Wine Yeast Preferment for Enhancing Bread Aroma and Flavor[1,2]

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ABSTRACT

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A liquid preferment containing water, flour, sucrose, and wine yeast was optimized to enhance bread aroma and flavor by time and temperature of prefermentation and yeast and flour concentration. Thirteen commercial or type yeast strains were compared for gas production and formation of volatile compounds different than baker's yeast. Four yeast strains were subjected to final screening but Flor Sherry yeast gave the most interesting aroma. Compared to bread made by the sponge-and-dough process, crumb and crust of bread prepared from preferment with Flor Sherry yeast contained more 2-butanone and unknown compound D but less ethanol (crumb only), unknown compound A, unknown compound C (crumb only), acetoin, diacetyl, acetaldehyde (crumb only), acetone, and unknown compound B.

Aroma and flavor are of major importance in bread quality. Ingredients as well as fermentation and baking conditions affect the intensity of bread aroma and flavor. In the baking industry, there is some trend towards the use of short breadbaking processes (no-time compared to sponge-and-dough), especially with reduced fermentations that can limit the development of bread aroma and flavor. Microorganisms have been very useful to develop flavor and aroma for bread or other food (Margalith 1981). The use of specific bacterial cultures (Kline 1979) or fermented dairy ingredients (Gélinas and Lachance 1995) have been proposed to enhance bread aroma and flavor. Some authors have combined lactic acid bacteria and yeast for the preparation of sour dough type bread (Spiller 1989, Lynn 1993). These breads can be slightly or strongly acidic.

The use of yeast, without lactic acid bacteria, has been used but does not lead to sour dough type bread flavors. Dassoux (1993) has proposed that bread be prepared with Champagne yeast instead of baker's yeast but no effect on bread flavor has been claimed. Biremont (1993) used yeast present on grapes to prepare a ferment. Williams and Luksas (1981) patented a process involving specific yeast cultures to rapidly produce aromatic compounds in regular breadbaking methods, except that these yeasts could not use sucrose. This area of research is attractive because wine yeast produces most of the volatile compounds involved in the aroma and flavor of wine (Suomalainen and Lehtonen 1979, Nykänen 1986). Such aromatic compounds include alcohols, aldehydes, and fatty acids and their esters. Fermentations involved in winemaking and breadbaking are somewhat related because yeast is involved in the fermentation of grape must or wheat flour. However, in grape fermentation as compared to dough fermentation, the temperature is often lower (10–30°C), the duration of the fermentation is much longer (days instead of hours), and the medium (must) is liquid instead of semi-solid (sponge) or solid (dough). Liquid preferments have been used by the baking industry; their main problem is the lack of flavor in the bread prepared from them (Kulp 1986). Wine yeasts are generally considered to be better flavor producers than baker's yeasts, and their use in liquid preferments might improve this process. Baker's yeast would play its regular role in gas production and wine yeast would add a special bouquet to the bread while contributing, to some extent, to gas production and dough proofing. Compared to baker's yeast, wine yeasts might produce more rapidly interesting aromatic compounds and precursors to slightly enhance bread flavor.

In this article, we report on the development of a wine yeast liquid preferment. Thirteen wine yeasts were screened to determine the characteristics and intensity of their aroma with the objective of finding one with aroma production very different than baker's yeast. Using a low concentration of sucrose in preferment and dough, we also studied the profile of volatile compounds in relation to the time and temperature of prefermentation, as well as flour and yeast concentration.

MATERIALS AND METHODS

Yeast Strains

Eight commercial and five ATCC yeast strains were tested. Envelopes of commercial yeast samples were kept at –20°C and, except where indicated, they were rehydrated in 30 ml of distilled water at 38°C for 15 min. Commercial yeasts were: Bernkastel (Kitzinger Reinheife, Germany), Fermichamp (*Saccharomyces bayanus*; Gist-brocades, Seclin, France), Fermivin (*S. cerevisiae*; Gist-brocades), Flor Sherry (*Torulaspora delbrueckii*; Red Star Yeast & Products, Milwaukee, WI), Lalvin EC-1118 (*S. bayanus*; Lallemand Inc., Montreal, QC, Canada), Lalvin K1-V1116 (*S. cerevisiae*; Lallemand Inc.), Lalvin 71B-1122 (*S. cerevisiae*; Lallemand Inc.), and Pasteur Champagne (*S. bayanus*; Red Star Yeast & Products). Type strains were selected because they have been found on grapes, in fruit juices, or in wine musts (ATCC, Rockville, MD): *Citeromyces anomala* ATCC 34087, *Hansenula anomala* ATCC 34080, *S. bayanus* ATCC 13055, *T. delbrueckii* ATCC 34086 and *T. pretoriensis* ATCC 58648. The standard was instant active dry baker's yeast (Fleishmann, Ville Lasalle, QC, Canada).

