10.5-12% less than for grains dried in air.

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