ABSTRACT

Date palms (Phoenix dactylifera) are a major fruit crop in the Kingdom of Saudi Arabia. Less than 10% of the produce is processed, and substantial quantities are lost because of pest infestation and lack of efficient marketing. Processing dates as date paste, which could be incorporated in such products as bread, could open new markets for dates.

Date paste is rich in sugars, dietary fiber, minerals, and trace elements (Yousif et al. 1990). Thus, incorporation of dates into other food items could contribute significantly to their nutritive value.

The moisture retention capacity of yeast-leavened products is affected by the level of fructose present in the formula (Bohn 1959). Breads made with a low sugar content may lose fructose and tend to dry out rapidly when exposed to air of low humidity. The situation is predominant in most areas of the Arabian Gulf. Because date paste contains substantial quantities of invert sugar (about 80% on a dry weight basis), and fructose accounts for about 50% of the sugars (Yousif et al. 1990), it could be an important addition to bread.

The effects of different sugar levels and sources such as molasses, date syrup, corn syrup, honey, and table sugar have been studied extensively in breads and pastries (Bohn 1959, Burham and Johnson 1925, Lee et al. 1955, Al-Noori et al. 1984, Al-Saady et al. 1979). These sugar sources are now widely used to enhance the internal as well as the external characteristics of the finished products. The effects of various date syrups on experimental bread was studied by Al-Zubaydi et al. (1983). Date syrups were found to cause a substantial increase in the weight and volume of loaves and to improve the texture of the finished bread. Zienke (1977) found that concentrated raisin syrup is multifunctional in a full range of baked products. It acts in flavoring and sweetening and as an anti-staling agent.

The lack of agreement in the literature concerning the role of sugar in bread characteristics (honey, fruit syrups, corn syrups, etc.) as anti-staling agents. Burham and Johnson (1951) reported that crust firmness was affected by sugar concentration and time of storage. Bohn (1959) indicated that bread goods made with high percentages of sugar retained moisture and freshness due to the moisture-holding properties of fructose.

The use of date paste as a substitute for sugar and/or enriching agents in breadmaking is possible only if it does not adversely affect the finished bread characteristics. Accordingly, this study was conducted to evaluate the effect of adding date paste on the dough and bread characteristics.

MATERIALS AND METHODS

A commercially untreated milled wheat bread flour was obtained from Allied Mills (Uxbridge, London). It is sold under the trade name of Sovereign flour. Sovereign flour is a composite made from many wheat varieties. The approximate composition (on 14% moisture basis) for Sovereign wheat flour was protein 12.11%, moisture 13.17%, ash, 0.54%, starch damage 2%, Farrand, and absorption, 62.33%. The flour was packed in 2 kg polyethylene bags and kept in a deep freezer (−20°C) prior to further treatments of analysis. Date paste was prepared by soaking Ruzeize dates for 5 min in tap water, draining for 10 min, and grinding. The date paste characteristics (on dry weight basis) were moisture, 18.8%; total sugars, 78.2%; pH, 5.6; dietary fiber, 7.00%; and water activity, 0.66. More details about the date paste preparation were reported in a previous study (Yousif et al. 1990). Fat (brand name Ambrex) suitable for breadmaking was used. Table salt, table sugar, and fresh compressed yeast were procured from the local market. Ascorbic acid tablets of 100 mg each were used after grinding for addition to the bread formulas.

Chemical Analytical Methods

Moisture content was determined by the modified vacuum oven method (AACC 1976, method 44-40). Protein was determined by the macro-Kjeldahl method (AACC 1976, method 44-10). Ash was obtained using the basic method (AACC 1976, method 08-01). Damaged starch was measured colorimetrically following the method of Williams and Fegol (1969).

Physical Dough Testing

Farinograms and amylograms were determined by AACC approved methods 54-21 and 22-10, respectively (AACC 1976). Two controls (one sugar-free and one containing 3% sucrose) and four treatments containing 4, 6, 8, and 12% date paste as flour replacement were used. The flour was milled in a laboratory mill and passed through a standard sieve at 60 mesh. The flour was re-weighed and the moisture content was measured to be 14% (dry weight basis). The flour was mixed with the desired amount of water and the dough was allowed to rise for 1 h. The dough was then divided into portions and mixed with the desired amount of water and the dough was allowed to rise for 1 h. The dough was then divided into portions and formed into doughs and allowed to rise for 1 h. The doughs were then placed on a tray and allowed to rise for 1 h. The doughs were then baked in a conventional oven at 550°F (290°C) for 15 min. The loaves were then allowed to cool before they were measured for volume, weight, and height.