Preparation of Preferment

A large batch of liquid preferment (preferment 1) was prepared in triplicate with 0, 100, 200, or 300 g of flour (hard red spring wheat, containing 13.8% protein, 0.54% ash and 11.6% moisture; Keynote 80; Robin Hood Multifoods Inc., Montreal, QC, Canada), 0, 20, 40, or 60 g of sucrose and 750 g of water. Flour and sucrose were sieved then mixed with water in a Hobart mixer (model N-50). From each type of preferment 1, four 143-g portions of preferment (preferment 2) were poured into Risograph jars containing 2 g (dwb) of yeast previously rehydrated. After adding a magnetic stir bar, jars were closed, placed on a mixing plate (250 rpm) and connected to a Risograph (RDesign,

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Pullman, WA) at room temperature. In a second series of assays, preferments 2 were placed at 28 or 38°C (without mixing) and contained 0.5, 1.0, or 1.5 g of yeast (dwb).

Growth of Yeast

Yeast (≈1 g) from a commercial envelope was rehydrated at 38°C in about 10 ml of malt broth (Difco Laboratories, Detroit, MI). An inoculated loop was used to spread this dilution on malt agar slopes that were incubated at 30°C for 24 hr. One colony was isolated from a tube, diluted in about 10 ml of malt broth, and used to inoculate a series of tubes containing malt agar with bacto agar (0.7%) that were incubated at 30°C for 48–72 hr. Tubes were then covered with sterile paraffin oil and kept at 4°C.

Type yeast strains were rehydrated according to ATCC (Rockville, MD). They were grown on yeast malt broth (Difco) for 24 hr at 24°C, then kept at 4°C on yeast malt agar slopes covered with sterile paraffin oil.

The method of yeast production was adapted from Gélinas et al (1993). Malt broth (6 ml) (Difco) was inoculated using a loop taken from a malt agar slope; 600 μl was used to inoculate two 125-ml Erlenmeyer flasks containing 40 ml of malt broth. Flasks were incubated for 24 hr at 30°C with 120 rpm shaking (Lab-Line Instruments Inc., Melrose Park, IL). Each culture was used to inoculate a 1-L Erlenmeyer that was incubated for 18 hr at 30°C with 120 rpm shaking. Cultures were then centrifuged at 5,500 rpm (5,350 × *g*) for 10 min. The supernatant was decanted, and the cell pellets were washed twice with sterile deionized water, centrifuged, and resuspended into water; the resulting yeast cream was stored at 4°C. Yeast dry weight was determined according to Gélinas et al (1993).

Relationship Between Gas Production and Total Volatile Compounds

In duplicate, 3 × 170 g of preferment 1 (300 g of flour, 60 g of sucrose, 750 g of water) was poured into Risograph jars containing 1 g (dwb) of Flor Sherry yeast strain (produced as described above). Jars were then connected to the Risograph and fermentation was performed at 38°C for 60, 120, 180, or 240 min. Then, 48 g of ethanol was added to each test preferment to stop the fermentation. After mixing for 1 min with a magnetic stir bar, the content of each Risograph jar was transferred into plastic tubes, cooled on ice, and stored at −30°C. Analysis of volatile compounds was performed as described below.

Yeast Screening

Commercial wine yeast samples were first screened. In duplicate, 4 × 170 g of preferment 1 (300 g of flour, 60 g of sucrose, 750 g of water) was poured into Risograph jars containing 1.5 g (dwb) of commercial dry yeast (rehydrated previously). Jars were then connected to a Risograph and incubated for 105 min at 28 or 38°C. The final volume of gas produced during each fermentation was noted and preferments were then smelled at least twice and compared to the control (preferment prepared with instant dry yeast). First, we searched for preferments with aroma markedly different than that obtained with baker's yeast, but high gas production was also interesting because it could reduce the quantity of baker's yeast to be added later to the dough.

