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Performance of baker's yeast produced using date syrup substrate on Arabic bread quality

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Baker's yeast was produced from three selected baker's yeast strains using date syrup as a substrate at low and high flow rate compared to those produced using molasses substrates. Performance of the produced baker's yeasts on Arabic bread quality was investigated. Baking tests showed a positive relationship between total Arabic bread quality and yeast gassing power. This relationship could be used as a general reference to estimate the quality of such yeasts. The Arabic bread made with Hollandia yeast produced using date syrup at low flow rate exhibited the highest overall total quality bread score. Moreover, NCYC 1530 baker's yeasts produced using date syrup at high flow rate or 1:1 molasses to date syrup at low flow rate, significantly produced high quality Arabic breads. Results also indicated that yeasts produced from the date syrup gave baking results comparable to yeasts produced from molasses. There were insignificant differences in gassing power between yeasts produced from date syrup and yeasts produced from molasses. So, it could be concluded that excellent quality Baker's yeast could be produced using date syrup substrate.

Key words: Date syrup, molasses, baker's yeast, fermentation, Arabic bread, gas production power.

INTRODUCTION

Dates contain high amounts of easily metabolizable sugars in form of glucose and fructose, therefore, they can be used as a substrate for microbial fermentations to produce a variety of commercial products such as baker's yeast, fodder yeast, ethanol, citric acid, vinegar. In these processes, dates will serve mainly as carbon and energy sources for the microorganisms, in addition to other nutrients such as minerals and vitamins. In this respect, date can compare very well with other conventional substrates used in industrial fermentations such as molasses. All baker's yeasts produced and used commercially in the world now, are strains of the species *Saccharomyces cerevisiae* that belongs to the fungal family *Saccharomycetaceae*. It is a unicellular, eukaryotic microorganism, usually diploid, reproduces vegetatively by budding and sexually by ascospore formation (Barnett et al., 2000). The role of the yeast in bread making is the raising of the dough to produce the characteristic loaf

preferred by consumers. Dough rising occurs as a result of the gases produced by the yeast as it grows in the dough. During growth, the yeast metabolizes the sugars in the dough with the help of a special enzyme system and produce alcohol and CO₂. The leavening power of the yeast depends on its activity and viability. Hence the yeast used must be fully active with a high viable cell count. Furthermore, the leavening power of any yeast strain depends on its genetic make up and on the production process and also on the storage conditions before use (Pylar, 1988).

Baker's yeast as a commercial product appears in several forms that can be grouped into two main types, compressed yeast, also called fresh yeast and dried yeast. Compressed yeast represents the traditional form of baker's yeast. It is prepared by centrifugation and filtration after completing the fermentation process. It has a dry matter content of about 27-34% (w/w) and a protein content of about 42-56% (on dry-weight basis). It is ready for immediate use and if it is handled properly, it should give good baking results in all types of dough systems. However, this type of yeast is perishable and

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should be stored at low temperatures, preferably between 0 and 4°C. At such temperatures, a shelf life of 3-4 weeks is possible with only a slight decrease in leavening capacity. At higher storage temperatures, keeping quality decreases progressively (Pyler, 1988).

Few investigations about the production of baker's yeast from date extracts have been conducted (Bassat, 1971; Mudhaffer, 1978; Al Obaidi et al., 1985; Al Obaidi et al., 1987). Comparisons were made between date extract and molasses, which is the traditional substrate for baker's yeast production. Positive findings were reported and claims were made that there were no technological constraints in using date extract for baker's yeast production. Nancib et al. (1997) used date wastes in the production of baker's yeast from strains of *Saccharomyces cerevisiae*. Date extract as carbon and energy source for the propagation of baker's yeast on pilot plant scale in comparison with molasses was investigated by Al Obaidi et al. (1986). The results showed that higher productivity of baker's yeast was observed when date extract was used. It was concluded from their study that date extract holds promise as a source of carbon and energy for the production of baker's yeast, although the average yields they reached were 47% only. None of these authors discussed the Crabtree Effect as a major technological problem encountered with baker's yeast propagation.

In a previous work the authors of this paper carried out a comparative study between nutrients contents of date syrup (Dips) and molasses as substrates for baker's yeast production. Results indicated that date syrup compares very well with molasses in its nutrients content and could be successfully used as a substrate form for Baker's yeast production (Aljasass et al., 2009).

