Original scientific paper
UDC 635.658-153.02(574)

STUDY OF THE FOOD SAFETY AND NUTRITIONAL VALUE OF THE BUCKWHEAT GRAINS OF KAZAKHSTANI SELECTION

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Abstract

Like the majority of developing countries, the Republic of Kazakhstan, being in a globalizing economy today, has faced with the serious problems of healthy and balanced diet of the population. The solution of developed situation is raised to the rank of priority directions of the state agrarian policy. The literature review shows that, depending on the: agro-climatic conditions of cultivation and the varietal characteristics, the chemical composition of buckwheat seeds includes: the following: phosphorus, iron, copper, cobalt, calcium, boron, zinc, iodine, nickel, complex carbohydrates (cellulose), and the malic, citric and oxalic acid, and also vitamins B and P. The literature also indicates the therapeutic and prophylactic properties of buckwheat, which are characterized as a: hypotonic, anti-sclerotic, and expectorant drug. Rutin contained in the buckwheat improves the angiasthenia properties and increases the permeability of vascular capillaries. In this regard, the investigations, which are aimed at studying the deep chemical composition to determine the value of useful substances by the extraction method for their further use in the pharmaceutical and medical purposes, are the relevant and innovative direction in the food industry.

The study techniques were as follows. The initial quality of buckwheat seeds (organic matter content) was evaluated by the short-time near-infrared spectroscopy. Germination of buckwheat seeds was studied by means of the experimental sowing of 50 seeds and a further counting of the number of germinated seeds. Studying of the buckwheat seeds chemical composition was carried out by using the nuclear gas chromatograph GS1000D Firm of Yokogawa (Japan) of the Company "Hofigal Export Import SA" at the different phases of their physiological development through the germination on 28, 38, 45, 49, 105th day. The data obtained was recorded in the laboratory notebook to conduct the further systematization and analysis. And then, based on the data obtained, the charts of chemical composition changes, depending on the variable germination periods, were drawn up.

The percentage of protein content in the grain of "Bogatyr" buckwheat was 11.1% (mostly globulins and

albumins), and an increased amount of lysine - up to 8% was established. Starch content was 66.2%, and the cellulose content was equal to 12.5%. Fat content in the selected samples of "Bogatyr" buckwheat grains was 3.2%. An antagonist of cholesterol - a fat-like lecithin substance prevails in the fats of buckwheat grains (up to 80%). The greatest amount difference of polyphenols content (at recalculation to caffeic acid) was observed on Day 49 day, and equal to 1.26%, and their smallest content was observed on day 28 of buckwheat growing - only 0.67%. Maximum total content of flavonoids was observed on Day 49 of the buckwheat vegetative development, and equal to 2.01%. The minimum total content of flavonoids was observed at the initial stage of buckwheat plants development – only 1.22% on Day 28 of physiological development. An analysis of received chart showed that there is no "trace" of microelements in the fresh sample of buckwheat, such as copper, lead, cadmium, and strontium. Buckwheat laboratory samples contained important microelements as a group of alkaline metals - sodium, potassium, and calcium, as well the important elements as: iron, magnesium, manganese, and zinc. An analysis showed that the content of microelements significantly increases in the dry wheat samples.

Based on the results of studies conducted we can conclude that the quantitative content of microelements is not uniform at the various phases of vegetation development of the grown buckwheat, which can be explained by the increasing physiological needs of plants that are associated with the intensification of growth, increased activity of metabolic processes and photosynthesis. It should be noted that in the early stages of development the buckwheat can dispense with its own reserves of microelements, but at the tillering phase they need an increase in the concentration of those microelements.

***Key words**: Nutritional value, Food safety, Buckwheat grains, Pharmaceutical and medical-prophylactic, Mineral composition, Minerals, Extract.*

1. Introduction

Like the majority of developing countries, the Republic of Kazakhstan, being in a globalizing economy today, has faced with the serious problems of healthy and balanced diet of the population. From the scientific monograph Ospanova *et al*, [1], follows that the solution of developed situation is raised to the rank of priority directions of the state agrarian policy.