A second test was performed as described above except that both the commercial yeast samples previously screened and the type strains that were grown in the laboratory (as described previously) were used. Preferments 2 contained 160 g of preferment 1 and 1 g of yeast (dwb). The most interesting preferments were also tested in a test bread recipe (based on 400 g of total flour): flour 90%, water 30.3%, instant active dry baker's yeast 1%, shortening 3%, ascorbic acid 100 ppm, and the content of one preferment 2. In the latter recipe, 10% of total flour, 20% of total yeast, 100% of total sucrose, and 54% of total water came from the preferment 2. Dry ingredients were mixed for 1 min at low speed in a Hobart mixer (model C-100). The other ingredients, except yeast, were then added and mixed for 30 sec. After addition of baker's yeast, dough was mixed 4 min at speed 1 and 2 min at speed 2. Two pieces of dough (340 g each) were rounded mechanically (Mono Equipment Ltd., Swansea, UK), bench-

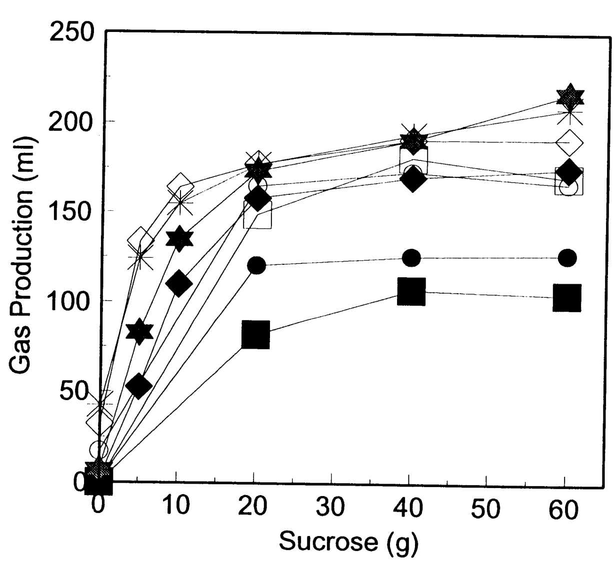

Fig. 1. Gas production by wine yeast as function of sucrose, flour, and mixing conditions. Gas production tests were performed in triplicate (each with four test preferments) at room temperature (≈23°C) over 105 min with a 143-g portion of liquid preferment that was poured into a Risograph jar (test preferment) containing 2 g (dwb) of commercial yeast Lalvin EC-1118 previously rehydrated in 30 ml of distilled water at 38°C for 15 min. ■ = 0 g of flour; □ = 0 g of flour with mixing; ● = 100 g of flour; ○ = 100 g of flour with mixing; ♦ = 200 g of flour; ◊ = 200 g of flour with mixing; ★ = 300 g of flour; * = 300 g flour with mixing.

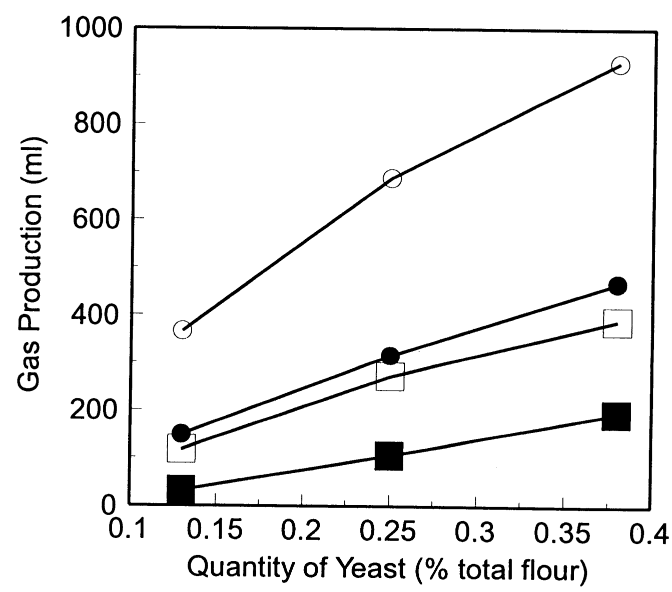

Fig. 2. Gas production as function of temperature and quantity of wine or baker's yeast. Preferment 1 contained 300 g of flour, 60 g of sucrose and 750 g of water. Gas production tests were performed in triplicate (each with four test preferment) over 105 min with a 143-g portion of liquid preferment that was poured into a Risograph jar containing 0.5, 1.0, or 1.5 g (dwb) of commercial wine yeast Lalvin EC-1118 or instant dry baker's yeast previously rehydrated in 30 ml of distilled water at 38°C for 15 min. Concentrations of yeast corresponded to 0.13, 0.25, or 0.38%, based on the weight of total flour used to prepare bread. ■ = wine yeast, 28°C; □ = wine yeast, 38°C; ● = baker's yeast, 28°C; ○ = baker's yeast, 38°C.

rested for 10 min, molded, and proofed for 70 min at 40°C and 100% rh. Doughs were baked at 210°C for 20 min. Loaf volume was measured by rapeseed displacement after the breads had cooled for 1 hr. Breads were then sliced mechanically, placed into two plastic bags and stored at –30°C. Two batches of six breads were prepared for each yeast strain.

