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*Stevan D. Popov, Siniša N. Dodić, Jasna S. Mastilović, Jelena M. Dodić, Jovanka V. Popov-Raljić**

Faculty of Technology, Bul. Cara Lazara 1, 21000 Novi Sad, Serbia and Montenegro
* Faculty of Agriculture, Belgrade, Serbia and Montenegro

ACTIVATION OF WASTE BREWER'S YEAST *SACCHAROMYCES CEREVISIAE* FOR BREAD PRODUCTION

ABSTRACT: The waste brewer's yeast *S. cerevisiae* (activated and non-activated) was compared with the commercial baker's yeast regarding the volume of developed gas in dough, volume and freshness stability of produced bread. The activation of waste brewer's yeast resulted in the increased volume of developed gas in dough by 100% compared to non-activated brewer's yeast, and the obtained bread is of more stable freshness compared to bread produced with baker's yeast. The activation of BY affects positively the quality of produced bread regarding bread volume. The volume of developed gas in dough prepared with the use of non-activated BY was not sufficient, therefore, it should not be used as fermentation agent, but only as an additive in bread production process for bread freshness preservation. Intense mixing of dough results in more compressible crumb 48 hrs after baking compared to high-speed mixing.

KEY WORDS: activation, baker's yeast, bread, waste brewer's yeast

INTRODUCTION

Brewer's yeast (BY) as the by-product in brewery ends mostly in waste waters, both in the world and our country (B a r a s, 1991). The chemical oxygen consumption of waste brewer's yeast (WBY) is about 5,30 g/l, therefore this by-product is considered to be one of the greatest pollutants of the environment (K u n z e, 1998). WBY is used as feed, in pharmaceutical industry (production of ergosterol, enzymes, nucleic acids, amino acids and B group vitamins), in fermentation industry (yeast autolysate as additive to media) and in food industry (food additive) (P e p l e r, 1970). Due to high content of proteins, B-complex vitamins and minerals, BY is very important in food processing industry. The flavor of WBY is very bitter and the direct use in food industry would affect negatively the sensory characteristics of food products. The bitterness originates from the presence of resin and tannins adsorbed to

the cell surface, in the fermentation step during beer production (N a n d, 1987). Therefore, the debittering of WBY is necessary before it can be used in food industry (K u n z e, 1998). No available literature data were found on the use of waste BY as the leavening agent for dough in bakery industry. Our brewing industry produces about 6.000 t of waste yeast per year, with cca 15% dry matter. At the same time, the use of baker's yeast is sbout 50.000 t. It can be assumed that bakery products of similar quality could be produced with double portion of BY in the composition of dough. WBY could be used in bakery industry after appropriate processing. Only 3% of used baker's yeast would be replaced by waste brewer's yeast, however, the decrease of dumping problem of WBY would be a significant contribution to environmental protection. The direct use of debittered BY as dough component does not result in appropriate effects, so it is necessary to activate the brewer's yeast in suitable media. The aerobic procedure activates the enzyme complex of BY cells, enabling the fermentation and dough rising (D o d i ć, 2002). The paper presents the investigation of possible use of WBY (*Saccharomyces. cerrevisiae*) as raw material for bread production. BY was compared to commercial baker's yeast regarding the volume of developed gas in dough and some characteristics of bread, as final product.

MATERIAL AND METHODS

BY *Saccharomyces. cerrevisiae* (waste yeast from a domestic brewery) and commercial pressed baker's yeast *Saccharomyces. cerrevisiae* with 27% of dry matter ("Fermin", Senta, Serbia and Montenegro) were used for the investigations. BY was debittered using 2N solution of NaOH (N a n d, 1987) and separated by centrifugation, 20 min at 7000 rpm (Westfalia separator). After the separation, the dry matter content of BY biomass was 27%. In our previous investigations of waste brewer's yeast revitalization for use in baking industry, the optimization process, which included composition of medium, process parameters and fermentation technique, was developed. The activation of WBY for use in bread production, applied in this work, was also defined. The debittered BY was activated for 45 min in media containing 5% (m/v) of malt extract (obtained from a domestic brewery, 80% dry matter, out of which 65% of sugars) at 30°C, mixing rate 300 rpm and specific aeration rate 4,5 l/l min (D o d i ć, 2002). The activation was performed in the laboratory fermentor Chemap-Pec (Mannedorf, Swiss), working volume 10 l. The biomass of BY was centrifuged for 20 min at 7000 rpm (Westfalia separator) to the final dry matter content of 27%. The investigated yeasts were: non-activated BY, activated BY and control baker's yeast. Dough was mixed in farinograph mixer (Brabender, OHG, Duisburg, Germany), using 100% of white flour, 2% of salt, 2% of baker's yeast or 8% of non-activated BY or 8% of activated BY and water in an amount necessary for the achieving of constant dough consistency of 500 FU (farinologic units) after 5 min of mixing. The dynamics and volume of gas developed in the dough were determined using the fermentograph (Brabender, OHG, Duisburg, Germany) according to the recommenda-

