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TECHNOLOGICAL SUITABILITY OF MONOSPOROUS POPULATIONS AND HYBRIDS OF BREWERS' YEASTS. PART II. PILOT — PLANT SCALE TESTS

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Key words: hybrides of yeast, production of beer, properties of beer, parameters of beer

The experiments conducted on a laboratory and on a large laboratory scale revealed the suitability of hybrides of brewers' and bakers' yeasts in the production of beers. The obtained beers were characterized by satisfactory physical and chemical properties and they were assessed as good from the flavour viewpoint. The beer produced with the use of hybride M27-2 had the most favorable parameters. In order to confirm the further technological suitability of this strain, the experiments were carried out on a pilot plant scale.

THE EXPERIMENTAL

For the microtechnical scale experiments, the strain M27-2 was selected on the basis of the results obtained in the first part of the present work. The control strain in this series was yeast strain no 77 which was suggested by Szmelich [8] on the basis of results of studies on the selection of yeast for production of top fermenting beer, carried out by the Institute of Fermentation Industry.

The microtechnical tests were carried out on wort with the following composition:

extract (% (g/g))	10.4
pH	5.9
colour	12.0
acidity (ml)	1.6
formol nitrogen (mg/100 ml)	24.5
iso- compounds (mg/l)	24.4

The tests were carried out in the Experimental Laboratory of the Institute of Fermentation Industry at the brewery in Biskupiec.

Table 1. The run of fermentation process of beers in the microtechnical scale

Strain	Extract in successive days (% (g/g)				Number of yeast cells in 1 ml × 10^6				Temperature in °C			
	2	3	4	6	2	3	4	6	2	3	4	6
M27-2	3.09	2.86	2.69	2.61	37	32	20	—	24	25	25	25
	2.73	2.86	2.51	2.61	28	37	23	—	24	25	24	25
77	8.27	8.07	7.18	6.00	2	7	15*	—	23	23	23	23
	6.30	5.51	4.48	3.65	21	2	7*	—	23	23	23	23

x — after mixing.

ANALYTICAL METHODS

Apart from the analyses performed for beers on the laboratory and large-laboratory scale (part I), the following determinations were made in the Institute of Fermentation Industry: content of acetic aldehyde, ethyl acetate, n-propanol, iso-butanol and amyl alcohols content. The determinations were made by a gas chromatography method [2].

RESULTS

During the fermentation process (Table 1), hybrid M27-2 revealed a substantially better fermentation capacity when compared with the control strain 77. After 2 days of the process, the hybrid M27-2 fermented already 70% of the initial extract of wort while the control strain 77 fermented only 30%. It may be stated that after two days, hybrid M27-2 completed fermentation of wort. The control strain achieved fermentation to 64% after 6 days of fermentation and in the second trial — to 43%. This differentiation was further maintained during the storage (Table 2). Hybrid M27-2 after three days of storing lowered value of extract by 27% in comparison with the initial value while strain 77 at the same time lowered it only by 5%. The differences in the wort fermentation rate were reflected in the results of beer analyses (Table 3). Beer produced

Table 2. The run of storing process of beer obtained in the microtechnical scale

Strain	Extract in successive days (% (g/g))					Number of cells in 1 ml × 10^6				
	2	3	4	5	7	2	3	4	5	7
M27-2	—	2.63 2.15	1.97 1.92	1.90 1.85	1.90 1.85	3.6 6.9	2.7 4.8	2.7 4.0	2.4 1.8	0.6 0.5
77	4.93	4.40	3.98	3.80	3.50	7.0	6.3	2.2	1.0	1.6

Warm storing 7 days at 18-22°C
Cold storing 3 days at 4°C

with the use of hybrid had a considerably higher rate of fermentation (about 20%), the remaining physical and chemical properties of both beers were similar. From the flavour viewpoint, the compared beers were evaluated as satisfactory.