Optimization of Flor Sherry Wine Yeast Preferment

Conditions for the preparation of liquid preferments were the same as described above (yeast screening) except that: commercial Flor Sherry yeast was used in this series of experiments, 4 g of yeast (dwb) was used in preferments instead of 1 g, 60 ppm of potassium bromate was added in the dough formulation, pieces of dough weighed 330 g instead of 340 g, bench-resting of dough was 30 min instead of 10 min, and doughs were proofed to constant height (2.5 mm above rim of pan) instead of constant time. Duration of prefermentation was either 1.5, 4, 12, or 24 hr, at 30 or 38°C. For 24-hr preferments, 2 g of yeast was also tested. The effect of flour concentration in preferments was also tested (on the basis of total flour present in dough). In these experiments, 40% flour was compared to 10% (standard preferment), meaning that four times the amount of flour was added to the global preferment 1.

Reference bread was produced by the sponge-and-dough process. The test recipe (based on 250 g of flour) used for the sponge was: flour (Keynote 80, Robin Hood Multifoods) 60%, water 57%, and compressed yeast (30% moisture; Lallemand Inc.) 2.75%. The latter ingredients were mixed for ≈1 min with a Swanson mixer (National Mfg., Lincoln, NE), placed in a stainless steel bowl, and fermented for 4 hr at 25°C and 80% rh. The dough formulation was: sponge 92%, flour 40%, sucrose 5%, water 3%, shortening 2.5%, and salt 2%. Dough was mixed for 1.5 min with the Swanson mixer, and processed as described previously (yeast screening).

Volatile Compounds Analysis

Volatile compounds were extracted by steam distillation (six extractions). A 30-g sample of liquid preferment or bread crumb or crust taken from five slices of bread (center of the loaf) and diluted with 14 ml of water and 4-methyl-1 pentanol (50 ppm) added as internal standard (Hansen et al 1989a,b). Samples were distilled at 65°C in a 250-ml flask. Distillate (≈5 ml) was collected and 3 ml was used for head-space sampling. Salting out was facilitated by adding 1.8 g of sodium sulfate to the samples, which were heated at 90°C in an oil bath for 123 min before head-space sampling (Hewlett-Packard, model 19395-A, Avondale, PA). This procedure was dependent on the equipment used, but in preliminary tests, the effect of heating time (15 min compared to 123 min) had no effect on the profile of volatile compounds.

Separation was performed by gas-liquid chromatography (Hewlett-Packard, model 5890 series II) using a DBWAX column (30-m length × 0.32-mm i.d.; J & W Scientific, Folsom, CA) and a flame-ionization detector. Injection used a split-mode with a ration of 10:1 and the rate of addition of helium was 2.5 ml/min. After 12 min, the oven temperature was raised from 35 to 150°C at a rate of 10°C/ min, with a 10-min hold at the end. The injection port and flame detector were maintained at 250°C and 200°C, respectively. Results were expressed as total relative area of volatile compounds (sections on yeast screening and optimization of preferment) or relative area of each volatile compound when standards were available to identify peaks (section on optimization of preferment).

Statistical Methods

Analysis of variance was performed at the 5% significance level and differences between treatment levels were tested by Duncan, using the general linear models procedure (SAS Institute, Cary, NC).

TABLE I
Aroma and Gas Production of Commercial Yeast Samples in Liquid Preferment at 28 or 38°C[a]

Yeast	Gas Production (ml)		Aroma Intensity		Aroma Description
	28°C	38°C	28°C	38°C	
Baker's yeast[b]	468	929	++	+++	Apple juice, flower
Flor Sherry[b]	135	329	+	++	Citrus, flower (intense)
Fermivin[b]	355	674	++	+++	Apple juice, flower
Lalvin 71B-1122	187	344	+	++	Apple juice, flower
Lalvin EC-1118	194	424	+	++	Apple juice, flower
Bernkastel	154	357	+	+	Flower
Lalvin K1-V1116	248	480	–	+	Flower (weak)
Fermichamp	105	254	–	+	Flower (weak)
Pasteur Champagne	58	146	–	–	Flower (weak)

[a] Gas production tests performed in duplicate (each with four preferments 2) with a 170-g portion of preferment 1 (300 g of flour, 60 g of sucrose and 750 ml of water) poured into a Risograph jar (preferment 2) containing 1.0 g of yeast (dwb) previously rehydrated in 30 ml of distilled water at 38°C for 15 min.
[b] Yeast retained for further testing.