Test Baking

Doughs and bread were prepared according to the Churley wood process.

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process (CBP) as described by Jain (1975). The baking included flour, 1,000 g; salt, 18 g; fresh compressed yeast, 7 g; improver (ascorbic acid), 100 mg; water, variable. Doughs were prepared with or without date paste. Test levels were 0, 4, 8, and 12% as a partial wheat flour replacement. A second control containing 3% sucrose was also included. All ingredients were combined, and the required amounts of water (after adjusting their temperature) as determined by the research water absorption meter were added (Oh et al. 1986). The water levels were 60, 58, 58, 55, and 50% for the sugar-free control, 3% sucrose control, 4% date paste, 8% date paste, and 12% date paste treatments, respectively. The ingredients were mixed to an energy expenditure of 11 W·hr⁻¹·kg⁻¹ of dough. Dough was divided into 400-g pieces and molded using a small commercial mold. Doughs were first proofed for 10 min at 30°C, then molded, panned, and final proofed at 43°C and 80% RH until the dough attained the height of 11 cm. Loaves were baked at 230°C for 25 min, then allowed to cool in pans for 15 min before measuring loaf height. Loaves were depanned and placed on wire racks to cool for 1 hr. Weights and volumes (rapeseed displacement) of loaves were taken, whereas specific volume and oven spring were calculated. The oven spring was calculated by subtracting the height of a fully proofed loaf (11 cm) at the time of entering the oven from the height after baking. Bread quality characteristics were evaluated independently by three baking technologists following the criteria suggested by Dalby and Hill (1960). Baking tests and bread evaluations were carried out three times and the data obtained were averaged.

Bread Storage Studies

After being cooled for 1 hr, breads were wrapped in polyethylene bags, sealed, and stored for 0, 24, 48, or 120 hr at 20°C. Mold appearance was examined using a 10X magnifier. Staling measurements were made on fresh and stored breads fortified with date paste using the Instron universal testing machine with a cylindrical disk. The portions within 4 cm of the ends of the loaf were discarded, and four cylindrical slices 2-cm thick were cut and used in staling or firmness measurements. The measurement factors were as follows: cross-head speed, 100 mm/min; chart speed, 500 mm/min; sensitivity, 5; and a full-scale load of 20 kg. Compressibility values (in kilograms) corresponding to the force applied for 50% compression of the bread slice (1 cm) were computed and the data obtained were averaged.

Statistical Analysis

Data were analyzed using an SAS computing system. The analysis of variance procedure was used and the LSD values were calculated for all means (SAS 1982).

RESULTS AND DISCUSSION

Physical Dough Testing

The farinograph, alveograph, amylograph, and zymotachigraph data determined for the sugar-free control (100% wheat flour), control with sucrose (wheat flour/sucrose, 97:3), and various blends of wheat flour and date paste (96.4:3.6; 94:6; 92.8:7.2; and 88:12) are presented in bar charts (Figs. 1-4).

The farinograph results show that water absorption (Fig. 1A) was significantly affected by the addition of either date paste or sucrose as a partial wheat flour replacement in the bread dough. Increasing the date paste replacement level resulted in a consistent decrease in the water absorption.

Farinograph and alveograph data (Figs. 1 and 2) indicate that the partial replacement of wheat flour by date paste or sucrose...
modified the bread dough properties and caused a marked increase in the dough development time, maximum overpressure, and deformation energy. It is clear that the date paste replacement level, which contains a similar amount of sugar (see date paste composition) as that of the sucrose control (3%) treatment, caused greater increases in the dough development time, maximum overpressure, and deformation energy values compared with the sucrose control. Evidence indicating the beneficial effect of sugars on gluten development in the dough system was reported by Fretzdorff et al. (1982).

Farinograph and alveograph data further showed that stability and extensibility values were slightly increased by the sucrose control treatment, but decreased by the date paste addition. The mechanical tolerance index was also improved by sucrose addition, whereas it was adversely affected by date paste addition, especially at higher levels (12%). At this high replacement level, the handling properties of the dough containing date paste deteriorated, and the dough was sticky and difficult to handle.

