STUDIES ON THE PROCESS OF SORIZ MALT OBTAINING

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Abstract

The production of new functional food ingredients based on the whole grains responds to the recent dietary recommendations of increasing whole grains' daily consumption. Sorghum Oryzoidum (soryz) is a sorghum hybrid obtained in Moldova. The nutrients' composition and the presence of anti-nutritional factors determine Soryz grains' nutritional quality. Germination of cereal grains is a way of nutritional quality improvement. The main outcomes of germination are the production of various enzymes capable of degrading the grain macromolecules into soluble compounds, the reduction of anti-nutritional factors and the increase of the anti-oxidant capacity. The present paper deals with the study of soryz grains steeping and germination the processes.

Keywords: *soryz, steeping, germination, malting.*

Introduction

Germination of cereal grains is a complex biological process involving a wide range of biochemical and physiological reactions. Germination can be used to improve cereals' nutritional value and texture. Malting represents a controlled germination of cereal grains. This process consists of three stages: steeping, germination and drying [1-5]. During the steeping stage the moisture content of the grains is increased gradually alternating immersion and air rest periods up to different levels, characteristic for each culture: barley (43-46%), wheat (37-38%). Grains germinate further under humid and aerobic conditions at 16-20°C for 4…6 days. The last stage of the germination process is drying. At this stage the grains are dried for about 24 hours at proportionally increased temperatures along with the humidity level reduction till 3-4%. Drying stops biochemical reactions and ensures microbiological stability of the product. The malt can be processed further into ingredients for a large scale of applications in food industry. Traditionally the malt is a principal ingredient in beer production and a material for distilled spirits production. At present the malt utilization extended to dairy products, bread, snacks and other food applications. The present paper deals with the study of steeping and germination processes of a new and perspective cereal for the food industry – Sorghum Oryzoidum or soryz in view of its further larger utilization in food industry.

Experimental

Sorghum Oryzoidum or soryz is a new annual cereal of hybrid origin obtained in the Republic of Moldova by the stepped crossbreding of the yellow sorghum grains pattern with flour-like endosperm consistency and Sudan plant and savage varieties of sorghum.

Grains of Sorghum Oryzoidum – Piscevoi-1 cultivar, 2005-year harvest from Cahul, yellow color, humidity – 6.7%.

Wheat grains - 2005-year harvest were used as a refernce in the study, humidity – 13.8%.

Standard physical, physioco-chemical and biochemical methods were used in the evaluation of germination process' parameters.

β-amylase activity was determined on the basis of total quantity of formed maltose in 100 g of malt extract during 30 minutes at the temperature of 20°C.

Carbohydrates content in cereal grains and the dynamics of their metabolization throughout the germination process was determined by cyanide method.

Fat content was determined by Soxhlet method based on lipids' solubilization and extraction from grains with organic solvents.

Humidity content was determined by drying in the oven till the constant weight at the temperature of 105°C.

Total acidity aws determined by titration with 0,1 n NaOH solution in the presence of colour indicator.

Measurement of hidrogen ions concentration in the liquid was made with the pH-meter pH-150MA and combined electrod ЭСК – 10603.

Germination energy and capacity were determined by counting the total number of germinated grains in the batch at the 3rd and 5th days of germination: germination energy represents the percent of germinated grains in 3 days, germination capacity represents the percent of germinated grains in 5 days.

Results and Discussion

Technologiacl aspects of soriz grains malting

Soryz grains malting was carried out according to the technological scheme presented in the figure 1:

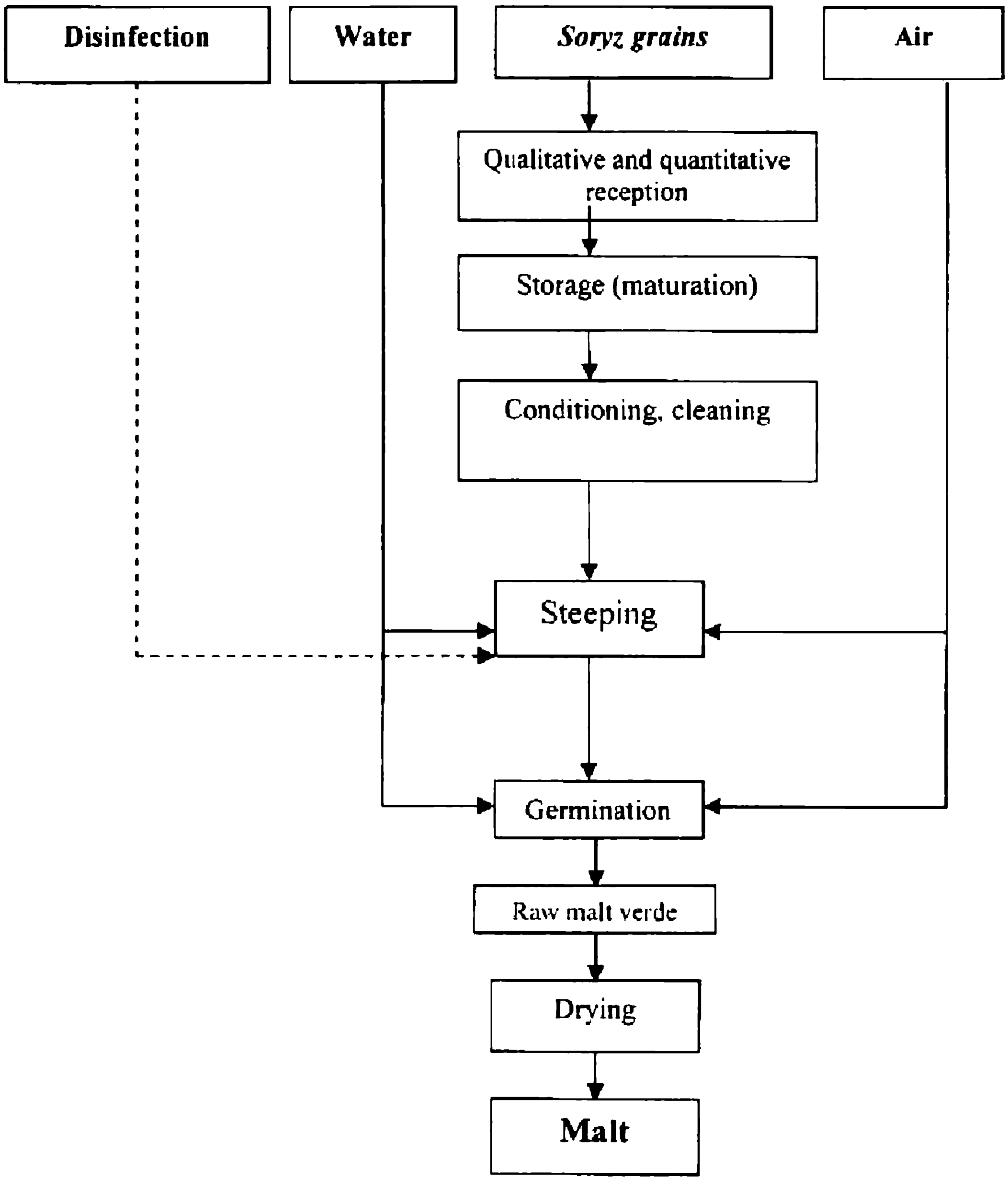


Fig. 1: Technological scheme of soryz malt obtaining

The harvested soryz is storaged for a minimal period of 3...9 weeks for maturation. Over this period grains are in a germination pause. At the end of maturation period grains reach the maximal germination energy and leave the germination pause. The grains conditioning consists of grains cleaning of impurities and dust and their categorizing by dimensions that ensure the obtaining of an homogenious quality malt.

Soryz steeping was made in several steps:

- *Washing* with water at the temperature 12°C. By washing and water agitation with compressed air, dust and flottant grains are removed.
- *Disinfection* was made with 0,25% $KMnO_4$ solution during 2 hours with water at 12...15°C by treating the grains bulk with ejected air. After desinfection solution removal one additional cleaning was made with clean water.
- *First wet steepng*. Grains are covered with 12°C water. The water level is 1,5- 2 cm higher than grains level. Wet steeing lasts 2 hours with air bubbling during 10-15 minutes each hour. Oxigen provision is essential for soryz grains' viability during steeping. Grains' humidity increase during the first steeping from 6,7% pînă la 24,2%. After 2 hours, steeping water is removed and dry steeping occur.
- *Dry steeping* lasts 15 hours with periodical watering and covering grains with humified paper, time the soryz humidity spreads uniformly in the bulk and reaches the value of 23,6 %.
- *Second wet steeping* lasts 4 hours. Grains are covered with water with temperature of 15°C and are bubbled with compressed air. Humidity increases till 28,65%.
- It followed another operation of *dry steeping that lasts* 15 hours. Soryz grains humidity reached 28,36%.
- *Third wet steeping* is done for 4 hours with 15°C temperature water. Humidity increases till 31,54%.
- It followed a new dry steeping for 24 hours. Humidity in the grains reaches 32,15%.
- It was performed the *forth wet steeping* for 2 hours with water at the temperature 17°C.
- During the last *dry steeping* the soryz grains reach saturation point corresponding to 37,8% of humidity. The proper germination starts and the humidity is completed by watering till the optimal value of 44,95%.

The total duration of soryz grains' steeping was 72-76 hours.

Grains' germination was performed in a 3-5 cm uniform layer at 15...18°C when vital functions of the raw malt and the enzymes' production occur slower and the development of rootlets and sprouting occur proportionally with the solubilization process. The air is cooling down the layer of raw malt and is deleting the accumulated CO_2. In the 7[th] day the sprouts reaches 3 mm and germination process is halted by drying.

Grains humidity changes at different malting stages are ilustrated in the steeping diagramm presented in the figure 2.

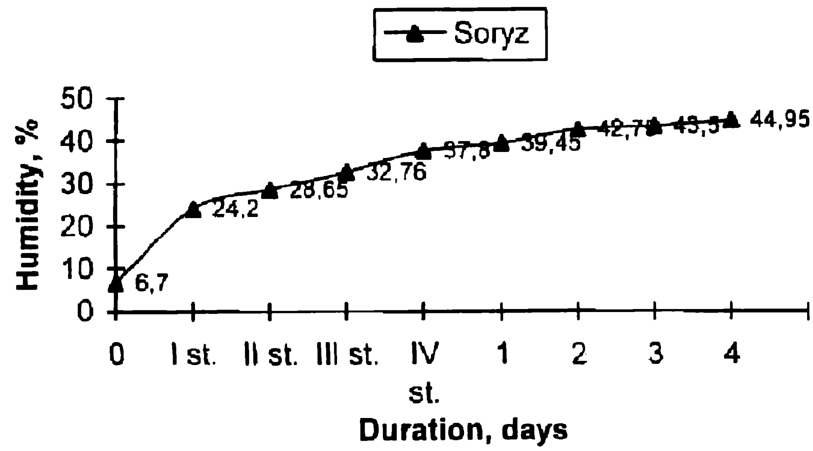
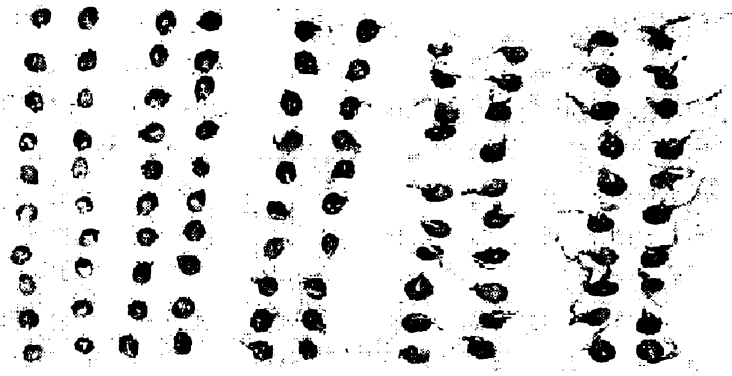


Fig. 2: Soryz grains' steeping curve and humidity modification during germination

The data in the fig. 2 reflets the increrase of grains humidity during steeping from 6,7% to 37,8%. Water absorption is maximale during the first hours, the rate reducing gradually till the saturation point of 37,8% is reached. During the dry steeping the increase of humidity is not significant – from 24,2% to 25,6% (during the first dry steeping), the humidity homogeneisation in all grains takes place. During the second wet steeping of 2 hours, the humidity increases more slowly that in the first period of steeping. After the 15 hours second wet steeping the humidity reaches 28,65%. At the end of the 3rd wet and dry steeping the final humidity reaches the value of 32,76%. By sensorial test (squizing, pressing the grains) it is determined that the steeping is not sufficiently done. Therefore soriz grains were addittionally submitted to wer steeping with the water at 15°C for 2 hours, the humidity reaching the value of 37,8%. După a patra înmuiere începe procesul de germinare şi umiditatea boabelor este menţinută prin stropire. During the following 3-4 days of germination it occurs the absorption of a sufficient quantity of water from 7,8% to 44,95%. In the fig. 3 are presented the pictures of native and germinated soryz grains.