TABLE II
Effect of Laboratory Grown Yeast Strains on Gas Production and Aroma in Liquid Preferment at 28 or 38°C[a]

Yeast	Gas Production (ml)		Aroma Intensity		Aroma Description
	28°C	38°C	28°C	38°C	
Baker's yeast	188	598	+	++	Apple juice, flower
Flor Sherry[b]	132	385	+	++	Citrus, flower (intense)
Fermivin	175	545	+	++	Apple juice, flower
Torulaspora delbrueckii (34086)	271	487	+	++	Grape juice
Saccharomyces bayanus (13055)	132	416	+	+++	Flower, fruit
Hansenula anomala (34080)	136	283	+	++	Nuts
Torulaspora pretoriensis (58648)	22	115	–	+	Apple juice, flower

[a] Gas production tests performed in duplicate (each with four preferments 2) with a 160-g portion of preferment 1 (300 g of flour, 60 g of sucrose and 750 ml of water) poured into a Risograph jar (preferment 2) containing 1.0 g of yeast (dwb) previously rehydrated in 30 ml of distilled water at 38°C for 15 min.
[b] Yeast retained for further testing.

RESULTS AND DISCUSSION

Effect of Preferment Conditions on Yeast Activity

The effect of flour, sucrose, and mixing on yeast gas production after 105 min is shown in Figure 1. The presence of sucrose in preferment had a major stimulating effect on yeast gas production. The presence of high concentrations of flour (200–300 g compared to 0–100 g) also improved gas production, but to a lesser extent. Mixing only had a significant effect ($P < 0.05$) on yeast gas production when low concentrations (0 or 100 g) of flour were present in the liquid preferment. This may be due to sedimentation problems that occurred under these conditions, because the higher the preferment viscosity, the lower the effect of mixing. In addition, flour proteins probably had a buffering effect that reduced the inhibition of yeasts by acidity (Kulp 1986). At the concentrations tested, sugar did not inhibit yeast activity. This was expected since wine yeast usually tolerate high concentrations of sugar in wine musts (Lafon-Lafourcade 1983).

The effect on gas production (after 105 min) of two incubation temperatures and two types of yeast at different concentrations is shown in Figure 2. Liquid preferments are usually prepared at 28–29°C (10% flour) or 26–27°C (50% flour and more) (Pyler 1988). From the results presented, at 28°C, commercial wine yeast that was used had a lower activity than baker's yeast while at 38°C, gas production of wine yeast was about equivalent to that of instant active dry baker's yeast at 28°C. In liquid preferments prepared with commercial baker's yeast, 0.5–3.5% (wb, compared to weight of preferment) of yeast is normally used, corresponding to 0.15–1.05% (dwb). For this reason, the concentration of wine yeast was fixed to a similar concentration of 0.4% (flour basis) corresponding to 0.9% (dry weight of yeast compared to the weight of preferment).

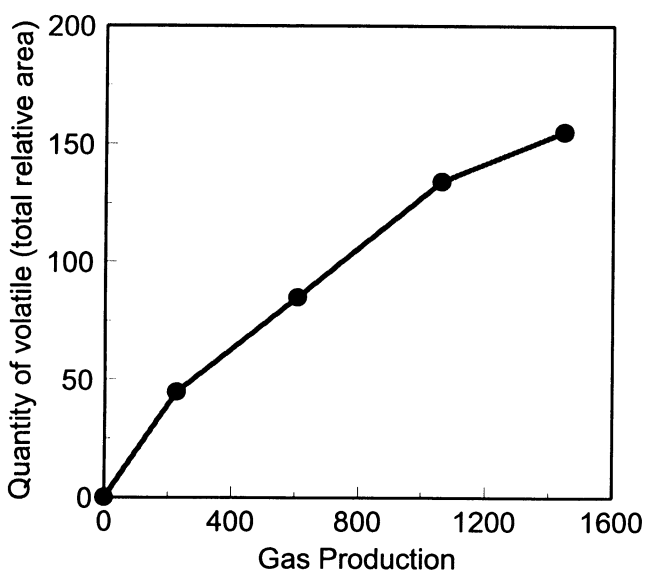

Fig. 3. Relationship between gas production and concentration of volatile compounds in test preferment. Gas production tests were performed in triplicate (each with two test preferments) at 38°C for 0, 1, 2, 3, or 4 hr with two 170-g portions of preferment 1 poured into a Risograph jar containing 1.0 g (dwb) of Flor Sherry wine yeast produced in laboratory.