tions given by the producer. Dough samples (flour 100%, yeast 2%, table salt 2%, vegetable fat 0.7%, and water according to farinographic water absorption) were prepared using the intense mixing process (mixer Stephan, 100 s, 1400 rpm, dough fermentation in mass 10 min) and high-speed mixing process (kneading machine DIOSNA, 1 min at 8 rpm and 7 min at 120 rpm, dough fermentation in mass 60 min). Bread was baked at 230+5°C for 30 min. The weight of bread was 500 g. Important elements for quality evaluation are: volume of bread and compressibility of crumb, e.g. freshness stability of bread for a certain period after baking. Crumb compressibility of bread samples prepared with the investigated yeasts was evaluated on the basis of PN, as the measure of compressibility, 8, 24 and 48 hrs after baking. The PN of crumb was determined with SUR Penetrometar (PNR 6) as the mean value of PN determined at 3 places on the cross section of bread (Jančić, Beleslin, 1979). Bread volume was determined by volume meter with millet (Instrumentaria, Zagreb, Hrvatska), 24 hours after the baking. All determinations were performed in triplicate. The standard error and T-test were analyzed. MS Origin program was used for data analysis.

RESULTS AND DISCUSSION

BY was evaluated on the basis of influence on dough properties and stability of bread freshness. Dough properties defined by gas developing dynamics (ml CO_2) during fermentation were registered on fermentograph, while

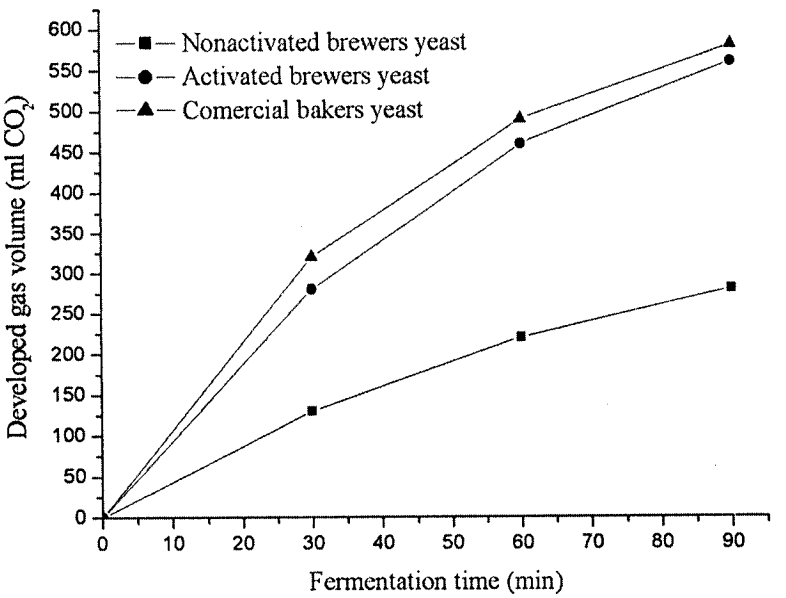

Figure 1. Change of developed gas volume (ml CO_2) during fermentation of dough prepared with different kinds of yeasts

bread freshness stability was monitored on the basis of crumb compressibility and volume of bread obtained during experimental baking. The fermentative activity of the investigated yeasts during dough fermentation, registered on fermentograph, are presented in Figure 1.

