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PRODUCTION OF ETHANOL FROM KANTATA WHEAT VARIETY

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Processing parameters of KANTATA wheat variety indicate that it is not suitable for bread making. Therefore, an investigation was carried out to evaluate the suitability of the variety for ethanol production. Wheat was cultivated at the following sites: Kovin, Zrenjanin, Pančevo and Vrbas. Ethanol yields depend on the location on which the samples were grown and on the temperature during thermal and enzymatic preparation of flour samples. Wheat sample cultivated on the Vrbas site gave the highest ethanol yield.

KEYWORDS: Ethanol; wheat; ethanol yield; enzyme

INTRODUCTION

Ethanol has been widely used as fuel, antiseptic, solvent, preservative, substrate for the production of other organic compounds, etc (1). Production of ethanol as a substitute for fossil fuels (i.e. additive to gasoline up to 15%) has been expanding (2). Ethanol produced from biomass (bioethanol) accounts for 60% of the total world's ethanol production, while 30-35% of ethanol is derived from petroleum (3). Ethanol production relying on the fermentation processes is based on carbohydrate rich raw materials (4). Starch-based crops (rye, wheat, buckwheat, oat, maize, millet, rice, triticale) and other carbohydrate sources (potato, topinambur, sorghum) have been used as a raw material for the food industry and pharmacy (5). A number of studies have been carried out on the use of novel ingredients such as cellulosic materials, agricultural field residues, by-products of food and wood industry (6). Modern technologies enable complex converting of cereal materials to ethanol, providing high yields of ethanol, high quality feed (adding new value to the raw material, i.e. gluten), energy, and high-value biological fertilizers (7, 8).

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In Europe, food-grade as well as fuel ethanol production is based on wheat. Wheat-based ethanol production involves enzymatic degradation of starch to glucose, and glucose fermentation with yeasts such as *Saccharomyces cerevisiae* (9). Beside wheat grain, wheat straw has a promising potential as a low-cost raw material. It contains a large amount of cellulose and hemicellulose (10). Even wheat bran could be used for ethanol production (6).

Wheat is a cost-effective raw material because of high yields and suitable composition of the grain. Loyce and Meynard (11) showed that the usage of low-cost cultivation techniques for wheat intended for ethanol production is possible compared to bread wheat. Processing quality of wheat depends on the complex activity of many factors, like genetic potential, cultivation techniques and environment. The present paper focuses on the possibility of using KANTATA wheat variety for ethanol production.

EXPERIMENTAL

Materials

Wheat. Bread making quality and suitability for ethanol production of KANTATA wheat variety, crop 2005, was assessed in the paper. Wheat flour from wheat cultivated at the following sites: Kovin, Zrenjanin, Pančevo and Vrbas was used in the experiment. Quality attributes of KANTATA variety, including rheology parameters and baking performance of flour were determined according to Kaluđerski and Filipović (12).

Enzymes. Two enzymes were used for starch hydrolysis:

- Termamyl 120L type S (Novozymes, Denemark) is a liquid concentrate of α-amylase. It was used to degrade starch from wheat substrate. The enzyme is heat stable at 90°C. The optimum temperature for this enzyme is 85-90°C.
- SAN Super 240L (Novozymes, Denemark) is a liquid concentrate of glucoamylase. It degrades dextrins to fermentative sugars. The optimum temperature for this enzyme is 55-60°C.

Producing microbial strain. As a producing microorganism, baker's yeast *Saccharomyces cerevisiae* from Budafok yeast factory, Lesaffre, Budapest was used (optimum working temperature 30-32°C). Fermentation was carried out at 28°C.

Methods

Determination of wheat-ethanol conversion factor. Fifty grams of ground wheat was mixed with 250 mL of water and 0,4 mL of Termamyl and placed in a Meischbath (Glasbläseire, Institut für Gärungs Gewerbe, Berlin). The temperature was maintained at 70°C with stirring for 30 min or 1 hour. The whole procedure was repeated at 80°C, 85°C and 90°C.

After cooling to 58-60°C, 0.1 mL of SAN saccharifying enzyme was added into the mixture. The mixture was kept at 60°C for 30 min. After this period the mixture was cooled to 30°C. The cooled content of the sample was quantitatively transferred to the Erlenmeyer flaks and inoculated with 5 g of well-stirred aqueous suspension of yeast. It was left to ferment for 72 h. Each day, the quantity of produced CO_2 was determined.