The study of humidity modification dynamics in soryz and wheat grains during the germination show some particularities for each of these two cereals. The steeping process in soryz grains occur more difficult due to the hardness of grains. Wheat grains have higher absorption capacity.



a) b) c) d) e)

Fig. 3: Soryz grains: a) initial native, b) 1st days of germination, c) 2nd day of germination, d) 3rd day of germination, e) 4th day of germination

This is why in soryz case was made one more steeping with higher temperature of water (15-18 ^{0}C). At the beginning of germ's vital activity at the basis of the grain appear the rootlet. In wheat it is splitting into 2 – 3 thin rootlets, and in soriz grains appear only one better developed rootlet with a spirale form. In wheat the rootlet appear after the first steeping, and in soriz grains – after the third one since the maturity degree corresponding to germ development was not reached yet. The humidity saturation point is less in soryz (37,8%) that in wheat (39,05%). Generally, the maximal water absorption was registered within the first 8 hours.

The main challenges of the steeping process is the optimal conditions choosing so that on one hand, the grains reach an appropriate degree of humidity in a shorter time, and on the other hand, avoiding the early germination that would degenerate the process by the formation of indesirable secondary products and germ suffocation.

Other malting steps, such as drying, conditioning and the storage do not differ, are similar for the both cereals. Germinated grains are easily perisable due to a high humidity content. The most secure method of their preservation is the protective drying with warm air. The water removal from the malt is performed in the oven by graduall water transfer from grains' interior toward the surface. The drying process of the germinated soriz consists of the following stages:

- Drying at 35...40°C during 24 hours. The humidity decreases from 42-47% to 20%;

- Drying at 55...60°C, during 10 hours up to the humidity of 5%;
- Soriz malt conditioning is performed by its cooling up to 20°C for enzymes inactivation, malt colour enhansing and removal of rootlets that become fragil after drying. Rootlets removal is necessary since they have a bitter taste and are hygroscopic and contribute to water absorption after drying. The removed rootlets 3.5-5% out of the weight of thr dryed malt.

During malt storage a slight increase in the humidity level by 1% occurs that influences positively the state of protective colloids of hemicellulose nature. The period of malt storage for maturation is minimum 4 weeks and is done in dried and clean silages. Malt is storaged at 15-20 °C. Under favourable storage conditions the malt could be preserved for 1-2 years without important quality changes [1].

The obtained malt from soriz and wheat have the following sensorial indices:

Appearance - uniformly dried, without molds, bright grains;

Colour – from light yellow till brown, without green and dark hues caused by moldes;

Smelt - specific to germinated cereals, slighltly acid. it is excluded molded smelt.

Physico-chemical changes at soryz grains' germination

In order to characterize the germination process, a number of indices were determined for native soryz and wheat grains and over the germination period, such as the humidity, lipids, carbohydrates' content, total acidity, active acidity, anti-nutritional factors (phytates and tanins), beta-amylase activity, green substance, germination energy and capacity. The results of investigations are presented in the tables 1,2.

During germination simple sugars can be transformed into the compelx ones and vice-versa. When analysing the starch content modification over the germination period, it is noticeable a more sharp decrease occurs in the first days of germination and more slow one in the next days. The starch content decrease is higher in wheat (from 56,31% D.M. to 40.00 % SU) that in soriz (58% D.M. to 45% D.M.), that might be explained with higher initial β-amylase activity. Concerning the sugars, the sacharose content is decreasing and the content of reducing sugars is inrecasing. In the case of soriz the saccharose is more rapidly consumed for breathing during the first days of germination.