Arabic bread has a round shape and forms pockets because of the high baking temperatures that make the dry exterior skin to set and carbon dioxide and water vapor to expand. These gasses disperse till the pressure is sufficient enough to force separation of the lower and upper layers, a phenomenon referred to as pocket formation (Quail et al., 1993). Qarooni et al. (1987) reported that white flour produced from hard wheat with intermediate strength and protein content of 10-12% gave high quality Arabic bread. The present study aims to evaluate the effect of using Baker's yeast produced using date syrup as a substrate on quality characteristics of Arabic bread.

MATERIALS AND METHODS

Baker's yeasts

The Baker's yeasts used in this study were Saf-instant active dry Baker's yeast (S. I. Lesaffre 59703 Marcq, France), Hollandia instant-active dry yeast (GB Ingredients, Mijlweg 77, Dordrecht, Holland) and strain from Specialized Laboratory: A *Saccharomyces cerevisiae* strain NCYC 1530 (laboratories of the National Center

Britain). The strain NCYC 1530 was provided in a freeze-dried form and was kept in its original form until use. These yeasts were produced using three substrate being (molasses, date syrup and 1:1 molasses to date syrup) at low and high flow rates as described by Al-Eid et al. (2009) and were used in the Arabic bread preparation. The sugars content was 80 and 50% for date syrup and beet molasses, respectively. The nitrogen content was 0.13 and 0.5% for date syrup and beet molasses respectively.

Flour

The flour used in the experiments was commercial local flour from hard wheat (Yecora Rojo variety), extraction rate of 80% and production year 2006, obtained in 10-kg paper packs (Grain Silos and Flour Mills Organization, Dammam, Saudi Arabia). The flour had 13.4% protein and 0.65% ash.

Flour tests

Falling number test

The falling number was determined according to the method standardized by international bodies (Perten Instruments group, 2009), using the Perten instrument model 1700, Hagberg, Sweden. Flour (6.9 g) was weighed based on 14% moisture content, transferred into the viscometer-tube tipped to 45 angel, 25 ml distilled water added, the tube shaken 10 times to obtain a uniform suspension of flour and water and placed with a stirrer in the boiling water bath. The stirring apparatus was started immediately. Heating (about 100°C), caused starch granules to swell and the viscosity of the suspension to increase. After stirring the sample for 60 s, the plunger was dropped for free fall. The rate and extent to which the viscosity of the starch suspension was reduced indicated the level of alpha amylase present. The optimum falling number was obtained in the reading between 200 and 300. This indicated optimal amylase activity and due to this the wheat bread crumb was likely to be good.

Farinograph test

Farinograph measures and records the resistance of dough to mixing. It was used to evaluate the water absorption capacity of the flour to determine the stability of dough during mixing. Measurement was done according to the AACC (1995) approved method 54 - 21 with the small (50 g) mixing bowl of a Brabender farinograph (C.W. Brabender Instruments, Inc. South Hackensack, N.J, USA). After one minute dry mixing, sufficient water was added within 25 s, till maximum resistance was centered on the 500 Brabender unit line. When the dough began to form, the sides of the bowl were scraped down with a plastic scraper and the machine was permitted to run until an adequate curve was available (that is, absorption, slightly beyond peak; stability, until top of curve recorded 500BU line after peak; 12min beyond the peak). The test was run three times and then the absorption was calculated on a 14% moisture basis.

Wet gluten and gluten index

Gluten indices of flour samples was determined by the AACC (1995) approved method 38 - 12 using the Glutomatic 2200 (Perten Instrument AB, Stockholm, Sweden). Wet gluten was washed from the flour sample, centrifuged through a sieve and the weight of wet gluten forced through the sieve and that of the total wet gluten were

measured. The total wet gluten was expressed as percent of sample and the gluten index was expressed as percentage of wet gluten remaining on the sieve after centrifuging.