Both strains produced acetoine and higher alcohols in beer in similar quantities (Table 4), while the hybrid produced a diacetyl amount by 30% lower. As it results from Table 4, amyl alcohols were produced in similar quantities (50 mg/l) while hybrid M27-2 formed smaller quantities

Table 3. The results of analyses of beer produced on the microtechnical scale

Strain	E_p (% in weight)	E_{rz}(% in weight)	A (% in weight)	B_p (% in weight)	V_p (% in weight)	V_{rz} (% in weight)	Colour	pH	Acidity (ml)	ITT in sec.	Hartong index (in ml)	Formol nitrogen in mg/100 ml	Iso-compounds in mg/l
M27-2	1.74	3.43	3.74	10.7	84	68	7.0-7.5	4.45	1.4	514	0.8	6.6	15.5
	1.69	3.37	3.66	10.5	84	68	7.0-7.5	4.40	1.4	465	0.6	7.0	12.7
77	3.19	4.55	2.96	10.3	69	56	7.5-8.0	4.40	1.4	432	0.8	7.4	12.1

Table 4. Level of certain by-products in beers produced on the microtechnical scale

Strain	Diacetyl	Acetoine	Higher alcohols	Acetic aldehyde	Ethyl acetate	n-propanol	Iso-butanol	Amyl alcohols
	mg/l							
M27-2	0.09	2.31	42	3.84	12.2	16.9	9.5	52.9
	0.05	1.91	44	4.00	7.25	6.5	6.6	50.6
77	0.13	2.42	36	7.50	4.56	13.3	10.5	46.3

of acetic aldehyde (by 47%) in beer and iso-butanol (by 23%) when compared with control strain 77.

The selected analytical data characterizing beer obtained with the use of hybrids in different scales (Fig. 2) and their organoleptic features revealed the best value of hybrid M27-2. Alongside with the increasing scale, an improvement of sensoric properties as well as lowering of by-products content in beers (Fig. 3) was observed. Exception was made by the content of acetoine, the amount of which did not exceed, however, the quantities accepted as criterion.

Hybrids formed up to 60 mg/l of higher alcohols in beer produced in a large-laboratory (part I) and microtechnical scale, so the content of these compounds was considerably lower in the experimental beers than in the typical top fermenting ones and it was comprized within the limits accepted for bottom fermented beers [7].

The contents of certain alcohols in beers produced in the microtechnical scale, using M27-2 strain were the following: n-propanol 6÷16 mg/l

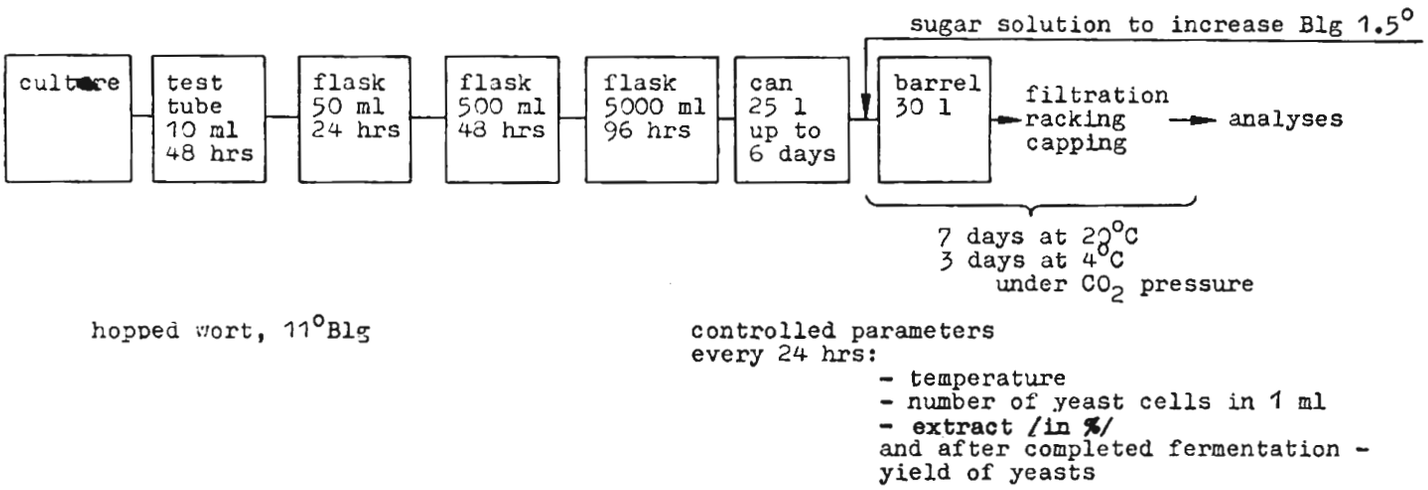

Fig. 1. Production of beer in the microtechnical scale

compared to 1÷20 mg/l and iso-butanol 7÷10 mg/l compared to 4÷30 mg/l reported by Baca [1]. These contents do not have any adverse effect on the flavour of beer.

