Research Journal of Applied Sciences 10 (9): 501-504, 2015
ISSN: 1815-932X

Sweet Sorghum Use in the Production of Alcohol

Erik B. Askarbekov and Gulgaisha I. Baygazieva
Almaty Technological University, Almaty, Kazakhstan

Abstract: The study describes the results of using sweet sorghum in the production of alcohol. The juice of sweet sorghum besides sucrose contained largely glucose and soluble starch that prevents crystallization. Therefore, from the sorghum juice not produce crystalline powdered sugar, sorghum and honey and molasses, have nutritional value, due to the high content of glucose. That is why, the relevance of the use of sweet sorghum syrup is greatly increased. The good organoleptic properties, the absence of methanol, higher alcohols moderate content in sorghum distillate allow to recommend it for quality of spirits of the developed technology.

Key words: Sorghum, sorghum stalks, juice from sorghum stalks, alcohol, distillate

INTRODUCTION

In world agriculture sorghum has over 30 million ha. In Russia, sorghum is cultivated on the area about 100 thousand ha. Exclusively high drought resistance and productivity do this culture very perspective for cultivation in droughty areas.

Considering that now sorghum is used in three main directions: the food industry, a forage production and bioenergetics, interest to this culture is huge. Due to environmental degradation and climate change, weather conditions, sorghum can be cultivated in the Southern droughty areas where it is impossible or unprofitable to grow up sugar beet, therefore, interest to sweet sorghum is indisputable. Thanks to it sorghum can compete with corn and sugar beet.

Sorghum is one of the most profitable cultures in the green conveyor. First, its crops grow till the 1st of July when the drought begins and plants have ability to grow intensively after bevelling, they give on the non-irrigation lands 2-3 and on irrigated to 4 hay crops of green mass with productivity, respectively 400-500 and 1000-1500 centners from hectare. Secondly, the norm of seeding of sorghum seeds is 3-4 times less than corn and the price of seeds the identical. Thirdly, at using grades and hybrids of sorghum cultures of various groups of ripeness and different sowing time is reached the guaranteed provision of forages in specifically planned terms and in necessary quantities. Costs for crops and harvesting decrease, there we can say: "Once seeded, it is possible to harvest the whole summer, having carried out some hay crops".

As a part of sweet sorghum syrups there are compounded the digestible microelements and vitamins which are no in sugar of beet and a reed. The sweet sorghum contains sucrose, fructose, glucose, Ca, P, Mg, K, Na, Cu, Zn, Co, Mn, Fe, S, a protein, all essential amino acids, B1, B2, PP, E and C vitamins. These factors do sugar from sorghum unique and remind on the metabolic influence of human as Biologically Active Additive (BAA) or honey (Isakov, 1992).

MATERIALS AND METHODS

Objects and methods of researches: For implementation of research work was used syrup from the Kazakh grades of sorghum, cultivated in Almaty Area: Kazakh 16 and Kazakh 20 and races of alcohol yeast.

The analysis of quality indicators of samples of sorghum grains and sorghum juice was carried out with use of the standard techniques of the analysis of quality indicators of grain crops and sacchariferous juice.

Quality identification of sorghum seeds was carried out according to state standard 3040-55 "Grain. Methods of quality identification" (Likhtenberg, 2001).

Nature of sorghum grains was identified according to state standard 10840-64 "Grain. Methods of nature identification" (Telikh, 2004).

Total 1000 grains mass was calculated in accordance with state standard 10842-89 "Grain. Grain crops and black crops, oilseeds. Methods of identification of 1000 grain mass or 1000 seeds".

Acidity was identified in accordance with state standard 10844-74 "Grain. Techniques of identification of acidity by the mix". Juice from stalks of sorghum was received by a pressing method.

The content identification of total sugar in sorghum juice was carried out on the manual refractometer of ATAGO brand (Japan).

Corresponding Author: Erik B. Askarbekov, Almaty Technological University, Almaty, Kazakhstan

As the decolorizing powders, it was investigated the samples of absorbent carbon of various brands and producers: NORIT GB1 ULTRA 0645-8 (Netherlands); NORIT DX ULTRA 8014.0 (Netherlands); Chinese production; Kaskelen town productions and Kieselguhr filter powders, perlite and radio litas (Russian production).

The decolorizing substances were investigated on indicators: dispersion, pH, the decolorizing ability and there was identified the effect of discoloration at their use. Applied filtering materials in research were estimated on dispersion, pH, the filtering ability and ratio (effect) of cleaning.