The increase of developed gas volume (ml CO_2) during dough fermentation was registered for all kinds of investigated yeasts. However, the developed gas volume in dough prepared with the use of non-activated BY is rather small, after 30 min and 90 min of fermentation the developed gas volume of this sample was by 60% e.g. 50% smaller compared to dough prepared with control baker's yeast. The use of activated BY resulted in significantly increased gas voume, practically by 100%, in dough prepared with this sample, compared to dough prepared with non-activated BY. Most probably the activation of BY resulted in shorter or lack of lag phase during fermentation of dough. The volume of developed gas after 30 min of fermentation of dough prepared with activated BY is by 10% smaller compared to dough made with baker's yeast (control), and after 90 min of fermentation the difference was less than 5%. Regarding the technological aspect, the minimal difference in volume of developed gas during fermentation of dough prepared with activated BY and control baker's yeast, is no barrier for the use of activated BY in production of appropriate quality bread. The activation of BY results in the activation of enzyme cell complex, necessary for the fermentation of fermentable sugars in flour and development of sufficient amount of CO_2 that affects directly and significantly the quality of dough and of bread, as final product. The quality of bread samples made with baker's, activated and non-activated BY by intense and high-speed mixing was evaluated through bread volume (Fig. 2).

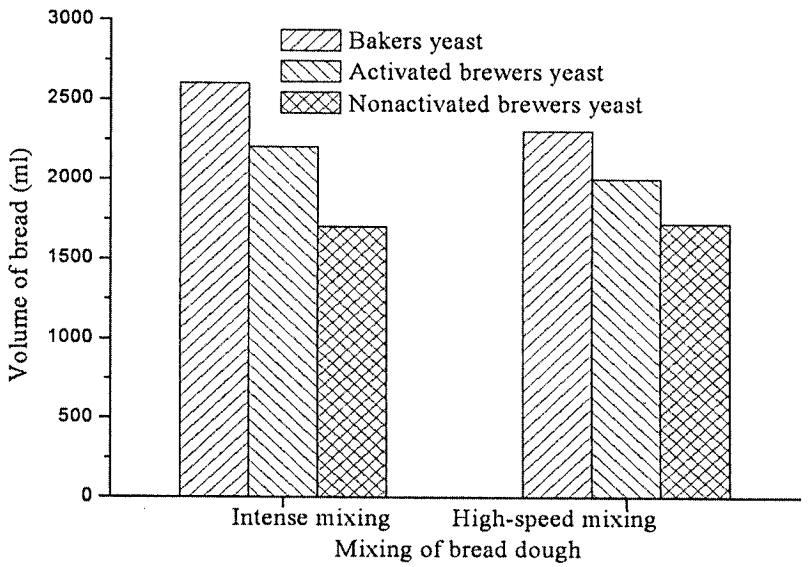

Figure 2. Volume of bread samples made with baker's, activated and non-activated brewer's yeast by intense and high-speed mixing

Volume of bread samples made applying the intense mixing process, with activated and non-activated BY was by 15% e.g. 40% smaller compared to bread made with baker's yeast. The activation of BY results in improved bread quality, regarding bread volume. Applying the high-speed mixing process and using the three kinds of investigated yeasts, somewhat lower values were found for bread volume, in average by about 10%, compared to the bread made applying the intense mixing process. The activation of BY affects positively the bread quality in this case as well. The influence of BY use on crumb compressibility, evaluated by PN of samples determined 8, 24 and 48 hours after baking is presented in Figures 3 and 4.