Hybrid M27-2 produced 0.09 mg/l diacetyl in beer while Haukeli and Lie [4] during their studies on the formation of carbonylic compounds by bottom and top brewers' yeast, reported variations in diacetyl amount in the limits 0.02-0.32 mg/l.

The examined hybrid produced less than 10 mg/l of ethyl acetate while Engan [3] reports in his studies about a content of ethyl acetate amouting to 16 mg/l.

Acetic aldehyde has small effect on the taste of beer when it appears in quantities not higher than 25 mg/l (averagely it constitues no more than 10 ml/l) but it is a precursor of compounds which, even in small

quantities, have an adverse influence on the taste of beer. Hybrid M27-2 produced 4 mg/l of acetic aldehyde in beer manufactured on a microtechnical scale while Engan [4] reported 8 ml/l and Otter et al. [6] informed even about 9 mg/l.

It should be stressed that beers containing higher quantities of by-products received a higher organoleptic evaluation. Hybrid M27-2 selected

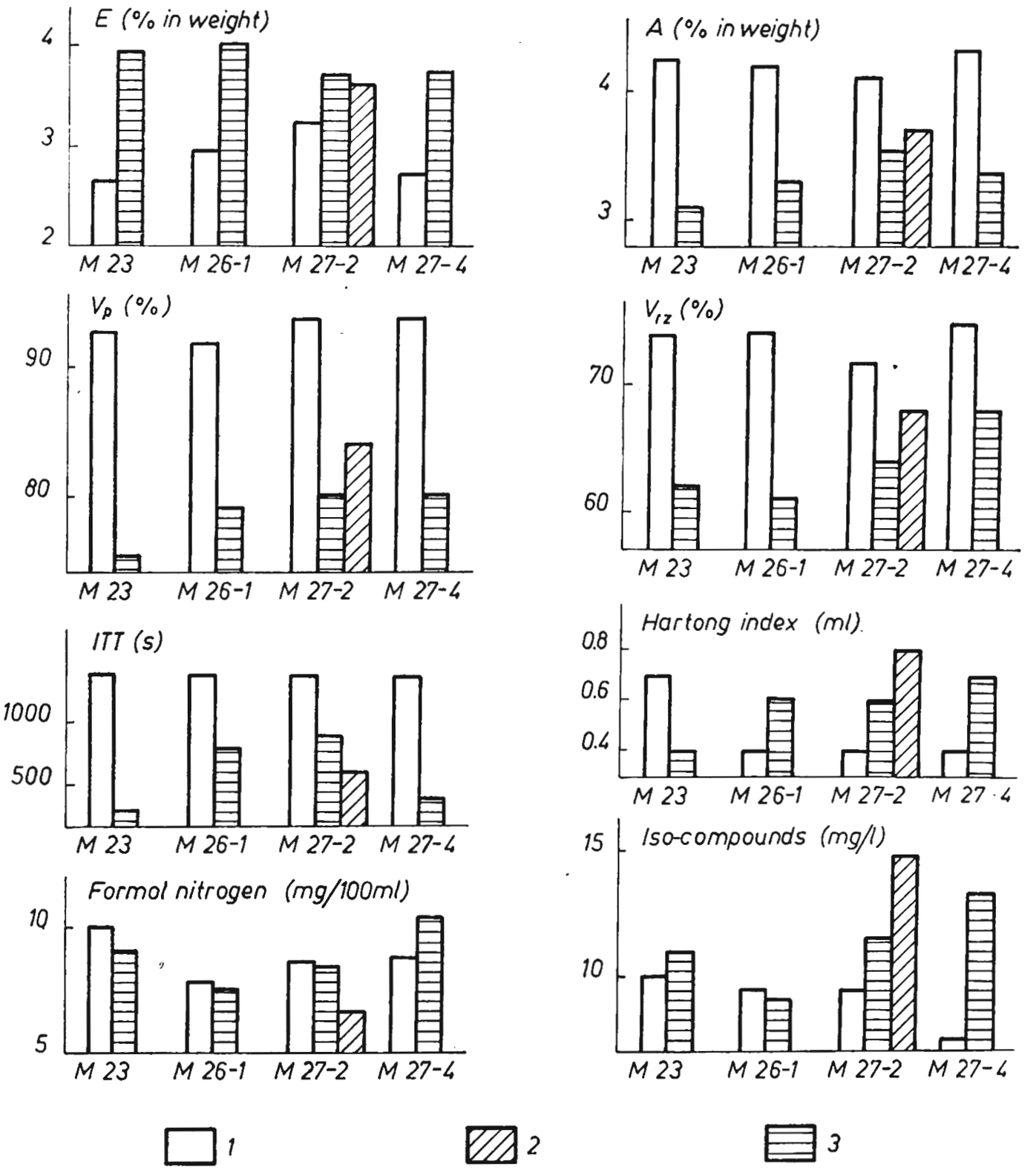

Fig. 2. Selected analytical data, characterizing beers produced with the use of strains: M23, M26-1, M27-2, M27-4 in the following scales: 1 — laboratory, 2 — large-laboratory, 3 — microtechnical