In juice from various sorghum grades, used in work (Kazakh 16 and Kazakh 20), there was identified the mineral structure by the ion-selective method and amino-acid structure by method of a capillary electrophoresis with use of system of a capillary electrophoresis "Kapell" (technique of M-04-38-2009).

The analysis of quality indicators of samples of sorghum juice was carried out with use of the standard techniques of the analysis of quality indicators of sacchariferous juice according to the content of solids, sucrose, acidity, purity (Alabushev, 2003).

RESULTS AND DISCUSSION

The research tasks were receiving ethyl alcohol from juice of sweet sorghum with application of yeast strain Fermentis Red Ethanol. Novelty of work was in development of resource-saving technology and in the capacity of a source there were used the sorghum sugars stalks.

For production of juice from sorghum stalks, sugar plants (elevated part) were gathered in milky-wax ripeness of grain. After stalk cleaning of the main and suckers from leaves, there was weighed and cut on the separate pieces from which right there were got a juice under a press with rollers. The received juice was filtered and evaporated on one-hotplate electric cooker to a condition of 75% density.

There was developed the technological scheme (presented in Fig. 1) for production of juice from stalks of sweet sorghum of the Kazakh grades which includes stages of harvesting (cut) of sorghum stalks; their cleaning of leaves and panicles; short-term storage; pressing and a filtration of the received juice. As a result of processing of green mass of sorghum plant, it was produced a juice with yellowish-greenish color with unusual specific aroma. Development of technology of sorghum juice production.

Among quality indicators of sorghum juice, there was determined the content of general sugar in juice which depending on degree of ripeness and storage conditions changed from 16-29%.

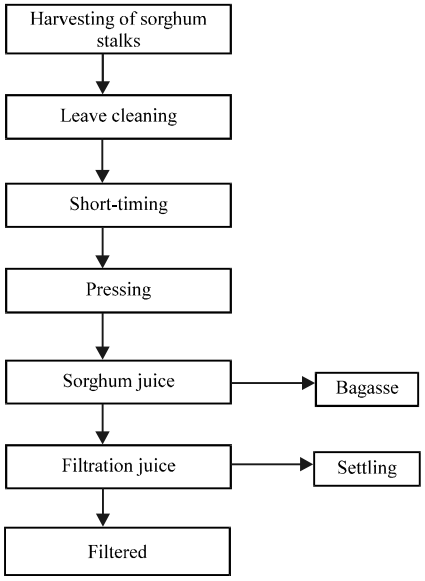

Fig. 1: Technological scheme of sorghum juice production

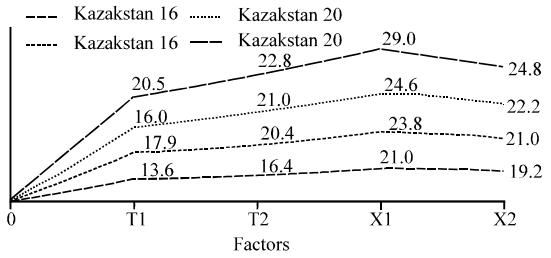

Fig. 2: Change of sucrose content in stalks of sweet sorghum of domestic grades in the process of cultivation

The juice coefficient was determined as a result of experiment: the juice quantity, received by pressing in relation to the mass of stalks of sorghum from which juice was squeezed out.

Depending on a condition of ripeness and used type of a press, it is established value of juice coefficient, fluctuating in the range from 0.80-0.85.

The received juice was filtered and evaporated on slow fire to a syrup state with 65% density. Syrup (wort) in such state is stored for a long time. The chemical composition of sorghum wort is presented in Table 1.

Observation over change of the sucrose content in stalks of sweet sorghum in the process of cultivation was made at stages of milky and wax ripeness. The received results are given in Fig. 2.

Mathematical treatment of results of sucrose change content in the process of cultivation and storage of

Table 1: The chemical composition of sorghum wort

Indicators of composition	Sugar content (100 g cm^{-3}) Refractometric	According to Bertran with inversion	According to Bertran without inversion	Specific weight (g dm^{-3})	Titrable acids* (g dm^{-3})
Kazakhstan 16	14.2	11.6	9.1	1,0625	4.0
Kazakhstan 20	14.8	13.6	8.7	1,0640	4.0

sorghum stalks was carried out taking into account the given factors and criteria below: Factors X1: Air temperature,°C; Criteria T1: Milky ripeness.