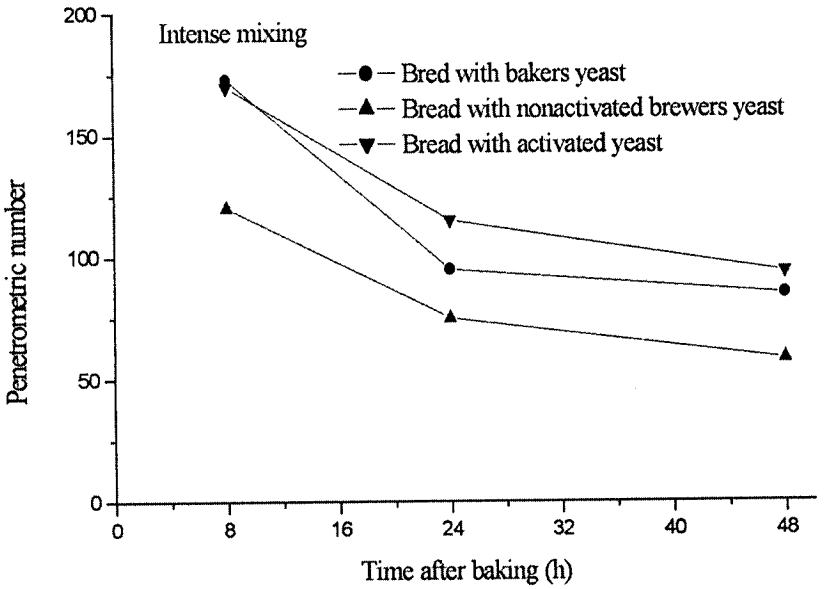

Figure 3. Change of PN of bread with time after baking of dough prepared by intense mixing

The results presented in Figure 3 show that the PN values of bread samples, 8 hours after baking of dough obtained by intense mixing, and with the use of activated BY and baker's yeast are similar. On the basis of this finding, it can be concluded that crumb compressibility of bread made with activated BY, determined 8 hours after baking, e.g. bread freshness is almost the same as of control bread prepared with baker's yeast. The use of activated BY in the high-speed mixing of dough, results in slower decrease of PN, in the period 8 to 24 hours after baking. The PV of control bread decreased by about 45% and of bread with activated BY by about 30% compared to values measured 8 hours after baking. The slower aging is a very important characteristic of bread made with the use of activated BY. The analysis of RV change in the subsequent period (24—48 hours after baking) shows that freshness stability of bread made with activated BY is significantly pronounced, e.g. the aging of this bread sample is clearly slower compared to bread samples made with ba-

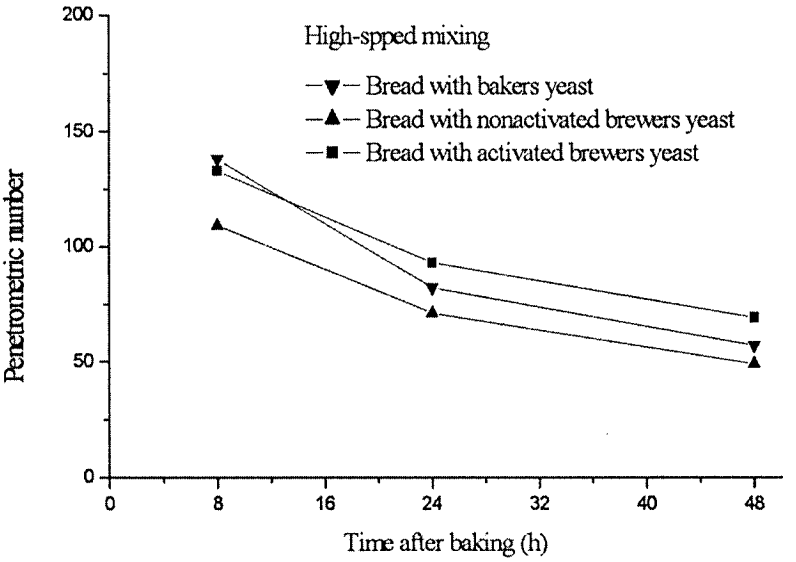

Figure 4. Change of PV after baking of bread samples prepared by high-speed mixing

ker's yeast. Bread made with the use of non-activated brewer's yeast is characterized by slower aging compared to bread made with baker's yeast. However, the shortage of brewer's yeast use is the insufficient volume of developed gas in dough.