The literature review shows that, depending on the agro-climatic conditions of cultivation and the varietal characteristics, the chemical composition of buckwheat seeds includes: phosphorus, iron, copper, cobalt, calcium, boron, zinc, iodine, nickel, complex carbohydrates (cellulose), and the malic, citric and oxalic acid, and also vitamins B and P.

Weinstein and Kauhova, [2], also indicates the therapeutic and prophylactic properties of buckwheat, which are characterized as a: hypotonic, anti-sclerotic, and expectorant drug, and the rutin contained in the buckwheat improves the angiasthenia properties and increases the permeability of vascular capillaries.

In this regard, the investigations, which are aimed at studying the deep chemical composition to determine the value of useful substances by the extraction method for their further use in the pharmaceutical and medical purposes, are the relevant and innovative direction in the food industry.

The chemical composition and food safety of the buckwheat seeds of Kazakhstani selection have been studied. The seeds of buckwheat "Bogatyr" developed by the Limited Liability Partnership "Aktobe Agricultural Experimental Station" of the Republic of Kazakhstan were taken as subject of study.

2. Materials and Methods

The study techniques were as follows. The initial quality of buckwheat seeds (organic matter content) was evaluated by the short-time near-infrared spectroscopy Vittenberg and Ioffe, [3]. Germination of buckwheat seeds was studied by means of the experimental sowing of 50 seeds, and a further counting of the number of germinated seeds. Studying of the buckwheat seeds chemical composition was carried out by using the nuclear gas chromatograph GS1000D Firm of Yokogawa (Japan) at the different phases of their physiological development through the germination on: 28, 38, 45, 49, 105th day. The data obtained were recorded in the laboratory notebook to conduct the further systematization and analysis. Based on the obtained data, the charts of chemical composition changes, depending on the variable germination periods, were drawn up (Plaksin *et* al, [4], and Nikolaeva [5]).

3. Results and Discussion

Based on the experimental studies conducted, the following results were obtained.

The results of experimental studies to determine the percentage of organic matter (protein, starch, cellulose, and fat) in the selected samples of buckwheat seeds are shown in Figure 1.

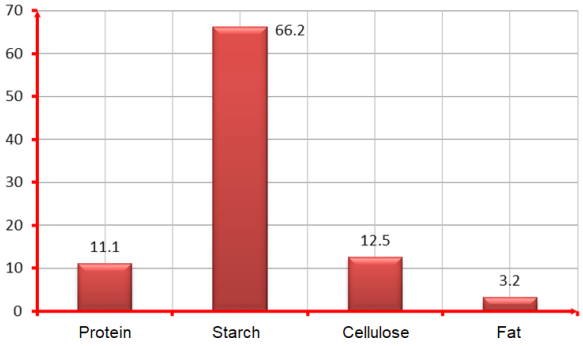

Figure 1. The content of organic matter in the buckwheat seeds

The percentage of protein content in the grain of "Bogatyr" buckwheat was 11.1%. The protein of buckwheat grain contains an increased amount of lysine up to 8%, and generally it's significantly exceeds the other grain varieties in the protein nutritional value and usefulness. The great bulk of protein is represented by globulins and albumins, and that factor determines their high nutritional value.

The starch of buckwheat grain are the small, round starch granules with a small cavity in the center. As a result of chemical composition study it was found that the grains of "Bogatyr" buckwheat contain great amount of starch - 66.2%. Cellulose content in the buckwheat seeds is equals to 12.5%. This is explained by the anatomical structure of buckwheat seeds and the nuclear structure, as well as the large percentage of flowering and fruit envelopes. The obtained values need to be considered in the development of formulations for the products of: therapeutic, prophylactic, and special purposes.

The percentage of fat content in the selected samples of "Bogatyr" buckwheat grains was 3.2%, in which a cholesterol antagonist of - a fat-like lecithin substance prevails in the fats of buckwheat grains (up to 80%).

Germination of "Bogatyr" buckwheat seeds was studied under the laboratory and field conditions. The gains yield of buckwheat is determined by the sowing qualities of seeds, in terms of - "laboratory germination", which characterizes the sowing and yielding qualities of buckwheat gains. Results of the laboratory sowing of buckwheat seeds are given in Table 1.

