APTEFF, 39, 1-212 (2008) UDC: 664.64.016.8:664.641.12:664.642
DOI: 10.2298/APT0839153M BIBLID: 1450-7188 (2008) 39, 153-159
Original scientific paper

EFFECTS OF MILL STREAM FLOURS TECHNOLOGICAL QUALITY ON FERMENTATIVE ACTIVITY OF BAKER'S YEAST *Saccharomyces cerevisiae*

Katarina V. Mirić and Dušanka J. Pejin

This work in concerned with the interdependence between technological quality of mill stream flours and fermentative activity of baker's yeast Saccharomyces cerevisiae. Each mill stream flour has its own specific properties, determined by the particle size, technological phase of its formation and part of the wheat kernel it consists of. Biochemical complexity of dough during examination of fermentative activity of baker's yeast confirmed the influence of a number of physical and biochemical flour properties, such as ash content, wet gluten content, rheological flour properties, phytic acid content and amylograph peak viscosity. Abudance of significant flour characteristic, their interaction and different behavior in the presence of the yeast, showed diversity and variation of result within the same category of the mill stream flour.

KEYWORDS: Wheat flour, mill stream flour, baker's yeast, fermentative activity, ash, wet gluten, phytic acid, amylograph peak viscosity

INTRODUCTION

Wheat flour is the major ingredient in many products and consequently it exerts a major effect on their quality. It is also a complex biological entity and, as such, varies significantly with the source of the wheat. As a complex system, and because it is obtained from a plant, wheat flour contains a multitude of compounds found in any living tissue. These include: moisture 14%, proteins 7-15% (albumins, globulins, prolamin, glutelin), starch 63-72% (amylopectin, amylose), nonstarchy polysaccharides 4.5-5.0% (pentosans and beta glucans), lipids 1%, as well as vitamins (thiamin, riboflavin, niacin) and minerals (iron, sodium, potassium, calcium, magnesium, copper, zinc). The most of these components play an important role in the way of how the flour-based and other product constituens will behave during processing or how the final product meets the consumer's requirements (1).The wheat processing in mill is based on separation of the endosperm material from the bran layers of the wheat kernel. The gradual reduction in size of the

Katarina V. Mirić, B.Sc., Kikindski mlin a.d., Svetozara Miletića 198, Kikinda, Serbia, Dr Dušanka J. Pejin, Prof., University of Novi Sad, Faculty of Technology, Bul. Cara Lazara 1, Novi Sad, Serbia

UDC: 664.64.016.8:664.641.12:664.642
BIBLID: 1450-7188 (2008) 39, 153-159
Original scientific paper

endosperm particles is achieved by a complex combination of grinding rolls (break, sizing and reduction rolls), sifters, purifiers, and other equipment. Depending on the design of the plant in the technological phases of grinding and sifting the different types of mill stream flours are formed (2). As an intermediate product each mill stream flour has its specifiic particle size, technological properties and part of wheat kernel it consists of (3). In dependence of their purpose as final products, the mill stream flours with known characteristic are combined and mixed in the precisely determined rates.

Dough preparation for loaf bread making involves the addition of water to a mixture of flour, salt, sugar, fat and baker's yeast. The water is absorbed by these ingredients, particularly by protein during mixing and by starch during backing. All the ingredients have specific functions.

In such complex biochemical system begins yeast activity, known as fermentation, which depends on many factors: wheat flour quality, yeast fermentative activity, temperature, influence of other ingredients, etc (4).

When yeast, together with water, is added to flour, the process of fermentation begins and it is based on two distinct series of enzymic changes that take place concurrently. The function of the yeast is to ferment the flour sugars already existing together with maltose produced by the action of the diastase of the flour on the starch (5). The carbon dioxide produced "aerates" and distends the gluten network and produces the structure of the loaf.

While the yeast is fermenting the flour sugars, some modifications in the structure of the gluten are taking place by the activity of alcoholic fermentation secondary metabolites. The process of bread making involves changing and improving the natural properties of gluten (5). The gluten in the flour forms elastic films within the dough, trapping myriads of tiny gas packets and stopping them from combining. Kneading, stretching and folding of the dough develops the protein structure to improve its elastic properties and its ability to hold carbon dioxide (1).

The ability to develop and to hold on the carbon dioxide during the fermentation process are crucial for the efficacy of fermentative activity of the used baker's yeast *Saccharomyces cerevisiae*.

Phytic acid (myoinositol hexakisphosphate) is widely distributed in commonly consumed food. In cereals, approximately 1–2% of the weight of the seed is phytic acid, and it can even reach 3-6%. Referring to its location in wheat, it is distributed in larger proportions in external bran, i.e. the covers in the pericarp and in the aleurone layer (6).

