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THE EFFECT OF DEHULLING AND THERMAL TREATMENT ON THE PROTEIN FRACTIONS IN SORYZ (SORGHUM ORYZOIDUM) GRAINS

RODICA SIMINIUC, LIDIA COŞCIUG, LILIANA POPESCU, VIORICA BULGARU
Technical University of Moldova
168 Ştefan cel Mare Street,, MD-2004, Chişinău, Republic of Moldova,
rada.siminiuc@gmail.com, l.cosciug@gmail.com, popescua@rambler.ru,
viorica.bulgaru@yahoo.com

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Cereals have a major importance in maintaining a healthy and balanced diet, they are tasty, easily assimilated and cannot miss the daily diet. Diversifying the assortment of cereal products is very topical in the context of increasing food security. Sorghum Oryzoidum or soryz is a relatively new cereal of hybrid origin obtained at the Research Institute for Maize and Sorghum, Republic of Moldova with great possibilities for valorification in human alimentation. In the present paper are presented and analyzed the results of the study of the content of fractional composition of proteins in whole grains and hulled soryz grains and the influence of hydrothermal treatment on soryz grains. The majority of protein fractions (determined by differential solubility in various solvents) of whole grains and hulled sorize is prolamins, followed by gluteline, globulins and albumins. Technological processes such as peeling, hydration and boiling did not significantly change the prolamins content, unlike the rest of the fractions. More pronounced changes following technological processes are observed in hydrosoluble fractions- albumins, some of which were removed with decortication and hidration and boiling significantly diminished their solubility. Whole grains preliminary hidration and later boiling have more pronunced negative effects on albumins and glutelins content compared to boiled whole grains wihout hidration. When boiling the loss of albumins and glutelins was bigger at hulled soriz than at whole grains. This can be explained by a more intensive diffusion of soluble substances of hulled beans relation to soryz beans in as a result of removing the protective outer covering to obtain hulled soryz. The results have scientific value and may be useful for a deeper understanding of soryz technological properties.

Keywords: soryz grains, hulled soryz grains, protein fractions, hydrothermal treatment

Introduction

World Health Organization recommends that most of the energy come from cereals. Increased consumption of cereals in human nutrition is an important objective because of their protective role against diabetes and other metabolic diseases and cancer. Cereals play a basic food security of the population thanks to complex compositions (Rigozzi, 2003). Currently in the world, cereal consumption is decreasing, and integral grains consumption has become more an exception than the norm (Buonfino, 2007). The reduced consumption of integral grains, according to nutritionists, has led to rapid growth of diseases associated with digestive and metabolic disorders: obesity, diabetes, allergies, etc. The number of people suffering from celiac disease or intolerance to wheat protein (gluten) is increasing. Currently there is an increasing incidence of celiac disease, which reaches an average of 1% of the population, being the highest in the following countries: Irland (1 case: 122 persons), USA-(1 case: 133 persons), Sarawi (located in West of Sahara, 1 case: 180 persons), Mexic (1 case: 183 persons) and more (Siminiuc, 2007).

In the Republic of Moldova according to data provided by Mr. Ion Mihu, habilitate doctor, university professor, Head of the Department of Gastroenterology of Scientific Research Institutions in the Mother and Child Health, the prevalence of celiac disease is 1 case: 670 persons and the number of diagnosed persons is only a part of the top of iceberg (Siminiuc et al., 2011). Therefore, research has been made on expanding the range of gluten-free cereals in the diet of people, especially those with gluten intolerance.

Sorghum (Sorghum) is the main bread cereal in Africa, South Europe, Central America and South Asia (Collier, 2010). Sorghum originated in East Africa, is a cereal adapted to the warm and dry climate and for many centuries it has been the most important raw food in semi-arid areas of Asia and Africa. Sorghum ranges the fourth in importance in global agricultural economy after wheat, rice and corn, it is used to produce flour, groats, starch and alcohol, and from stems of some varieties of sorghum is extracted syrup (FAO, 1997). The biggest producers of sorghum are the USA (9800 tons), India and Nigeria (800 thousand tons).

Chemical composition of sorghum is close to other cereals: a carbohydrates (70.7 to 75.3%), followed by proteins (10.4 to 11.8%) and lipids (3.0 -3.7%) and it is influenced by genotype and environmental factors (Steel, 2010). Sorghum characteristic is variability, probably because it grows in different climatic conditions (Burleson, 1956).