RESULTS AND DISCUSSION

In Table 1, are listed trading quality parameters of KANTATA variety grown at different location.

Table 1. Trading q uality of KANTATA wheat variety

No.	Location	Test weight (kg/hL)	1000 Kernel weight (g dm)*	Flour yield I_1 (%)	Protein content (% on dm*)	Sedimentation value according to JUS	Quality class according to JUS	Falling number(s)
1	Kovin	83.9	35.2	69.5	13.1	40	I	249
2	Zrenjanin	83.7	34.6	67.3	14.1	49	I	314
3	Pančevo	83.5	37.8	66.8	13	39	I	293
4	Vrbas	84.9	38.5	67.1	12.8	29	III	244
Average		**84**	**36.5**	**67.7**	**13.3**	**39.3**	**I**	**275**
Minimum		83.5	34.6	66.8	12.8	29	III	244
Maximum		84.9	38.5	69.5	14.1	49	I	314

* dm = dry matter

By analysi ng the individual samples of KANTATA across locations, a large variability in quality could be observed. Test weight was high, over 82 kg/hL. Kernel plumpness, measured by 1000 kernel mass varied by 4 g across localities; sample from Zrenjanin site was the lowest in this parameter but also showed highest protein quality and quantity (classified into the first quality class). Largest kernels in size were observed in the sample from Vrbas site, but the quality parameters (protein content and sedimentation value) classified it into the third quality class. Optimum value for falling number according to Hagberg is 250 s; lower values point to higher α-amylase activity. Samples collected from Kovin and Vrbas had lower value of this parameter. KANTATA showed excellent milling properties at the observed localities, similar to those required for bread varieties.

Table 2. Dough rheology properties obtained from KANTATA variety

No.	Location	Water absorption on 13 %moisure basis (%)	Quality number	Quality class	Extensigraph area (cm^2)	Resistance / Eyxten	Amylograph peak viscosity (BU)	Wet glutten content (%)	Dry gluten content (%)
1	Kovin	63.1	67.5	B1	39	1.2	330	32	12
2	Zrenjanin	63.3	75.6	A2	43	1.16	1050	32	11
3	Pančevo	62.7	68.8	B1	18	0.79	510	35	11
4	Vrbas	64.2	64.7	B1	34	1.06	220	30	10
Average		**63.3**	**69.2**	**B1**	**33.5**	**1.1**	**527.5**	**32.3**	**11**
Minimum		62.7	64.7	B1	18	0.79	220	30	10
Maximum		64.2	75.6	A2	43	1.2	1050	35	12

In Table 2, are presented rheology properties of dough obtained from KANTATA flour. Dough rheology quality estimated on farinograph varied from B_1 to A_2 quality subgroup. According to this parameter and high/dry gluten content, KANTATA could be graded positively but extensigraph parameters did not confirm this. Extensigraph area and ratio r/e (resistance/extensibility) are below the optimum value required for bakery industry (EA min 50 cm^2, r/e≈2.0).

In Table 3, is presented baking performance of flour obtained from KANTATA wheat variety.

Table 3. Baking performance of flour from KANTATA variety

No.	Location	Bread yield (g/100g flour)	Volume yield (cm3/100g flour)	Crumb Quality Number
1	Kovin	136.8	530	5.1
2	Zrenjanin	137.1	494	4.2
3	Pančevo	136.4	421	3.1
4	Vrbas	136.6	521	4.8
Average		**136.7**	**B1**	**4.3**
Minimum		136.4	B1	3.1
Maximum		137.1	A2	5.1

According to the bread volume yield and crumb quality number, KANTATA could be classified into each of the three quality classes (I-III) but the bread yield disqualified it, reaching a required level for bread varieties only at the Kovin site.

On the basis of the short survey of the processing quality of KANTATA variety observed on the samples taken from different sites it could be concluded that KANTATA belongs to the class of basic varieties and thus it was not suitable for bread making. This is the reason why KANTATA was considered for ethanol conversion.

Ethanol yield dependence on temperature for the samples from the observed localities are graphically presented in Fig. 1.