Phytic acid has a strong chelating capacity and forms insoluble complexes with divalent metals such as calcium, magnesium, iron and zinc. As humans lack enzymes in the gastrointestinal tract to degrade phytate, a diet rich in phytate may lead to considerably impaired absorption of dietary minerals (7). During bread making, much of the phytate is hydrolyzed due to the enzyme phytase, present both in the grain and the yeast, thus improving the bioavailability of minerals in the bread (8). As the most commonly consumed cereal product in our region is wheat flour bread, which contains hydrolyzed products of phytate – myoinositol and orthophosphate, it is socially significant to study, beside the other parameters, the interaction of phytic acid content in wheat flour and fermentative activity of baker's yeast (9).

APTEFF, 39, 1-212 (2008) UDC: 664.64.016.8:664.641.12:664.642
DOI: 10.2298/APT0839153M BIBLID: 1450-7188 (2008) 39, 153-159
Original scientific paper

EXPERIMENTAL

Materials

The examined wheat sample represents an average quality of wheat harvested in 2007, being a mixture of similar varieties intended for production of bread flour. Mill stream flours were sampled under real production condition of industrial wheat milling. End products were as follows: flour for leavened pastry, flour type 500-1, flour type 500-2, flour type 850 and flour for specialty type of bread produced in a regular technological process, by combining of mill stream flours whith properties that satisfy the sequirements for the qualitative characteristics of the above final products. Commercial baker's yeast *Saccaromyces cerevisiae* available on domestic market was used for the determination of fermentative activity.

Methods

Standard methods, according to the Regulations on methods of physical and chemical analyses for quality control of wheat, were used to determine the quality properties of mill stream and end products, milling and bakery products, pasta and frozen dough (10, 11). Phytic acid content in flour was determined by the method for rapid determination according to Haug and Lantzsch (12, 13). All determinations were performed in triplicate.

Fermentative activity of yeast in dough was determined as a volume of carbon dioxide produced during 1h and 2h (SJA method) (11). According to the measured results for volume of carbon dioxide, specific fermentative activity was calculated as volume of produced carbon dioxide in cm^3 in 2h per 1g on dry matter of yeast. All determinations were performed in triplicate.

RESULTS AND DISCUSSION

The quality properties of wheat products, phytic acid content and specific fermentative activity of baker's yeast Saccharomyces cerevisiae are given in Table 1.

Table 1. Quality properties of wheat products, phytic acid content and specific fermentative activity of baker's yeast *Saccharomyces cerevisiae*

	Flour for leavened pastry (flour 1)	Flour type 500-1 (flour 2)	Flour type 500-2 (flour 3)	Flour type 850 (flour 4)	Flour for specialty type of bread (flour 5)
Water content (%)	14.6	14.9	15.0	14.7	14.3
Ash content (% dm**)	0.36	0.48	0.48	0.88	0.98
Wet gluten content (%)	27.00	26.80	27.70	31.30	25.80
Area (cm^2)	102.8	85.1	78.8	31.5	21.1
Amylograph peak viscosity AU)	1220	850	800	440	310
Phytic acid content (mg/g dm**)	0.66	1.36	3.58	7.38	11.60
SFA* (cm^3 CO_2 in 2 h per 1 g dm*)	743.39	814.81	808.15	843.92	804.23

Note: *SFA–specific fermentative activity
**dm–dry matter

Flour for leavened pastry showed the lowest ash content (0.36%), as well as specific fermentative activity (743.39 cm^3 CO_2 in 2 h per 1 g dm) (Table 1). Although this flour type contains pure wheat endosperm and represents a raw material for fine bakery products, it is poor in protein, nucleic acid, enzyme, minerals, vitamins, lipids and other wheat kernel ingredients located in aleurone layer, which are needed for better yeast activity.

As the flour becomes enriched with different wheat kernel ingredients located in aleurone layer (flour type 500 - 1 and flour type 500 - 2) flour ash content icreases (0.48%) as well as specific fermentative activity (814.81 and 808.15 cm^3 CO_2 in 2 h per 1 g dm). These values of specific fermentative activity are the result of fermenting flour sugars with enzymes present in both flour and yeast, and phytases activity which hydrolyses phytate to orthophosphate and myoinositol essential for the *Saccharomyces cerevisiae* (14).

Further increase in flour ash content, for example in Flour type 850 (0.88%) showed maximum fermentative activity (843.92 cm^3 CO_2 in 2 h per 1 g dm), which confirmed that flours with mixture of endosperm and aleurone layer of the wheat kernel provide a significant number of ingredients important for baker's yeast activity (Fig. 1).