Sorghum Oryzoidum or soryz is a relatively new cereal of hybrid origin obtained by Gheorghe MORARU, PhD in Agricultural Sciences at the Institute of Plant Protection and Ecological Agriculture of the Academy of Sciences, the Republic of Moldova, with great possibilities for valorification in human alimentation.

By combining words Sorghum (sorghum) and Oryzoidum (rice), this hybrid was called "soryz". The quality of these beans was very much appreciated by the most important specialized institutes, in Odessa and Moscow. Croup obtained from soryz had a protein content of around 10 %, (up there a 3.0 -4.0 % than rice, fat – 0.2 - 0.5 %, starch – 82-85 %). From the grain were obtained about 75-80% of

croup of the highest quality (Moraru, 2008).
From the soryz there can be obtained not only croups, but also flour, which can be successfully used for making pastry products, cakes (Siminiuc et al., 2011). Percentage distribution of protein fractions in soryz and its derivatives directly influence their technological properties. Protein fractions were determined in grain sorghum and other cereals, but the results show a high variability of their composition (Table 1).

Table 1. Average percentage distribution of protein fractions in grains

Fractions	Sorghum	Wheat	Rice	Corn	Rye	Oat	Barley
Albumins+ globulins	17.4-6.0	18.0	18.0	16.0	20.0	50.0	22.0
Prolamins	25.2-55.0	42.0	7.0	44.0	40.0	15.0	41.0
Glutelins	39.7-39.0	40.0	75.0	40.0	40.0	35.0	37.0

Source: FAO. 1995. Le sorgho et les mils dans la nutrition humaine.

The purpose of this study was to research the fractional composition of proteins in whole soryz grains and hulled soryz grains and amendments there to under the influence of de-hulling and heat treatment.

Materials and methods

The following research materials were used:

- Whole soryz grains and hulled soryz grains „Alimentar 1" purchased at the Institute of Plant Protection and Ecological Agriculture of the Academy of Sciences of Moldova;
- Whole soryz grains cooked in distilled water until full penetration (for about 120 min at 100°C, 1 part of soryz : 5 parts of water);
- Whole soryz grains cooked in distilled water until full penetration (for 80-90 min, at 100°C, 1 part of soryz : 4 parts of water), after a preliminary soaking of beans for 8 hours in distilled water (at 18-20°C);
- Hulled soryz grains cooked in distilled water for 35-45 min (at 100°C, 1 part of soryz : 3 parts of water).

In order to determine of protein fractions the methods presented in Table 2 were used.

Results and discussion

In Table 3 are presented experimental data on proteins content in whole soryz grains and hulled soryz grains before and after hydrothermal treatment.
From data presented we can see that the hydrothermal treatment affects less the protein content in whole grains and hulled soryz. Thus, the protein content in soryz beans after boiling decreased by 0.17 %, and in cooked soryz beans after hydration - by 1.23 %. Protein loss as a result of hydrothermal treatment was somewhat

higher in hulled soryz – 2.72 %. This can be explained by a more intensive diffusion (Merlini, 1977) of soluble substances of hulled beans in relation to soryz beans as a result of removing the protective outer covering to obtain hulled soryz.
Cereal proteins are broadly classified into four fractions according to their solubility characteristics: albumin (water soluble), globulin (soluble in dilute salt solution), prolamin (soluble in alcohol) and glutelin (extractable in dilute alkali or acid solutions) (Calogero, 2005).
In Table 4 are presented the experimental data on protein fraction content whole soryz grains and hulled soryz grains and subjected to hydrothermal treatment.

Table 2. Methods used for determining the analyzed indices

The indices determined	Method of analysis according to
Dry matter	GOST 5900-73
Protein	Kjelldal (total nitrogen conversion factor of protein equal to 5.75 - mean average nitrogen conversion factor for grain) (Ermakov, 1987).
Protein fractions (albumins, globulins, prolamins, glutelins)	Differences in solubility in various solvents. For the extraction of albumins and globulins was used solution KCl-0.5M, prolamins - ethylic alcohol (80°) heated to 70°C, globulins - alkaline solution NaOH-0.2%. Proteins were separated by centrifugation and determined by the Kjelldal method (Ermakov, 1987)

Table 3. Protein content in soryz samples (g/100g d.m.)