Table 1. Determination of germination and sprouting evaluation

No.	Parameter	Periods	Q-ty
1	Sprouting	3 - 4 days	100% / 50 seeds
2	Germination	after 7 days	100% / 50 seeds

In the laboratory conditions, the germination power was characterized by vigor and speed seed germination. In the study of germination power of buckwheat seeds, it was found that the sort of "Bogatyr" meets the prescribed basical conditions. The average value of germination power was 100% (Figure 2). The seedlings had the long branched roots, and a strong germ could be seen. The laboratory germination rate was calculated on the seventh day, and it was equal to 100%.

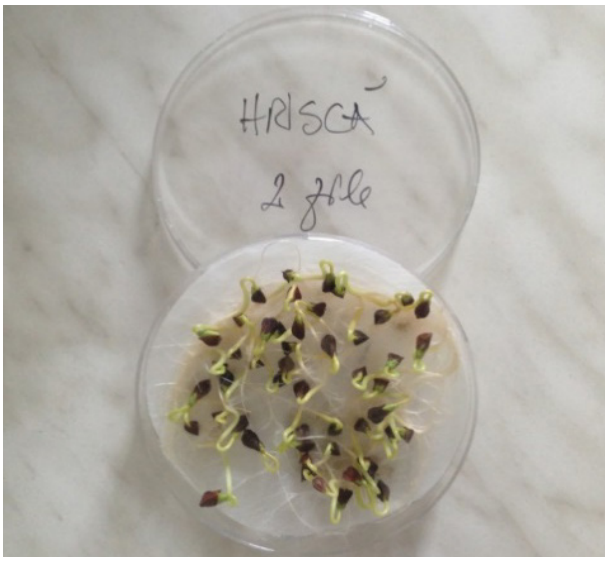

Figure 2. Results of the laboratory sowing of "Bogatyr" buckwheat seeds

At the same time, in the field conditions the germination power was significantly different to those obtained in the laboratory conditions (Figure 3), and characterized by low germination number. The first seedlings appeared only on the fifth day, and their percentage ratio was less than 45% of total sown seeds.

Figure 3. Results of the field germination (Day 5) of "Bogatyr" buckwheat seeds

One of the major tasks of modern pharmacognosy is the search for the new sources of biologically active substances to develop the highly efficient therapeutic and preventive agents based on the plant raw materials. In this regard, we studied the content of: polyphenol, flavonoids, amino acids, and sugars in the buckwheat plants. The preliminary studies showed a positive content of flavonoids and polyphenols, but the content of amino acids and sugars was not detected.

In this regard, the content of flavonoids and polyphenols was studied, depending on the buckwheat ripening on the: 28, 38, 45, 49 and 105th day of planting. Polyphenol content was measured by recalculation to the caffeic and chlorogenic acids (Figure 4), and the flavonoids content by recalculation to the rutin (Figure 5).

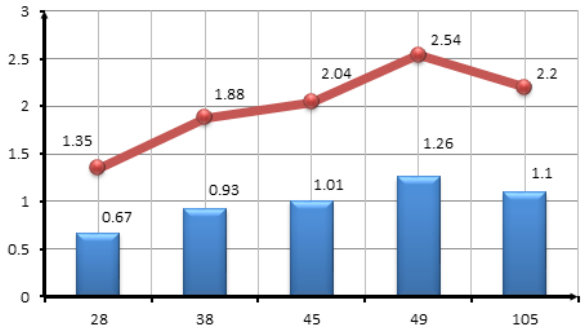

Figure 4. The content of polyphenols by recalculation to the caffeic (1) and chlorogenic (2) acids,%

Analysis of the presented chart showed that the test samples differ by the content amount of polyphenols, due to the different physiological periods of buckwheat growing. The greatest amount difference of polyphenols content (at recalculation to caffeic acid) was observed on day 49 day, and equal to 1.26%, and their smallest content was observed on day 28 of buckwheat growing - only 0.67%. At that, an increase in the terms of buckwheat ripening leads to the lower content of polyphenols, and on day 105 it was equal to 1.1%.