Screening of Yeast

Preliminary screening involved eight commercial dry yeasts which were tested directly in preferments without having to produce the yeasts. Table I shows that these wine yeasts varied markedly according to characteristics and intensities of aroma developed. After 105 min of fermentation, most yeasts tested did not develop aroma distinct from that of the control (baker's yeast). Flor Sherry yeast was an exception: the aroma of its preferment was very special compared to that of baker's yeast and it was an acceptable gas producer compared to the others. Commercial yeasts Lalvin 71B-1122, Fermivin, and Lalvin EC-1118 gave preferments with aromas very close to that of baker's yeast, but slightly more intense. Considering the intense activity (gas production) of Fermivin, it was decided to retain Fermivin yeast as well as Flor Sherry yeast for future screening test in which yeasts were grown in the laboratory. The four other commercial wine yeast samples were eliminated because they produced liquid preferments with neutral or poor aroma (Lalvin K1-V1116, Fermichamp, Pasteur Champagne and Bernkastel).

The final screening results of the yeast samples grown under identical conditions in our laboratory are shown in Table II. Two commercial yeasts (Flor Sherry and Fermivin) and five ATCC strains were compared according to their gas-producing activity and, most important, the aroma of their preferment and breads. Two ATCC strains were eliminated because of their low biomass yields (*C. anomala* ATCC 34087) or because of their weak gas production in preferment and lack of aroma development (*T. pretoriensis* ATCC 58648). Fermivin yeast was very active in preferments but its aroma was too close to that produced by baker's yeast compared to Flor Sherry and the three other type strains (*H. anomala* ATCC 34080, *S. bayanus* ATCC 13055 and *T. delbrueckii* 34086) which produced aroma that was different than that of baker's yeast. When bread was prepared with preferment containing the latter type strains, its loaf volume was not very different compared to that prepared with baker's yeast. Aroma and concentration of volatile compounds in crumb or crust were not significantly different among all yeasts except for Flor Sherry yeast, which had a distinct and more intense aroma (data not

TABLE III
Effect of Prefermentation Duration on Dough Proof Time, Specific Loaf Volume, and Concentration of Total Volatile Compounds in Crumb and Crust[a]

			Volatile Compounds (total relative area)	
Prefermentation (hr)	Proof Time (min)	Specific Volume (cm^3/g)	Crumb	Crust
Control	42e	6.02a	7,416a	3,521a
1.5	70d	5.61bc	4,080c	2,231b
4	79bc	5.67bc	5,435bc	2,977ab
12	84ab	5.58c	5,977ab	3,285a
24	90a	5.88ab	5,457bc	2,654ab
24[b]	86ab	5.81abc	5,642bc	3,330a

[a] Means in a column followed by the same letter are not significantly different at the 5% significance level (Duncan). Except where indicated, dough was prepared in four replicates (each dough yielded two breads) with one 160-g portion of preferment 1 (300 g of flour, 60 g of sucrose, and 750 ml of water) poured into a Risograph jar (preferment 2) containing 4.0 g of commercial Flor Sherry yeast (dwb) previously rehydrated in 40 ml of distilled water at 38°C for 15 min. Fermentation was performed at 38°C. In the bread formulation, 10% of total flour was brought by preferment. Means were obtained from eight (proof time, bread specific volume; eight doughs) or six data (volatile compounds; six breads × one extraction). Control was prepared by the sponge-and-dough process (4-hr) fermentation.

[b] Preferment prepared with 2 g of yeast instead of 4 g.

shown). Because we wished to select only one yeast and considering that the aroma produced by Flor Sherry yeast (*T. delbrueckii*) was so special and interesting compared to that of baker's yeast, it was decided to retain this yeast for the rest of the study.

Optimization of Flor Sherry Yeast Preferment

A positive correlation (r^2 = 0.97) was obtained between gas production and concentration of volatile compounds produced by Flor Sherry yeast grown in our laboratory (Fig. 3). Reed and Chen (1978) proposed to determine the activity of wine yeast by measuring its gas production activity. Gas production is easier to measure than volatile compounds so it was used in the following screening tests as an indicator for the production of volatile compounds by the Flor Sherry yeast. As discussed above, gas production is not useful to screen highly aromatic yeasts; this is why this test was used only for screened yeast. Gas production by wine yeast was also interesting because it complemented the activity of baker's yeast during dough proofing.

Using a low concentration of sucrose in preferment and dough, we have focused on the effect of the duration of the prefermentation period on dough proof time, specific loaf volume, as well as content of total volatile compounds in crumb and crust (Table III). The composition of volatile compounds was also determined in crumb (Table IV) and crust (Table V). We have observed that the longer the period of prefermentation, the longer the dough proof time ($P < 0.05$); this was related to the concentration of residual sucrose at the end of the prefermentation, considering that no sucrose was added at the dough stage. In a separate series of experiments, sucrose supplementation at the dough stage reduced proof time (data not shown). For long prefermentation periods, addition of yeast foods and buffers might also improve the activity of wine yeasts at the dough stage (Kulp 1986). Specific loaf volumes and total concentration of volatile compounds in crumb and crust (data not shown) were not significantly changed by the length of the prefermentation period or the concentration of wine yeast in the 24-hr preferment ($P < 0.05$).