Samples	Whole grains	Hulled soryz	Boiling grains	Boiling soryz beans after hydration	Boiling hulled soryz
Proteins, %	13.13	12.88	12.96	11.9	10.16
Dry matter, %	87.6	87.2	29.4	33.6	21.0

Table 4. Distribution of protein fractions in soryz

Sample	Albumins	Globulins	Prolamins	Glutelins	Residues
	%, of total protein				
Whole soryz grains	6.7	7.3	56.0	22.4	7.6
Boiling whole soryz grains	1.8	4.5	59.2	10,5	24.0
Boiling whole soryz grains after hydration	1.6	5.82	60.7	8.8	23.1
Hulled soryz grains	4.3	9.55	57.9	22.8	5.4
Boiling hulled soryz grains	0.5	5.22	60.1	10.3	23.9

Albumins and globulins content in whole soryz grains reaches 14.0 % of the total proteins. These results are comparable to cereals frequently used in food such as

wheat (17.0-18.0 %), sorghum and maize (6.0-17.4 %), rice - (8.0 to 18.0 %) (Siminiuc, 2007). The majority of the proteins fraction of whole soryz grains was represented by prolamins - 56 %, being close to their content in sorghum – 24.0-55.0 %, 40.0-42.0 % wheat and corn – 22.6-44.0 % (FAO, 1995).
Glutelins also after prolamins, showed a significant amount of protein of whole soryz grains – 22.4 % (Castro, 2004). In references are given values of their contents in these cereals such as: wheat, sorghum, corn and rice that contained ranging from 18.3 to 40,0%, 39.0 to 40.0 %, from 26.6 to 4.0 % and 60.1 % (FAO, 1995).
The fractional composition of proteins of hulled soryz grains was close to that of whole soryz grains. The hydrothermal treatment modified the fractional composition of proteins of whole soryz grains and hulled soryz grains. Thus, the content of albumin in whole soryz grains decreased from 6.7 % to 1.8 % in boiled whole soryz grains and 1.6 % - boiled whole soryz grains after hydration. Possibly, this can be explained by the distortion of the hydrosoluble protein fraction which results in a decreased solubility in water.
Globulins content, also, decreased from 7.3 % (whole soryz grains) to 4.5 % (boiled whole soryz grains) and 5.8 % (boiled whole soryz grains after hydration). The same as albumin, this can be explained by changes in solubility of this fraction results in treating thermal denaturation.
Prolamins content increased from 56.0 % (whole soryz grains) up to 59.2 % (boiled whole soryz grains) and 60.7 % (boiled whole soryz grains after hydration). Glutelins have become less representative in boiled whole soryz grains – 10.5 % and boiled whole soryz grains after hydration – 8.8 %, compared to the whole soryz grains – 22.4 %.
Insoluble proteins content after hydrothermal treatment increased from 7.6 % to 24.0 % - in whole soryz grains and 23.1 % - in boiled whole soryz grains after hydration. Thus, part of gluteline lost its solubility in alkaline solutions and became insoluble.
Quantitative modification of protein fraction in hulled soryz grains under the action of technological factors had the same trends as for whole soryz grains. Thus, albumin and globulin content in boiled hulled soryz grains down from 13.9 % to 5.7 % and prolamines increased from 57.9 % to 60.1 %. Glutelins presence in boiled hulled soryz grains was about two times lower compared to that in whole soryz grains, but that increased from 5.4% insoluble residues to 23.9 %.

Conclusions

Content and percentage distribution of protein fractions in whole soryz grains and hulled soryz grains do not differ essentially.
More than half of the total protein in the samples investigated were represented by prolamins.
Soryz decortication of whole soryz grains led to lower albumins content (by 2.4 %) and globulins content (by 2.25 %) and for prolamines and glutelines changes were insignificant.
Hydrothermal treatment of whole soryz grains and hulled soryz grains led to lower

albumins content (by 4.9 % for whole soryz grains and 3.8 % for hulled soryz grains), globulins (by 2.8 % for whole soryz grains and 4.3 % for hulled soryz grains) of glutelins (approximately 12.0 % both for whole soryz grains and hulled soryz grains), but for prolamins there was a slight increase (by 4.7 % for whole soryz grains and 3.8 % for hulled soryz grains).

Hydration preliminary to whole soryz grains growth leads to non-essential globulins content (by 1.3 %) and prolamins (by 1.5 %) than those boiled without preliminary hydration and slightly decreasing glutelins content (by 18 %), changes in albumins are insignificant.

Shelling resulted in protein residues decreasing (2.2 %) and hydrothermal treatment increased their content (by 15.5 to 16.4 %) for whole soryz grains (by 18.5 %) for hulled soryz grains, which can be explained by the loss of proteins solubility under the action of high temperature.

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