Observing the dynamics of changes in the concentration of polyphenol in organic acids it was found that the quantitative polyphenols content increases at recalculation to chlorogenic acid, by an average 2 times, which corresponds to the following values: the greatest amount difference of polyphenols content (at recalculation to chlorogenic acid) was observed on day 49 day, and equal to 2.54%, and their smallest content was observed on day 28 of buckwheat growing - only 1.35%. At that, an increase in the terms of buckwheat ripening leads to the lower content of polyphenols, and on day 105 it was equal to 2.2%. In this regard, we can confidently assert that the use of chlorogenic acid significantly improves the biological value of polyphenols in the buckwheat.

Then, they studied the content of flavonoids in the buckwheat plants buckwheat at recalculation to rutin. The results of studies revealed some differences in the content of flavonoids amount at the various stages of buckwheat vegetative growth (Figure 5).

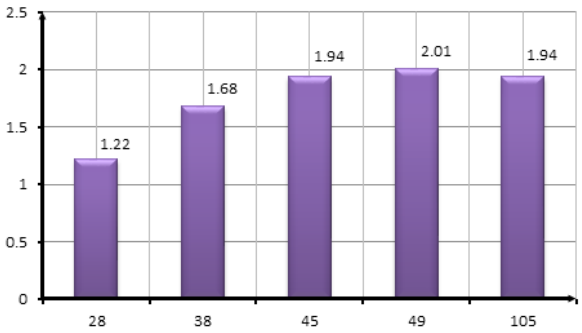

Figure 5. The content of flavonoids in the buckwheat plants at recalculation to rutin, %

As it follows from the above data, the flavonoids can be found in all organs of the plant, but they are distributed unevenly. The analysis showed that, in general, the maximum total content of flavonoids was observed on day 49 of the buckwheat vegetative development, and equal to 2.01%. The minimum total content of flavonoids was observed at the initial stage of buckwheat plants development - only 1.22% on day 28 of physiological development. In this case, the results indicate that an increase in the terms of buckwheat ripening leads to the decrease in the total content of flavonoids, e.g. on day 105 the values were equal to 1.94%.

It is known that the microelements are actively involved in the physiological processes of growth, vegetative development, and agricultural plants fruiting. Also the microelements can stimulate or inhibit the biological processes and reproductive functions. Many of the microelements are part of: enzymes, vitamins, hormones and other biologically active compounds that perform the functioning of plant organism. The microelements are important in improving the plants resistance to adverse environmental factors and many diseases caused by both, their lack and pathogens.

In this regard, we further studied the content of microelements in the buckwheat plant at the various stages of buckwheat physiological development on the: 28, 28, 45, 49 and 105th day of vegetative development, in a fresh lab sample and in the dry state. Figure 6 shows the results of experimental studies on the microelement composition in the fresh samples of buckwheat.

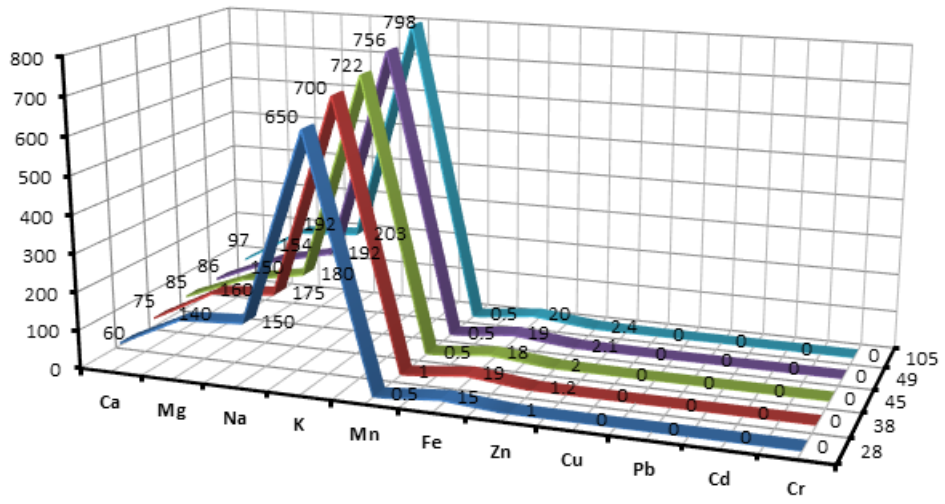

Figure 6. The content of microelements (mg/100 g) of produced fresh product obtained in the greenhouse