Arabic bread baking

Baking was made according to Qarooni et al. (1987). A modified bread formula was chosen for this experiment. Dry ingredients: 700 g flour, 7 g salt and 7 g yeast on dry weight basis (18 different bread treatments were prepared using the different produced baker's yeast treatments: molasses, date syrup and 1:1 molasses to date syrup) at low and high flow rates as described by Al-Eid et al. (2009) and were mixed at low speed for 1 min using Hobart mixer Model A-120 (The Hobart Manufacturing Company, Tory, Ohio), then water was added (30°C) and mixing continued for 2 min at low speed and then for 4 min at medium speed. The optimum amount of water was determined using the formula of Qarooni (1989) and Qarooni et al. (1993), with some modifications based on experimental experience (Baking absorption (%) = $20 + 0.596$ multiplied by the water absorption capacity determined by the farinograph test described above). The dough was then left to ferment in bulk for one hour at 30°C and 85% relative humidity (rh), then it was divided into pieces of 80 g, rounded by hand, covered with a cloth and allowed to relax for 15 min in the same fermentation cabinet. These dough pieces were then flattened by hand and cross sheeted in a machine (0.8 mm thickness). All sheeted doughs were put in a wooden board and transferred into the proofing cabinet for 30 min at 30°C and 85% rh. The proofed pieces were put on a pre-heated solid aluminum tray and baked at 425°C for 100 s in a bench top furnace (Muffle-Thermolyne 6000 Series). Loaves were cooled for 15 min and wrapped in plastic bags.

Yeasts gassing power

Samples of dough prepared as described above were used for the estimation of yeast activity by measuring the gas production ability of the yeast. Since no fermentograph was available, measuring cylinders were used for assessing gas production ability. 20 g of dough was carefully placed in a 100-ml glass measuring cylinder, which was then incubated at 30°C and 90% relative humidity in a National MFG incubator (National MFG. Co., Lincoln, Nebraska). The increase in dough volume due to CO₂ production was measured every 30 min for 2 h (Hamad and Al Eid, 2005).

Sensory evaluation of Arabic bread

A scoring system for quality parameters based on a numerical scale reported by Qarooni et al. (1987) was used. The scores sheet was assigned according to consumer preference in the Middle Eastern countries. At least six loaves of bread (14-16 cm diameter) were baked for each treatment and were evaluated on the first day, then kept overnight at room temperature in plastic bags for evaluation on the second day. On the first day, a total of 47 points were given to external quality factors and 53 points to internal factors, whereas a total of 50 points were given for the second day evaluations. In all cases, the higher the score, the better the individual quality of the breads (Qarooni et al., 1987).

Sensory assessment for bread quality was performed by 13 volunteer panelists chosen among students and technicians from King Faisal University, Saudi Arabia. They were nonsmokers aged 19 - 38 years, semi-trained and received instructions regarding the evaluation procedures both verbally and written. The panelists performed the tests at self-determined pace with no time limit,

though the evaluation sessions were intended to last 15 - 30 min. To minimize adaptation, panelists were instructed to take breaks of 2 - 3 min as they desired and the evaluation was associated with the control. Evaluation was conducted after one hour of baking and on the next day.

Experimental design and statistical analysis

A 3 x 3 x 2 factorial experimental design was employed with three types of substrate, three yeast strains and two feeding flow rates as variables. A randomized block design was chosen to run the experiments. Analysis of variance (Steel and Torrie, 1980) of the data collected during the course of each trial was performed. Analysis of Variance (ANOVA) was performed to estimate the interaction effect among independent variables using SAS software (Ver. 6.02). Least Significant Differences (LSD) ($P > 0.05$) between treatment means was determined using Fisher's test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Flour protein content

The average protein content for flour (80% extraction) used in this study was 13.4%. The results obtained, were similar with results reported by Quail (1990) who found that high extraction flours may have protein contents slightly higher than the corresponding straight run flour. Qarooni et al. (1988) found that the optimum flour protein for Arabic bread was 10-12% whilst Quail et al. (1991) found that flour with a protein content of 9-12% was suitable. So, this protein content was slightly higher than those recommended by Qarooni et al. (1988) and Quail et al. (1991) and may result in a decrease in dough strength and elasticity.

Farinograph

It was found that Farinograph water absorption was 66.6% for flour used in this study. These results were in agreement with those reported by Quail et al. (1991) who, reported that water absorption should be high for flours used for Arabic bread production with Farinograph values ranging from 58 to 65%. Also Qarooni (1988) defined preferred water absorption greater than 60% suitable for Arabic bread. So Farinograph test is a useful complement of baking test because it pinpoints the causes of poor baking performance of flours (Bloksma and Bushuk, 1988).

Wet gluten and gluten index

All reported data are average of three replicates. Gluten of tested flour indicated high wet gluten weight being 29.71 g. On the other hand, the gluten index value and dry gluten content were 99.36% and 11.85 g, respectively. Duska et al. (2001) found that gluten index in flours

Table 1. Gas production power (ml/20g dough) for baker's yeasts (LSD Test*).