The use of a low concentration (2 g instead of 4 g) of wine yeast in the preferment did not affect dough and bread characteristics (Tables III–V). A lower concentration of yeast would have the benefits of reducing cost and limiting the formation of off-flavor (yeasty) in bread. Temperature (30°C instead of 38°C) or the use of higher proportions of flour in preferment (40% compared to 10%) did not have a significant effect on dough proof

TABLE IV
Effect of Duration of Prefermentation on Profile of Volatile Compounds in Bread Crumb[a]

		Prefermentation Time (hr)				
	Control	1.5	4	12	24	24[b]
Acetaldehyde	4.37a	1.44b	1.54b	1.38b	1.68b	1.33b
Ethanol	7,269.10a	4,007.90c	5,351.00bc	5,872.90ab	5,367.20bc	5,536.00bc
1-Propanol	12.35a	6.38c	7.91bc	10.00ab	8.98b	10.30ab
Acetoin	8.61a	0.28b	0.31b	0.25b	0.30b	0.23b
Ethyl lactate	0.39bc	0.36c	0.41bc	0.51a	0.48ab	0.54a
Unknown A	51.51a	21.97b	26.44b	29.32b	21.66b	28.59b
Unknown B	0.39a	0.00b	0.07b	0.05b	0.04b	0.13b
Unknown C	59.26a	34.37b	44.70b	59.46a	58.84a	60.18a
Unknown D	0.00b	0.02b	0.07b	0.26a	0.22a	0.26a
Acetone	4.30a	3.89a	2.35a	2.79a	3.56a	2.25a
2-Butanone	0.00c	3.32a	0.00c	0.00c	0.87c	1.51bc
Diacetyl	5.63a	0.00b	0.00b	0.00b	0.20b	0.21b

[a] Means (total relative area) in a row followed by the same letter are not significantly different at the 5% significance level (Duncan). Except where indicated, dough was prepared in four replicates (each dough yielded two breads) with one 160-g portion of preferment 1 (300 g of flour, 60 g of sucrose, 750 ml of water) poured into a Risograph jar (preferment 2) containing 4.0 g of commercial Flor Sherry yeast (dwb) previously rehydrated in 40 ml of distilled water at 38°C for 15 min. Fermentation was performed at 38°C. In the bread formulation, 10% of total flour was brought by preferment. Means were obtained from eight (proof time, bread specific volume; eight doughs) or six values (volatile compounds; six breads × one extraction). Control was prepared by the sponge-and-dough process (4-hr) fermentation.

[b] Preferment prepared with 2 g of yeast instead of 4 g.

TABLE V
Effect of Duration of Prefermentation on Profile of Volatile Compounds in Bread Crust[a]

		Prefermentation Time (hr)				
	Control	1.5	4	12	24	24[b]
Acetaldehyde	2.00a	1.07a	1.16a	1.41a	1.26a	1.50a
Ethanol	3,435.90a	2,188.70b	2,926.80ab	3,219.70a	2596.90ab	3269.20a
1-Propanol	6.53a	3.63bc	4.17abc	5.83ab	4.57abc	5.03abc
Acetoin	4.77a	0.14b	0.26b	0.21b	0.19b	0.25b
Ethyl lactate	0.19b	0.21ab	0.26ab	0.29a	0.24ab	0.29a
Unknown A	28.49a	13.23b	14.95b	17.75b	13.63b	16.45b
Unknown B	0.13a	0.00b	0.00b	0.00b	0.00b	0.07ab
Unknown C	33.45ab	20.02c	26.92bc	37.12a	30.97ab	32.93ab
Unknown D	0.00b	0.00b	0.08ab	0.16a	0.09ab	0.16a
Acetone	7.60a	2.40c	2.10c	2.87bc	5.33ab	2.86bc
2-Butanone	0.00b	1.71a	0.00b	0.00b	0.66ab	1.14ab
Diacetyl	2.14a	0.00b	0.00b	0.00b	0.00b	0.26b

[a] Means (total relative area) in a row followed by the same letter are not significantly different at the 5% significance level (Duncan). Except where indicated, dough was prepared in four replicates (each dough yielded two breads) with one 160-g portion of preferment 1 (300 g of flour, 60 g of sucrose, 750 ml of water) poured into a Risograph jar (preferment 2) containing 4.0 g of commercial Flor Sherry yeast (dwb) previously rehydrated in 40 ml of distilled water at 38°C for 15 min. Fermentation was performed at 38°C. In the bread formulation, 10% of total flour was brought by preferment. Means were obtained from eight (proof time, bread specific volume; eight doughs) or six values (volatile compounds; six breads × one extraction). Control was prepared by the sponge-and-dough process (4-hr) fermentation.