An analysis of received chart showed that there is no "trace" of microelements in the fresh sample of buckwheat, such as: copper, lead, cadmium, and strontium. Such elements are the heavy metals, and their absence is an evidence of ecological safety of the fresh buckwheat samples. In its turn, the buckwheat laboratory samples contain such important microelements as a group of alkaline metals: sodium, potassium, and calcium, as well the un-exchangeable and important elements: iron, magnesium, manganese, and zinc. The experimental evidence suggests that an increase in the vegetative growing periods of buckwheat leads to the gradual increase in the concentration of microelements of the plant under study. It is seen from the chart presented that the calcium content (60 mg/100 g) on day 28 of development is lower than in the following days: day 38 - 75 µg/100 g, day 45 - 85 µg/100 g, day 49 - 86 µg/100 g, and day 105 - 97 µg/100 g of product. The same scheme of accumulation was observed with the other salts of microelements: magnesium, sodium, manganese, iron, and zinc. However, the dynamics of potassium accumulation in the developing buckwheat is somewhat different from the other microelements and characterized by a high and maximum content on day 105 - 798 µg/100 g and the minimum on day 28 - 650 µg/100 g.

Figure 7 shows the results of experimental studies on the microelement composition in the dry buckwheat samples.

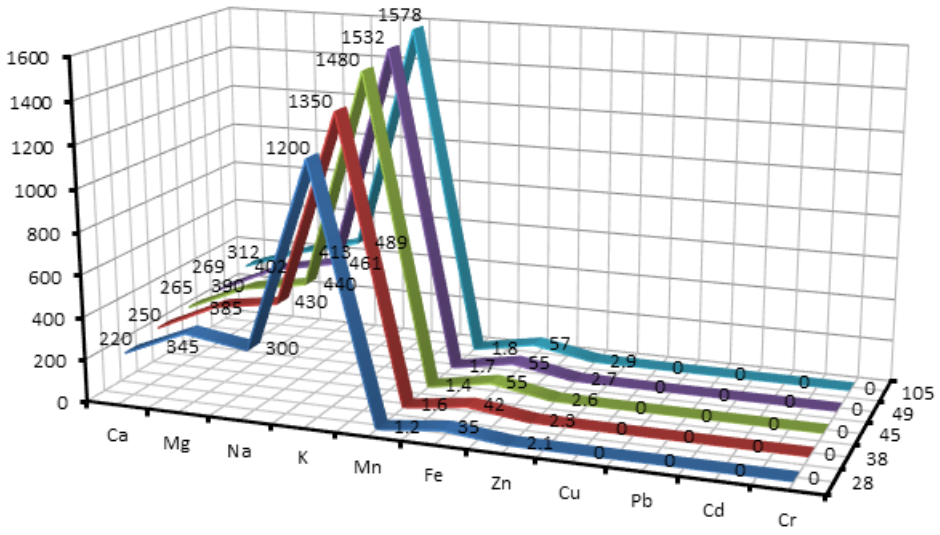

Figure 7. The microelements content (µg/100 g) in the generated dry product, which was received in the greenhouse

An analysis of presented chart shows that the content of microelements significantly increases in the dry wheat samples. For example, the calcium content has increased from 60 µg/100 g to 220 µg/100 g, at that, an increase in the terms of vegetative development also increased the values of calcium content up to 312 µg/100 g of product. A similar situation was observed on the accumulation of other salts of the microelements and magnesium, sodium, manganese, iron, zinc.

However, the dynamics of potassium accumulation in the dry product was significantly different from the other microelements, and characterized by a high and maximum content on day 105 - 1578 µg/ 100 g and the minimum on day 28 - 1200 µg/100 g.

4. Conclusions

- Based on the results of studies conducted we can conclude that the quantitative content of microelements is not uniform at the various phases of vegetation development of the grown buckwheat, which can be explained by the increasing physiological needs of plants that are associated with the intensification of growth, increased activity of metabolic processes and photosynthesis.

- It should be noted that in the early stages of development the buckwheat can dispense with its own reserves of microelements, but at the tillering phase they need an increase in the concentration of those microelements.

5. References

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