Figure 3 shows that the replacement of wheat flour with non-wheat components (date paste or sucrose) produced a significant decrease in the malt index values (peak value or maximum viscosity). This decrease was expected to have an adverse effect on the functionality of blends of date paste and wheat flour in breadmaking, since the bread wheat flour used (Sovereign flour) has a low malt index value. Amylograph data also showed that as the replacement level of date paste increased, the pasting temperature of the starch increased, indicating a retarding effect on starch gelatinization.

The increase in pasting temperature resulting from the addition of date paste or sucrose was highly significant (6 ± 1°C, \( P < 0.05 \)). Evidence has already been published (Varriano-Marston et al. 1980, Spies and Hoseney 1982, Bhaty 1986) that the increase in the pasting temperature means a retardation in the starch gelatinization process and has a beneficial effect on the functionality of the starch paste in the bread system. On the other hand, gelatinization temperature was not affected by the substitution of date paste or sucrose for wheat flour.

As shown in Figure 4A, which represents the gassing properties of the different date paste-wheat flour doughs, the highest gas production values during fermentation, which extended to 210 min, were achieved by the 4% date paste treatment. The markedly low gas production for the 12% date paste treatment compared with other doughs is of particular interest. With regard to total gas retention, it is clear from Figure 4A, that the optimum date paste concentration for gas retention properties was between 4 and 8%. These results are in agreement with the findings reported earlier by Barham and Johnson (1951) and Lee et al. (1959). The gassing properties results further show (Fig. 4B) that during the first 30 min of fermentation, the rate of gas production for the dough containing 4% date paste was higher than that of the sugar-free control or sucrose control.

Test Baking

Addition of date paste did not significantly affect (\( P > 0.05 \)) the dough mixing time (Fig. 5), which varied between 5.15 min for the sucrose control and 5.66 min for the 8% date paste treatment. On the other hand, significant differences could be detected (Fig. 5), in the final proof time as a result of adding date paste. It is clearly evident from the test baking results (Fig. 6) that the 4% date paste treatment increased loaf volume by 3% and produced a bread superior to the sugar-free control bread in volume, weight, specific volume, oven spring, and height. In contrast, increasing the date paste replacement level to 12% produced a loaf with physical properties much inferior to those.
breads supplemented with date paste did not show any significant increase, indicating a marked retarding effect of date paste on bread crumb firming after two days' storage.

The retarding effect of date paste on bread staling may be attributed to fructose at high levels in date paste (37.21%); the release of moisture in bread (Bohn 1959) or to complex formation from one or more components of date paste and starch. The complex formed may interfere with the starch retrogradation or crystallization (Risom et al. 1984).

The partial replacement of wheat flour with date paste in the bread formula significantly improved the shelf life of the bread loaves, as judged by the storage study. The sugar-free control and the sucrose control breads had no mold growth after three days of storage at 20°C, whereas the date paste supplemented bread had no mold growth after five days, indicating the possibility of an antimicrobial agent in the date paste. Similar results with other date products were reported by Al-Saidy et al. (1979), who found that addition of date syrup increased the shelf life of the experimental bread.

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**Fig. 3.** Effect of adding date paste on the amylograms of Sovereign flour: A, malting index; B, pasting and gelatinizing temperature. CL = sugar-free control; CII = control with 3% sucrose.

**Fig. 4.** Effect of adding date paste on the zymotachograms of Sovereign flour: A, total gas production and retention; B, rate of gas production.

**Fig. 5.** Effect of adding date paste on the dough physical properties. CL = sugar-free control; CII = control with 3% sucrose.

**Fig. 6.** Effect of adding date paste on loaf volume. CL = sugar-free control; CII = control with 3% sucrose.
The partial replacement of wheat flour with date paste (4%) modified the dough characteristics as shown by marked increases in the dough development time, maximum overpressure, and deformation energy.

The partial replacement of wheat flour by date paste (4-6%) markedly improved both gas production and retention.

Amylograph data and test baking showed that addition of date paste at levels of 4-6% had a beneficial effect on the pasting properties of the bread flour and dough.

The partial replacement of wheat flour by date paste at the 4% level produced bread superior to the control bread in most physical measurements. Therefore, it could be concluded that date paste may be used as a substitute for sucrose in breadmaking.

Date paste supplemented bread had lower compressibility values for up to 48 hr of storage at 20°C compared with control breads.

Bread supplemented with date paste also did not show any mold growth after five days of storage at 20°C, whereas mold growth was apparent on control breads after three days of storage. This result may indicate the possibility of an antimicrobial agent in date paste.

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LITERATURE CITED


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