Run	Substrate	Flow Rate	Incubation Time (min.)				
			Zero	30	60	90	120
Saf-Instant							
1	Molasses	Low	19 ^b	43 ^a	46 ^a	47 ^b	47 ^d
2	Molasses	High	18 ^c	37 ^b	42 ^d	44 ^e	46 ^e
3	Date Syrup	Low	19 ^b	37 ^b	44 ^b	47 ^b	47 ^d
4	Date Syrup	High	18 ^c	35 ^d	43 ^c	46 ^c	46 ^e
5	1:1	Low	21 ^a	35 ^d	42 ^d	46 ^c	50 ^a
6	1:1	High	17 ^d	35 ^d	42 ^d	45 ^d	46 ^e
Hollandia							
7	Molasses	Low	18 ^c	34 ^e	44 ^b	46 ^c	49 ^b
8	Molasses	High	18 ^c	22 ^m	29 ⁱ	37 ⁱ	42 ^j
9	Date Syrup	Low	18 ^c	31 ^f	41 ^e	45 ^d	48 ^c
10	Date Syrup	High	17 ^d	26 ⁱ	36 ^f	44 ^e	46 ^e
11	1:1	Low	17 ^d	29 ^j	33 ^g	45 ^d	46 ^e
12	1:1	High	17 ^d	24 ^k	33 ^g	41 ^g	44 ^g
Strain NCYC 1530							
13	Molasses	Low	18 ^c	31 ^f	42 ^d	44 ^e	45 ^f
14	Molasses	High	18 ^c	23 ^l	31 ^h	36 ^j	42 ^j
15	Date Syrup	Low	19 ^b	25 ^j	42 ^d	43 ^f	45 ^f
16	Date Syrup	High	18 ^c	34 ^e	43 ^c	44 ^e	46 ^e
17	1:1	Low	18 ^c	27 ^h	42 ^d	43 ^f	45 ^f
18	1:1	High	18 ^c	23 ^l	31 ^h	39 ^h	43 ^h
Control*			18 ^c	36 ^c	46 ^a	49 ^a	50 ^a

Control = Hollandia Yeast.

Within each column, means with the same letter are not significantly different.

made from the most important Croatian wheat cultivars varied from 55.92 to 99.6%. Pylar (1988) reported that a more or less definite correlation also exists between the wet and dry gluten values, with those for wet gluten being slightly over three times higher than that for dry gluten. The ratio of wet to dry gluten was used as an index of protein quality with the belief that the water-holding capacity represents a significant quality attribute. The quantity and quality of gluten were considered the most important quality parameter of wheat flour responsible for physical dough properties (Duska et al., 2001).

Falling number

The falling number is a method of determining the relative level of alpha amylase activity. The falling number of the experimental flour was 447 s. However, Brain (2005) indicated that a falling number value of 350 s or longer indicated low enzyme activity and very sound wheat. As the amount of enzyme activity increases, the

falling number decreases. Values below 200 s indicated high level of enzyme activity.

Yeast activity (gas production power)

Samples of the prepared bread dough used for Arabic bread making were also used for estimation of yeast activity through gas production ability. Values of gas production power (ml/20 gm dough) of the different experimental yeast treatments are presented in (Table 1). It could be noted that there were significant differences due to the substrate used in yeast propagation and also for the flow rate used. However, there was insignificant effect to yeast strain in this respect. The highest significant effect on the gas production power was noticed for the flow rate. Usually, the baker's yeast produced using the low flow rate showed significantly higher gas production power than those produced following the high flow rate system.

Concerning the substrate used in the yeast production, it could be noticed there were insignificant differences for

Table 2. F- Factors (Analysis of Variance) of Arabic Bread.