[b] Preferment prepared with 2 g of yeast instead of 4 g.

time, specific volume, or profile of volatile compounds (data not shown). According to Kulp (1986), the higher the proportion of flour in the preferment, the better the quality of the bread, but these benefits are more evident when the concentration of flour is greater than 50% (Pyler 1988).

The main components of bread crumbs and crusts were ethanol, unknown C, unknown A, 1-propanol, acetone, 2-butanone, and acetaldehyde (Tables IV and V). According to Frasse et al (1993), there are many more volatile compounds produced in dough fermentation but the objective of this work was to search for major quantities of volatile compounds produced by wine yeasts compared to baker's yeast. Consequently, our intention was not to characterize completely the aroma compounds produced in wine yeast preferments. According to Hironaka (1986), a positive correlation was established between the concentration of 2-butanone and the acceptance level of bread in sensory evaluation tests. The latter compound was present in some of the wine preferments, but it is not clear why it was mainly found after 1.5 hr but not after 4 hr of prefermentation (Tables IV and V). There is a possibility that 2-butanone can be transformed after long fermentation periods, especially in cases where sucrose is limiting, such as in the present case (preferment and dough).

In addition to 2-butanone, bread (crumb or crust) prepared from preferment with wine yeast had higher concentrations of an unknown compound D, compared to that of standard bread prepared by the sponge-and-dough method (baker's yeast). However, bread crumb and crust prepared with wine yeast had less ethanol (crumb only), unknown compound A, unknown compound C (crumb only), acetoin, diacetyl, acetaldehyde (crumb only), acetone and unknown compound B. Moreover standard bread had more sugar than did bread prepared from the wine preferment; this could affect the activity of the yeast as well as production of volatile compounds. Ethyl lactate comes from the reaction between ethanol and lactic acid, which also leads to the formation of 1-propanol (Scott and Eagleson 1988). Under our conditions, with *T. delbrueckii*, pyruvate was probably not decarboxylated into acetoin (odorless) which is transformed into diacetyl (Scott and Eagleson 1986); this could explain the lower production rates of the latter volatiles by *T. delbrueckii*. Presence of high concentrations of acetoin in wine is considered undesirable (Shinohara et al 1979), so commercial wine yeasts are not expected to produce high concentrations of acetoin and diacetyl. Contrary to sherry wine, bread prepared with sherry preferments did not contain much acetaldehyde, probably because it is only formed during long storage periods of the wine, as a result of ethanol oxidation catalyzed by alcohol dehydrogenase (Lafon-Lafourcade 1983).

Sensory Evaluation

In the last series of experiments, we wished to briefly find out whether bread prepared with a liquid preferment containing wine yeast was judged different and, possibly, acceptable to a sensory panel. Two types of bread from wine preferments (2 g of commercial Flor Sherry yeast) were prepared: A) containing 40% flour and fermented at 38°C for 90 min; or B) containing 10% flour and fermented at 30°C for 24 hr. Bread prepared by the sponge-and-dough process was used as a reference. Five untrained panelists could identify the wine yeast preferment and indicated that the three blind-coded bread crumbs were all acceptable but different according to aroma (more intense), taste and texture (data not presented).

CONCLUSIONS

Wine yeast may be used to prepare a liquid preferment to enhance bread aroma and flavor. We have found that few wine yeast strains rapidly produce interesting aromatic compounds in liquid preferments containing low concentration of sucrose. Yeast used for sherry wine production was considered as a good choice for liquid preferments for breadbaking. Best prefermentation conditions were obtained within a short period (1.5 hr instead of 4, 12, or 24 hr), at 38°C instead of 30°C, with low concentration of flour (10% instead of 40%), considering that the amount of volatile compounds was acceptable under these conditions. Concentration of wine yeast was kept at a minimum, 0.5% or less (dwb), corresponding to about 1.6% (30% moisture), which corresponded to a supplement to the regular concentration of compressed baker's yeast in dough (≈3%, flour basis). The profile of volatile compounds from bread prepared from wine preferments (not supplemented with sucrose at the dough stage) was very different than sponge-and-doughs prepared with standard baker's yeast. We look forward to the development of dehydrated ferments prepared with wine yeast and to test further the acceptability of bread prepared from wine yeast preferments.

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