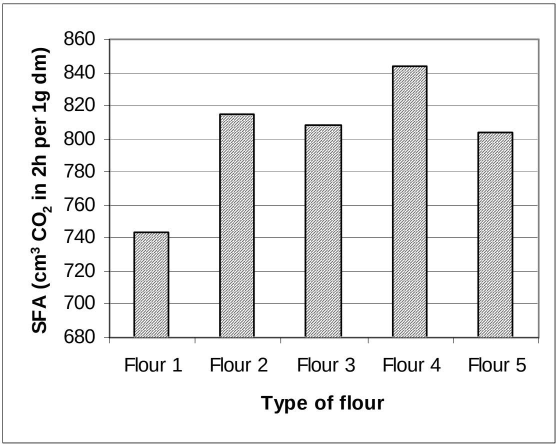

Figure 1. Influence of flour ash content on specific fermentative activity

Considering processing phase that mill stream flours are derived from, there are three categories:

I category: mill stream flours from the first part of break and reduction system, which mostly consists of endosperm from the central part of wheat kernel;

II category: mill stream flours from the middle part of break and reduction system, which consists of the peripheral part of endosperm of wheat kernel and

III category: mill stream flours from the last part of break and reduction system, which consists of the aleurone layer of wheat kernel (15).

APTEFF, 39, 1-212 (2008)
DOI: 10.2298/APT0839153M
UDC: 664.64.016.8:664.641.12:664.642
BIBLID: 1450-7188 (2008) 39, 153-159
Original scientific paper

When the wet gluten content in mill stream flours was analyzed according to the processing phase (Fig. 2, Fig. 3), some similarity between the mill stream flours from I and II category was found: average wet gluten content was 27.10 and 28.80%, and average specific fermentative activity was 825.80 and 856.83 cm^3 CO_2 in 2 h per 1 g dm, respectively.

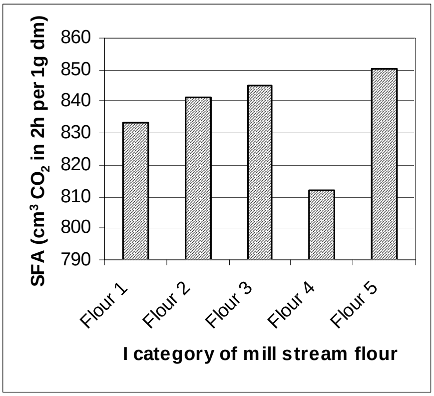

Figure 2. Influence of wet gluten content of category I of mill stream flour on specific fermentative activity

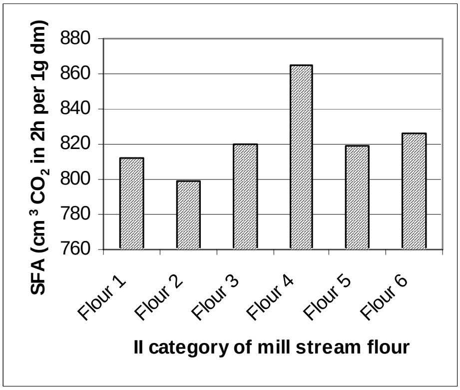

Figure 3. Influence of wet gluten content of category II of mill stream flour on specific fermentative activity

Other properties of mill stream flours, such as energy according to extensigraph, maximum peak viscosity, and phytic acid content, showed a number of diversity in behavior, regardless of the processing phase, wet gluten content and ash content as the basic characteristic of the flour category on the market (Table 2).

Table 2. Influence of different mill stream flour properties on specific fermentative activity

Property	I category of mill stream flour		II category of mill stream flour		III category of mill stream flour	
Ash content (%)	0.50	0.47	0.59	0.59	0.91	0.94
Wet gluten content (%)	25.70	28.50	29.40	28.10	31.20	28.70
Area (cm^2)	64.4	95.4	66.4	77.4	73.6	47.6
Maximum peak viscosity (AU)	530	645	540	730	730	410
Phytic acid content (mg/g dm)	6.69	4.25	2.31	8.00	7.42	6.65
SFA	885.73	765.89	920.13	792.84	699.82	931.22

Note: *SFA–specific fermentative activity
**dm-dry matter

 UDC: 664.64.016.8:664.641.12:664.642
DOI: 10.2298/APT0839153M BIBLID: 1450-7188 (2008) 39, 153-159
Original scientific paper

CONCLUSIONS

From the presented results on the effects of mill stream flour technological quality on fermentative activity of baker's yeast Saccharomyces cerevisiae, the following conclusions can be drawn:

- Baker's yeast showed certain fermentative activity in each dough sample prepared with different mill stream flour;
- Ash content in flour as final product, formed by combining defined mill stream flours, showed correct behavior in respect of fermentative activity, which gradually increased to 843.92 cm^3 CO_2 in 2 h per 1 g dm for Flour type 850, confirming that the diversity of flour ingredients had a positive influence on yeast activity;
- Mill stream flours of categories I and II showed that when the wet gluten content reached 30 % in average, fermentative activity was approximately 856 cm^3 CO_2 in 2 h per 1 g dm, regardless of other flour characteristics;
- The flours as end products and the mill stream flours from categories I and II, which a contained mixture of wheat kernel endosperm and aleurone layer, rich in flour sugars, proteins, nucleic acid, enzyme, vitamins and minerals, were the most suitable as yeast substrate;
- With more complex of mill stream flour technological parameters (extensigraph area, maximum peak viscosity and phytic acid content) the effect on yeast fermentative activity must be considered only in a narrow group of similar mill stream flours or even in the individual cases.

REFERENCES

1. Atwell, W. A.: Wheat Flour, Composition of Commercial Flour, Chapter 3, www.foodesource.org
2. Žeželj, M., B. Mickov: Karakteristike pasažnih brašna. Žito-hleb **31**, 3 (2007) 103-114.
3. Pejin, D., K. Mirić, M. Sakač: Zavisnost tehnološkog kvaliteta pasažnih brašna od sadržaja fitinske kiseline. Žito-hleb **34**, 3-4 (2007) 51-58.
4. White, J.: Yeast Technology, London (1954) Chapter 30, pp.380-407.
5. White, J.: Yeast Technology, B. Sc (Birmingham) F.R.I.C. Chapman & Hill (1954) pp.321-333.
6. Febles, C. I., A. Arias, A. Hardisson, C. Rodriguez – Alvarez, A. Sierra: Phytic Acid Level in Wheat Flours. Journal of Cereal Science **36** (2002) 19-23.
7. Haraldsson, A. K., J. Veide, T. Andlid, M. L. Alminger, A. S. Sandberg: Degradation of Phytate by High – Phytase Saccharomyces cerevisiae Strains diring Simulated Gastrointestinal Digestion. Journal of Agricultural and Food Chemistry **53** (2005) 5438-5444.
8. Harland, B. F., W. Frolich: Effects of Phytase from Three Yeasts on Phytate Reduction in Norwegian Whole Wheat Flour. Cereal Chemistry **66**, 4 (1989) 357-358.
9. Fretzdorff, B., J. M. Brummer: Reduction of Phytic Acid During Breadmaking of Whole – meal Breads. Cereal Chemistry **69**, 3 (1992) 266-270.

10. Pravilnik o metodama fizičkih i hemijskih analiza za kontrolu kvaliteta žita, mlinskih i pekarskih proizvoda, testenina i brzo smrznutih testa (“Sl. list SFRJ”, br. 74/88).
11. Kaluđerski, G., N. Filipović: Metode ispitivanja kvaliteta žita, brašna i gotovih proizvoda. Univerzitet u Novom Sadu, Tehnološki fakultet, Zavod za tehnologiju žita i brašna (1998).
12. Haug, W., H. J. Lantzsch: Sensitive method for rapid determination of phytate in cereals and cereal products. J. Sci. Food Agric. **34** (1983) 1423-1426.
13. Latta, M., M. Eskin: A simple and rapid colorimetric method for phytate determination. J.Agr. Food Chem. **28** (1983) 1313-1315.
14. Pejin, D.: Tehnologija pekarskog kvasca. Univerzitet u Novom Sadu, Tehnološki fakultet. Novi Sad (1989) pp.76-80.
15. Skendžić, M.: Principi raspodele međuprodukata mlevenja prema kategorizaciji faza prerade, Mlinpek almanah **122** (2006) 15-20.

УТИЦАЈ ТЕХНОЛОШКОГ КВАЛИТЕТА ПАСАЖНИХ БРАШНА НА ФЕРМЕНТАТИВНУ АКТИВНОСТ ПЕКАРСКОГ КВАСЦА *Saccharomyces cerevisiae*

Катарина В. Мирић и Душанка Ј. Пејин

У раду је испитивана зависност технолошког квалитета пасажних брашна и ферментативне активности пекарског квасца *Saccharomyces cerevisiae*. Свако пасажно брашно има своје специфичне особине, одређене величином честица, технолошком фазом у којој је формирано, као и делом пшеничног зрна од којег је настало. Биохемијска сложеност теста током испитивања ферментативне активности пекарског квасца, потврдила је утицај многих физичких и биохемијских особина брашна, као што су количина пепела, количина влажног глутена, реолошке особине, количина фитинске киселине и максимални вискозитет. Изобиље значајних карактеристика брашна, њихове интеракције и различито понашање у присуству пекарског квасца, показали су различитост и промењљивост резултата у оквиру исте категорије пасажних брашна.

Received 14 July 2008
Accepted 30 September 2008