Quality attribute	Yeast	Substrate	Flow rate	Yeast* Substrate	Yeast* Flow rate	Substrate* flow rate	Yeast *Substrate *Flow rate
Crust smoothness	19.1***	7**	51**	4.8*	16**	NS	4.6**
Shape	4.2*	11.2**	NS	8***	37.2***	7.5**	99***
Crust color	6.3**	NS	NS	14.75***	6.8**	NS	6.2**
Cracks	7.2**	9.5**	21.8**	2.9*	22.3***	NS	2.3***
Blisters	34***	8**	NS	4.8*	28.1***	NS	10.4***
Roll and fold (1)	NS	8**	29.7**	NS	7.5**	NS	7***
Separation of layers	NS	13**	NS	26***	NS	45***	NS
Evenness of Layer	NS	NS	NS	3.9**	NS	NS	11.7***
Grain appearance	NS	NS	NS	NS	NS	NS	NS
Grain uniformity	NS	NS	NS	NS	NS	NS	3.3*
Crumb texture	NS	NS	NS	NS	NS	NS	NS
Tearing quality (1)	5.4*	NS	30.2**	NS	NS	NS	3.6*
Crumb color	18***	83.1***	NS	NS	7.1**	NS	NS
Roll and fold (2)	NS	99***	402***	19.9***	25.***	NS	32***
Tearing quality (2)	133**	18.6***	NS	NS	26.1***	24.5***	999***
Total	8**	79***	29**	8.5***	999***	NS	999***

* = Significant at $p \leq 0.1$; ** = Significant at $p \leq 0.05$; *** = Significant at $p \leq 0.01$; NS = Not Significant.

the gas production power between yeasts produced using either molasses or date syrup substrates. However, the highest gas production power was noticed for yeasts produced using 1:1 molasses to date syrup substrate at the low flow rate system after 60, 90 and 120 min of incubation. These conditions of growth gave biochemical properties of the yeast a special emphasis and demand specific measures to ensure high quality and efficient dough aeration (Stear, 1990). Joshi et al. (2005) used Apple Pomace in Comparison to Molasses under fed batch cultivation for baker's yeast production. There was no appreciable difference in the dough raising capacity of the produced yeast compared to the commercial yeast. These findings demonstrated that apple pomace is a comparable energy source for the production of baker's yeast. The technological role of yeast in wheat flour dough is a strong alcoholic fermentation with extensive carbon dioxide liberation. The gassing power of pressed yeast depends on the zymase enzyme-complex of the yeast cells and available fermentable carbohydrates (Stear, 1990). The differences in the gassing power in the produced yeasts used in this work might be due to the various maltase and zymase activities of these yeasts.

Arabic bread quality

The effect of the three selected baker's yeast strains produced from date syrup and molasses substrates under low and high flow rates on the quality of Arabic bread was investigated. Analysis of Variance (ANOVA) was performed to estimate the interaction effect among

independent variables. Separation of means among all external and internal quality parameters were analyzed using least significant parameters, Fisher's (LSD) test.

Crust smoothness and shape

The ANOVA analysis showing the effect of baker's yeasts from different fermentation treatments on Arabic bread quality can be observed in (Table 2). There was strong interaction of Yeast*Substrate*Flow rate effect on crust smoothness ($p \leq 0.05$) and shape ($p \leq 0.01$) values of Arabic bread. Breads made with yeasts from date syrup showed no significant decrease in crust smoothness and shape among all yeast strains compared to those produced using molasses. Arabic bread made with yeasts and produced under the following parameters: 1:1 molasses to date syrup, Hollandia yeast and high flow rate (Treatment # 12) showed the highest score for bread shape as compared with other treatments (Table 3). All breads showed a marked significant variation in crust smoothness.

Crust color, cracks and blisters

Arabic bread showed a marked variation in crust color, cracks and blisters among all treatments. There is a strong significant interaction effect Yeast*Substrate*Flow rate on crust color ($p \leq 0.05$) as well as blister appearance and crakes ($p \leq 0.01$) of the Arabic bread as shown in Table 2. It could also be noted from results of

Table 3. Quality characteristic of Arabic bread (LSD Test*).