The PV of dough prepared by high-speed mixing process, are in average by 25% lower compared to intense mixing. The PV of bread (8 hours after baking) made by high-speed mixing, with activated BY, is similar to control bread with baker's yeast. So, the crumb compressibility of bread made with activated BY and of control bread are almost the same. Bread made with non-activated BY is characterized by a tougher crumb e.g. aging is more pronounced compared to bread with activated BY and control bread (measured 8 hours after baking). 24 hours after baking, the PV of control bread and of bread with non-activated BY decreases by about 40%, and of bread with activated BY by about 30% of the value determined 8 hours after baking. This confirms the conclusion from the experiment with the use of intense mixing, i.d. that crumb compressibility is more expressed in control bread compared to bread with activated BY. In the subsequent period after baking (24—48 hours), the dynamics of PV decrease is almost the same for all three bread samples. The biggest crumb compressibility was again found in bread with activated BY, followed by control bread, and bread with non-activated BY, at the end. The mean values of developed gas volume in dough were analyzed (T-test), as well as the standard error of developed gas volume during fermentation (90 min) (Table 1) and of PV, e.g. crumb ST of bread samples prepared with the investigated yeasts. No significant difference (significance factor 0,05) was found in developed gas volume during 90 min of fermentation when baker's yeast and activated BY were used. However, the volume of developed

gas during fermentation of dough prepared with non-activated BY is significantly different (significance factor 0,01) compared to other two bread samples. Values of standard measuring error of developed gas volume of dough, bread volume and PV of crumb are in acceptable range.

Table 1. T-test and standard error (+%) during determination of developed gas volume, bread volume and PV.

Uzorak	T — test						Standard error (±%)						
	Fermentographic investigation						Intense mixing			High-speed mixing			
							Penetrometric number						
	Baker's yeast	Activated brewer's yeast	Fermentation of bread dough (min)			ml bread	Time after baking (h)						ml bread
			30	60	90		8	24	48	8	24	48	
Baker's yeast	—	—	3,1	3,0	3,4	0,9	2,8	3,0	3,1	2,5	2,3	2,6	0,8
Nonactivated brewer's yeast	**	**	3,4	3,1	3,3	1,1	2,4	2,9	2,4	2,4	3,0	2,8	0,9
Activated brewer's yeast	NS	—	2,9	3,2	3,1	1,2	2,6	2,8	2,2	2,4	2,9	3,0	0,9

All determinations were performed in triplicate.

CONCLUSIONS

On the basis of the analysis of results obtained in this work, the following can be concluded: The fermentative activity of debittered BY (from brewery) without activation is not satisfactory in dough compared to commercial baker's yeast, so this yeast can be used as the additive for bread stability (freshness) improvement. The use of activated BY (45 min in media with 5% (m/v) at 30°C, 300 rpm, specific aeration rate 4,5 l/l min) results in an increased developed gas volume in dough by about 100% compared to non-activated brewer's yeast, but the developed gas volume is by 5—10% smaller compared to dough made with commercial baker's yeast. The activation of BY affects positively the quality of bread regarding the volume of the final product. The use of activated BY in bread production affects positively the crumb ST, e.g. freshness stability preservation.

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АКТИВАЦИЈА ОТПАДНОГ ПИВСКОГ КВАСЦА *SACCHAROMYCES CEREVISIAE* ЗА ПРИМЕНУ У ПРОИЗВОДЊИ ХЛЕБА

Стеван Д. Попов, Синиша Н. Додић, Јасна С. Мастиловић, Јелена М. Додић, Јованка В. Попов-Раљић*
Технолошки факултет, Нови Сад
* Пољопривредни факултет, Београд

Резиме

Извршена је оцена отпадног пивског квасца *Saccharomyces cerevisae* (активираног и неактивираног) у односу на комерцијални пекарски квасац са аспекта запремине развијеног гаса у хлебном тесту, запремине и одрживости свежине произведеног хлеба. Поступком активације отпадног пивског квасца запремина развијеног гаса у хлебном тесту се повећава за око 100% у односу на неактивиран пивски квасац и добија се хлеб са постојанијом свежином у односу на хлеб са пекарским квасцем. Поступак активације пивског квасца позитивно утиче на квалитет произведеног хлеба и то са аспекта запремине хлеба. Неактивиран пивски квасац не даје потребну запремину развијеног гаса у хлебном тесту и не може се користити као средство за дизање теста него само као адитив у производњи хлеба у циљу одржања свежине хлеба. Интензивни замес хлебног теста даје стишљивију средину хлеба током 48 h након печења у односу на брзоходни замес.