Regularity of change of sucrose content in the Kazakhstan grades of sorghum "Kazakhstan 16 and Kazakhstan 20" was established during researches depending on storage conditions. It was determined the content of sucrose in sorghum stalks in lactic phase, waxy and full ripeness phases. It is revealed that the content of sucrose in a grade "Kazakhstan 16" is less on 7.0-9.4% in comparison with the content of sucrose in a grade "Kazakhstan 20". At the analysis of the content of sucrose in internodes, it was noted the highest content of sucrose in 5-7 internodes in a grade "Kazakhstan 20 and Kazakhstan 16". At the analysis of the content of sucrose in various stages of ripeness, the content of sucrose at the transition stage to waxy and at stage of full waxy ripeness reaches a maximum level. It was established decrease in the content of the general sugar at full ripeness. Thus, the maximum content of sucrose of grade "Kazakhstan 16" was 16.8% and "Kazakhstan 20" grade had 29.0%.

Syrup fermentation and receiving ethyl alcohol: For receiving ethyl alcohol from the received syrup there was prepared a fermented substratum with a density 16-18% and pH 5.0. Fermentation was carried out in the thermostat at 29-30°C by dry yeast (*Saccharomyces cerevisiae*) of Fermentis "Ethanol Red" firm which are specially selected strains, developed for industrial production of ethanol (Efremova, 2012). With high tolerant properties, this high-speed strain sustains higher concentration of alcohol and sustains high viability of cells especially during the beginning of fermentation. There was added 15 g dry yeast to sorghum sugar wort with volume 500 mL.

Process of fermentation made 72-78 h. The received fermented wort was distiled to distillation on the distiller for alcohol-containing liquids. The main admixtures accompanying ethyl alcohol after distillation of wort were determined on the gas-liquid chromatograph There were got the following obtained data as a result:

- Strength of ethyl alcohol is 91.53%
- Mass concentration of aldehydes 9.0 mg cm^{-3}
- Mass concentration of methyl alcohol 0.003%
- Mass concentration of average ether 7.0/100 mg cm^{-3}
- Mass concentration of the highest alcohols 14.0/100 mg cm^{-3}

Results were showed that most of all from admixtures there are esters, aldehydes and the highest alcohols. The average fraction of sorghum alcohol as well as sorghum material is different in the low content of methanol. The increased value of the sum of ethers is caused by the high content of the ethyl acetate which is the defining component. Possibly, it can be explained by the intensive proceeding processes of etherification during distillation. Its maximum quantity was recorded in first running fractions which in process of distillation tended to decrease. Also, it was noted substantial increase of concentration of the highest alcohols from the provided data.

The organoleptic analysis showed that sorghum alcohol had no special differences from grain alcohols. Thus, it is proved the possibility of production of ethyl alcohol from sorghum syrup by fermentation according to the scheme: biomass of sorghum stalks, juice, syrup, ethyl alcohol. There are defined optimum pH and ratios of yeast cells to a substratum at fermentation and receiving ethyl alcohol.

Good organoleptic properties, low presence of methanol, the moderate content of the highest alcohols in sorghum distillate, allow recommending it for production in the food industry.

CONCLUSION

Thus, as a result of the analysis and generalization of the obtained experimental data, it was developed the technology of production ethyl alcohol from syrup of sorghum stalks of Kazakh grades with the high content of soluble sugars (15-16%), including production juice, its evaporation to density of 65-70%, fermentation by the dry yeast (*Saccharomyces cerevisiae*) of Ferments "Ethanol Red" at a temperature of 29-30°C, pH 5.0, distillation of fermented wort.

Good organoleptic properties, low presence of methanol, the moderate content of the highest alcohols in sorghum distillate, allow recommending it for production of ethyl alcohol.

REFERENCES

Alabushev, A.V., 2003. Sorghum (Selection, Seed Farming, Technology, Economy). L.N. Anipenko, N.G. Gursky and N.Ya. Kolomiyets (Eds.), Rostov-on-Don: "Kniga" JSC, pp: 368.

Efremova, E.N., 2012. Sweet Sorghum Reserve Culture for Production of Sugar. E.N. Efremova, (Eds.). Development of Innovative Activity in Agrarian and Industrial Complex of the Region: Materials of the International Scientific and Practical Conference. A.M. Zubakhin (Eds.). Barnaul: AZBUKA, pp: 137-140.

Isakov, Ya.I., 1992. Possibilities of Sweet sorghum. Agriculture of Russia, 5: 46-48.

Likhtenberg, L.A., 2001. Influence of Processing Methods on Quality of Alcohol. Production of Alcohol and Alcoholic Beverage Products, 2: 28-29.

Telikh, K.M., 2004. Sorghum in Tula region. Corn and Sorghum, 5 (1): 18-20.