Treatment	Substrate	Flow rate	Crust smoothness (5)	Shape (8)	Crust color (8)	Cracks (8)	Blisters (8)	Rolling and folding (1) (10)	Separation of layers (15)	Evenness of layers (5)	Grain appearance (5)	Grain uniformity (5)	Crumb texture (8)	Tearing quality (1) (10)	Crumb color (5)	Rolling & folding (2) (30)	Tearing quality (2) (20)	Total (150)
Saf-Instant																		
1	Molasses	Low	4.5 ^c	6 ^d	7.8 ^{ab}	6.8 ^b	8 ^b	10 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	4.8 ^{ab}	13.3 ^{ef}	9.3 ^c	115.9 ^{hi}
2	Molasses	High	4.7 ^c	7 ^b	7.7 ^{abc}	6.9 ^{ab}	8 ^b	10 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	4.6 ^c	11.3 ^{gh}	9.6 ^c	115.1 ⁱ
3	Date Syrup	Low	5 ^a	7 ^b	8 ^a	6.9 ^{ab}	8 ^b	10 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	5 ^a	13.9 ^{de}	9.8 ^{bc}	119.8 ^{cde}
4	Date Syrup	High	4.8 ^{bc}	7 ^b	8 ^a	6.9 ^{ab}	6.9 ^e	10 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	5 ^a	13.3 ^{ef}	9.6 ^c	116.5 ^{fgh}
5	1:1	Low	5 ^a	7 ^b	8 ^a	6.9 ^{ab}	6 ^b	10 ^a	14.8 ^b	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	5 ^a	13.5 ^{de}	9.3 ^c	117.3 ^{efg}
6	1:1	High	4.9 ^{ab}	7 ^b	7.8 ^{ab}	6.9 ^{ab}	7.6 ^{cd}	10 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	4.8 ^{ab}	11.6 ^{efg}	9.5 ^c	115.4 ⁱ
Holendia																		
7	Molasses	Low	5 ^a	7 ^b	8 ^a	6.9 ^{ab}	7.8 ^{cb}	10 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	7.7 ^e	4.5 ^d	9.3 ⁱ	7 ^d	109.9 ^{jk}
8	Molasses	High	4.5 ^c	6.7 ^b	7.8 ^{ab}	6.9 ^{ab}	8 ^b	10 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	4.7 ^c	9.3 ⁱ	6.2 ^e	108.3 ^k
9	Date Syrup	Low	5 ^a	7 ^b	7 ^e	6.9 ^{ab}	7.5 ^d	10 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	7.9 ^{ab}	5 ^a	21.6 ^a	8 ^d	123 ^a
10	Date Syrup	High	5 ^a	7 ^b	8 ^a	6.9 ^{ab}	8 ^b	9.8 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	7.9 ^{ab}	5 ^a	14 ^{de}	9.6 ^c	116.5 ^{cde}
11	1:1	Low	4.8 ^{bc}	7 ^b	7.7 ^{bc}	6.9 ^{ab}	7.8 ^{bc}	10 ^a	15 ^{ab}	4.8 ^b	5 ^a	5 ^a	7 ^a	7.8 ^d	4.8 ^{ab}	18 ^b	8 ^d	119 ^{bcd}
12	1:1	High	4.8 ^{bc}	7.9 ^a	7.9 ^{ab}	6.9 ^{ab}	8.3 ^a	8.8 ^c	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	7.9 ^c	5 ^a	12.3 ^{efg}	9.3 ^c	116.1 ^{gh}
Strain																		
13	Molasses	Low	5 ^a	7 ^b	7.2 ^{de}	6.9 ^{ab}	8 ^b	9.8 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	4.6 ^c	13.3 ^{ef}	12.3 ^a	116.1 ^{def}
14	Molasses	High	5 ^a	6.6 ^{cb}	7.5 ^{cd}	6.4 ^c	8 ^b	9.3 ^{bc}	14.6 ^c	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	4.5 ^d	10 ^{hi}	9 ^c	111 ^j
15	Date Syrup	Low	5 ^a	7 ^b	8 ^a	6.9 ^{ab}	8 ^b	10 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	5 ^a	13.6 ^{de}	12.3 ^a	120 ^{bcd}
16	Date Syrup	High	5 ^a	6.3 ^{cd}	7.9 ^{ab}	6.9 ^{ab}	8 ^b	9.6 ^{ab}	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	5 ^a	16 ^c	12 ^a	121 ^{ab}
17	1:1	Low	5 ^a	7 ^b	7.8 ^{ab}	7 ^a	8 ^b	9.6 ^{ab}	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	8 ^a	4.8 ^{ab}	14 ^{de}	12.6 ^a	121 ^{ab}
18	1:1	High	5 ^a	6.1 ^d	7.7 ^{bc}	6.5 ^c	8 ^b	9.6 ^{ab}	15 ^{ab}	4.8 ^b	5 ^a	5 ^a	7 ^a	8 ^a	4.8 ^{ab}	15 ^c	10.6 ^b	118.7 ^{cde}
	Control		4.8 ^{bc}	6.9 ^b	8 ^a	7 ^a	7.8 ^{bc}	9.8 ^a	15 ^{ab}	5 ^a	5 ^a	5 ^a	7 ^a	7.8 ^{ab}	5 ^a	13 ^f	9 ^c	115.1 ⁱ

Table 3 that there were insignificant difference in crust color, cracks and blisters in case of using date syrup baker's yeast as compared with those of molasses, but yeast produced from 1:1 date syrup to molasses showed the highest score for these bread properties.