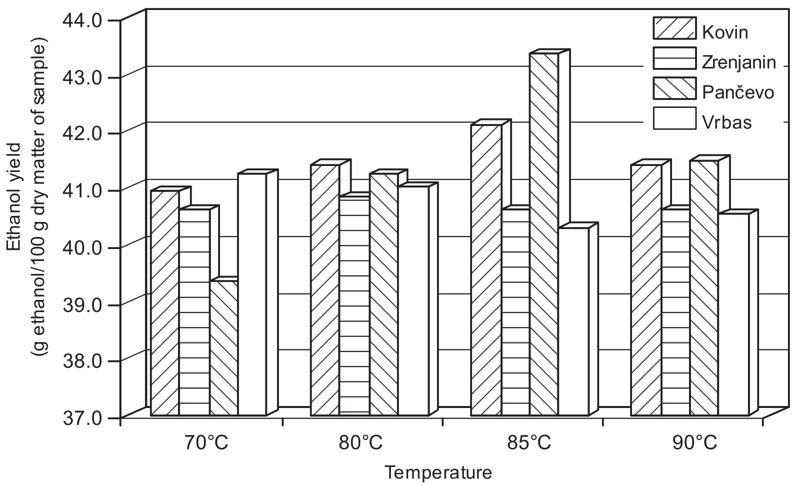

Fig. 1. Ethanol yield dependence on temperature and locations (preparation time 1 hour)

The observed data pointed out that the most favorable conditions for ethanol conversion were: 85°C and 1 hour of preparation for the samples from Kovin and Pančevo, 70°C for the samples from Vrbas (because of increased α-amylase activity of wheat origin in the samples – falling number less than 250 s), and 80°C for the sample from Zrenjanin.

Fig. 2 shows ethanol yields as a function of temperature for the locations and preparation time 30 minutes.

On the basis of ethanol yields obtained after thermal and enzymatic preparation of the flour samples during 30 minutes at different temperatures, it can be concluded that the preparation procedure at 70°C is not suitable because of a low ethanol yield for the majority of the locations. The highest yield was observed for the sample from Vrbas at 80°C (43.4 g/100 g dry matter). Preparation temperature of 85°C was suitable only for the sample from Zrenjanin while the other samples performed worse. The highest temperature, 90°C did not increase ethanol yields, thus its application is not justified because of high-energy consumption. The ethanol yields obtained in these investigations are in accordance with those obtained by Wesenberg (13).

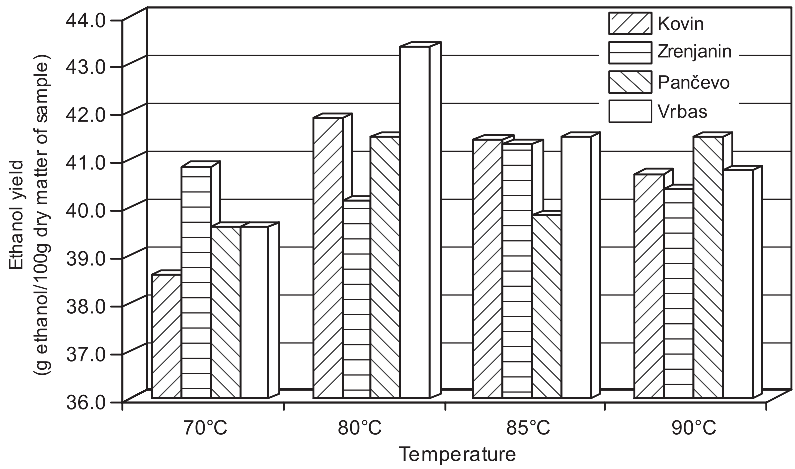

Fig. 2. Ethanol yield dependence on temperature and location (preparation time 30 minutes)

CONCLUSION

Processing parameters of KANTATA wheat variety indicate that this variety is not appropriate for bread making. Therefore, an investigation was carried out to evaluate its suitability for ethanol production.

Ethanol yields depend on the location from which the samples were taken and on the temperature during thermal and enzymatic preparation of flour samples. The highest ethanol yields were achieved when the preparation was conducted at 80°C for 30 min. Similar yields were achieved with sample from Pančevo at 85°C for 1 hour. Preparation procedure conducted at 90°C did not increase the ethanol yields.

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ПРОИЗВОДЊА ЕТАНОЛА ОД ПШЕНИЦЕ СОРТЕ КАНТАТА

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Током испитивања показало се да сорта пшенице Кантата не може сама да се користи за производњу хлеба. Због тога је ова сорта испитивана као сировина за производњу биоетанола. Пшеница Кантата је култивисана на четири локације: Ковин, Зрењанин, Панчево, Врбас. Резултати приноса етанола су показали да принос зависи од локације са које потиче пшеница, а исто тако битно зависи од температуре термичке и ензимске припреме узорака. Најбољи приноси етанола су добијени за узорак пшенице са локације Врбас.

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