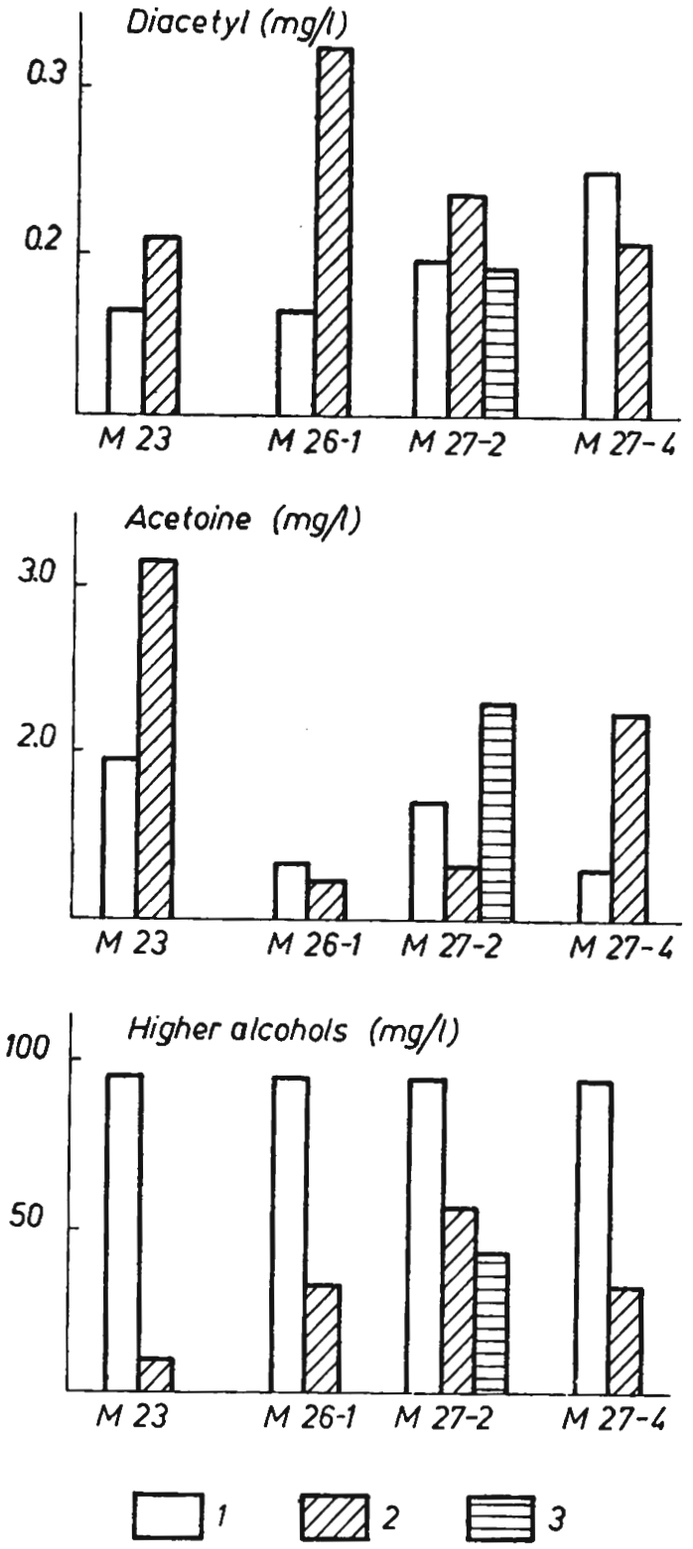

Fig. 3. Level of certain by-products in beers produced with the use of strains M23, M26-1, M27-4 in scales: 1 — laboratory, 2 — large-laboratory, microtechnical

as the best one, produced beer with optimized levels of the particular by-products.

Comparing the result of analyses of beer produced with the use of hybrid M27-2 in successive scales, we may observe, during the increasing volume, an improvement of sensoric properties as well as lowering of by-products content in beer, except for acetoine, the amount of which did not exceed, however, the accepted standards.

Hybrid M27-2 was obtained as a result of combining the monosporous brewers' population having a weak fermentation activity but giving beer

with a low content of by-products, and the monosporous population of bakers' yeasts having a high fermentation activity but giving beer with a high level of by-products. The hybrid was very active in the technological process, it accelerated the time of fermentation by about 50% when compared with the control strain; it produced beer with a low content of by-products.

CONCLUSIONS

1. The possibility of applying yeast hybrids in the production of top beer was shown. Harmonized technological parameters were obtained as a result of the combination of sexually active monosporous populations of brewers' and bakers' yeasts.

2. The suggested several-stage sequence of strains selection taking into consideration the results of trials in a laboratory, large-laboratory and microtechnical scale, provides the possibility of choice of hybrids with optimized technological parameters.