Ability to roll and fold

The ability of Arabic bread to roll and fold was evaluated for the first and second day after baking. There was a strong interaction effect Yeast*Substrate*Flow rate on the roll and fold features of Arabic bread in the first day and in the second day ($P \leq 0.01$) as can be seen from Table 2. Arabic bread made with yeast produced using date syrup as a substrate, low flow rate and Hollandia yeast (treatment # 9) scored the highest value on the ability to roll and fold on the first as well as on the second day (Table 3).

Separation and evenness of layers

There was insignificant interaction effect due to the Yeast*Substrate*Flow rate on the quality of separation of layers. However, there was a strong interaction effect ($P \leq 0.01$) due to the Substrate*Flow rate on the quality of separation of layers (Table 2). There was a significant interaction effect ($P \leq 0.01$) due to the Yeast*Substrate*Flow rate on the evenness of layers. Arabic breads showed insignificant variation in the scores of both separation and evenness of layers among all treatments (Table 3) which indicated that the use of date syrup baker's yeast resulted in good quality Arabic bread.

Grain appearance, grain uniformity, crumb texture and crumb color

There was insignificant interaction effect due to the yeast, substrate, flow rate as well as their interactions on grain appearance, grain uniformity, crumb texture and crumb color. However, the only significant interaction effect ($P \leq 0.01$) was due to the Yeast*Substrate*Flow rate on the grain uniformity and effect ($P \leq 0.05$) due to Yeast*Flow rate on crumb color. There was strong effect ($P \leq 0.01$) due to substrate on crumb color (Table 2). All Arabic breads showed no significant differences in values of grain appearance, grain uniformity and crumb texture among all treatments (Table 3). Breads made with yeasts produced from date syrup only showed the highest crumb color scores (Table 3).

Tearing quality

The ability of Arabic bread to tear in an acceptable

manner was evaluated for the first and the second days. The interaction effect due to Yeast*Substrate*Flow rate on the tearing feature of Arabic white bread was significant in the first day and in the second day ($P \leq 0.1$) (Table 2). Tearing quality of Arabic bread made with yeasts from Saf-Instant and The NCYC 1530 Strain showed insignificant variations in tearing quality in the first day as could be seen from Table 3. However, there was a marked significant variation in tearing quality of Arabic bread in the second day among all treatments (Table 2).

Total score

There was a significant interaction effect due to the Yeast*Substrate*Flow rate on the total score of the Arabic bread ($P \leq 0.01$) as can be seen in Table 2. Ferrari et al. (2001) produced Baker's yeast production from molasses/cheese whey mixtures, Molasses substitution of 46%, in terms of sugar fed to the bioreactor, was reached and no significant differences in baking quality was observed. One out of 18 treatments exhibited the highest overall total quality bread score. Nine treatments was the Arabic bread made with yeast produced using date syrup, low flow rate and Hollandia yeast as shown in Table 3. Two treatments (16 and 17) also exhibited a high total quality bread score (Table 3). One of these two treatments were the Arabic breads made with yeast produced using date syrup, high flow rate and NCYC 1530 yeast strain. The second was the Arabic bread with yeast made from 1:1 molasses to date syrup, NCYC 1530 yeast strain and low flow rate. Pylar (1988) reported that bread doughs prepared only from flour, water, yeast and salt (such as Arabic bread) will initially contain only about 0.5% of glucose and fructose derived from the flour. This is adequate to start fermentation and to activate the yeast's adaptive maltozymase system that is responsible for maltose fermentation. Different yeast strains have been shown to vary in their maltase activity and may also exhibit variable maltase activity under different dough conditions. Yeast itself brings same changes in the bread dough in the course of fermentation, such as depletion of fermentable substances, accumulation of products in the form of carbon dioxide, alcohols, acids and esters, modification of pH conditions, and softening or mellowing of the gluten character. In this present study, all of these factors may have contributed to the quality differences among baker's yeast produced in this study.

Conclusion

Baker's yeasts produced using the date syrup substrate gave baking results and gas production power comparable to those of yeasts produced from molasses, indicating

that using date syrup as substrate for beaker's yeast production results in excellent quality yeasts to be used in the baking industry.

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