Table 1: Physico-chemical changes in soryz grains over germination process

Physico-chemical indices	Native whole grains	Germination period, days						
		1	2	3	4	5	6	7
Humidity, %	6.7	24.20	32.15	37.8	39.45	42.75	43.50	44.95
Lipids ,%	0,79	-	-	-	-	-	-	0.56
Carbohydtares, %D.M., including:								
- starch	58,0	55.8	53.0	52,6	52.0	50.0	47.0	45.0
- saccharose	0,046	traces	traces	traces	traces	traces	traces	traces
- reducing sugars	0,38	0.40	0.30	0.25	0.14	0.18	0.25	0,62
Total acidity, ⁰	1,67	1,45	1.89	4,29	4.84	4.90	4.95	5.50
Active acidity (pH)	6.36	6,63	6.57	6.22	6,21	6,25	6.07	5.82
Phytates content, mg%	1,10	0.85	0,85	0.85	0.70	0.55	0,50	0.45
Tanins, mg%	0.20	0,10	0,08	0.06	0,01	0.06	0.04	0,04
Germination energy, %	-	-	-	70	-	-	-	-
Germination capacity, %	-	-	-	-	-	72	-	-
Green substance, %	-	-	-	0.07	0.08	6.10	8.90	12.90
β-amylase activity, mg/100g	15							223

Table 2: Physico-chemical changes in wheat grains over germination process

Physico-chemical indices	Native whole grains	Germination period, days						
		1	2	3	4	5	6	7
Humidity, %	13,8	25,4	39,05	43,6	45,8	48,0	46,7	45,5
Lipids ,%	0,97	-	-	-	-	-	-	0,45
Carbohydtares, %D.M., including:								
- starch	56,31	48	47,8	46,7	45	44,4	41,18	40
- saccharose	0,276	0,2	0,17	0,09	traces	traces	traces	traces
- reducing sugars	0,6	0,75	0,94	1,00	1,01	1,06	0,85	0,56
Total acidity, ⁰	1,67	1,45	1.89	4,29	4,84	4,9	4,95	4,9
Active acidity (pH)	6,25	6,24	6,12	6,085	5,92	5,92	5,85	5,88
Phytates content, mg%	0,95	0,80	0.70	0,70	0,65	0,45	0,40	0,35
Tanins, mg%	0,2	0,1	0,1	0,05	0,01	-	0,04	0,04
Germination energy, %	-	-	-	82	-	-	-	-
Germination capacity, %	-	-	-	-	-	86	-	-
Green substance, %	-	-	-	3,8	6,1	9,2	13,6	19,65
β-amylase activity, mg/100g	24							164

The content of lipids in germinating grains decreases generally: in soryz – from 0,79 to 0,56%, and in wheat – from 0,97 to 0,45%. During germination part of lipids is consumed in breathing process and celullar metabolism. Partially lipids are hydrolised in glycerides and fat acids.

The total acidity of soriz and wheat grains increases during germination, that confirms the cereals macronutrients' (proteins, lipids) metabolization. Another important source of acidity increasing are phosphates and phytates, that form under enzymes' influence the phosphoric acid and also the organic acids' formation at the nitrogen substances and phosphates' decomposition.

The active acidity of soryz and wheat malt varies from day to day. The increase in pH value proves that within the grains profound chemical and biochemical changes take place. Oscilatory character of pH value change could be explained by the different intensity of hydrolisis and breathing processes in germinating grains.

The germination process is accompanied by an important reduction of phytates and tanins content, especially after the 4th days of germination. This could be explained by the optimal pH-value of endogeneous phytase activity – pH 4,0-6,0. Thus the reduction of phytates content starts in the 4th day when the active acidity within the grains approaches the optimal values. The initial content of phytates reduce by the 7th day of germination by about 60%. The germination process reduces also considerably by 80% the tanins content by the end of germination.

Due to high biological value comditioned by modifications occured within the grains during the germination (higher availability of essential amino-acids, vitamins, minerals, the presence of fibers, enzymes, lower content of anti-nutritionla factors and higher anti-oxidant activity), soriz malt can be processed in flakes, grits, flour, malt extracts and used as ingredient in food industry, including the dairy products [6].

Conclusion

The results of present paper proved the processability of the new cereal - Sorghum Oryzoidum or soriz, through the germination process, into the malt for the purpose of its utilization as an ingredient in food industry. Further investigations are needed to study the optimal conditions in terms of temperature, steeping regime, germination duration and exempting the molding processes for obtaining a high quality malt and its application in a variety of agro-indistrial foods.

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