3. The hybrid of brewers' and bakers' yeasts accelerated the fermentation of beer by 50% in comparison with the control industrial strain. It produced beer with high flavour values and with a harmonized content of by-products.

4. During the increasing scale of the experiments, an improvement of sensoric properties as well as a lowering of by-products level in beer produced with the use of hybrids, was observed.

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PRZYDATNOŚĆ TECHNOLOGICZNA POPULACJI MONOSPOROWYCH I MIESZAŃCÓW DROŻDŻY PIWOWARSKICH. CZ. II. PRÓBY W SKALI ĆWIERĆTECHNICZNEJ

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Streszczenie

Potwierdzono w skali ćwierćtechnicznej pełną przydatność mieszańców drożdży piwowarsko-piekarskich do produkcji piwa górnej fermentacji. Wyniki zamieszczone w tab. 1 wykazują, że mieszaniec M-27, wybrany jako najlepszy w próbach laboratoryjnych i wielkolaboratoryjnych posiadał o ok. 50% wyższą aktywność fermentacyjną niż szczep kontrolny, a piwo otrzymane przy jego użyciu (tab. 3) wykazało do 30% wyższy stopień odfermentowania, wysokie walory smakowe i zharmonizowaną zawartość produktów ubocznych. Ich poziom był niższy niż w piwach kontrolnych. Mieszaniec M-27 wytworzył do 60 mg/l alkoholi wyższych, tj. ilości dopuszczalne dla piw dolnej fermentacji. W piwach doświadczalnych szczególnie korzystnie była obniżona przy użyciu mieszańca M-27 zawartość acetoiny i dwuacetylu oraz octanu etylu i aldehydu octowego.

Otrzymane wyniki, oprócz dokumentacji przydatności mieszańców drożdży do produkcji piw górnej fermentacji, potwierdzają także wartość metod kwalifikujących te szczepy na cele przemysłowe.