

Functionality of Date Paste in Breadmaking

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ABSTRACT

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Partial replacement of wheat flour with date paste (4-8%) modified bread dough as indicated by farinograph and alveograph studies. Addition of date paste decreased the malt index and delayed gelatinization. Total gas production and retention were improved by 4-6% addition compared with the sugar-free control. A higher concentration (12%) of date paste resulted in a negative effect on the gassing and handling properties of the bread dough. A good quality bread with improved external and internal

characteristics could be produced by a partial replacement of the wheat flour with 4% date paste. Increasing the date paste replacement level had an adverse effect on the crust and crumb color of the bread produced, as shown by the scores for the bread supplemented with 8 and 12% date paste. Addition of 4-8% date paste as a wheat flour replacement to the bread formula significantly retarded firming of the bread crumb after two days' storage. Date paste also prolonged the shelf life of breads.

Dates (*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 outlets 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 contain little fructose and tend to dry out rapidly when exposed to air of low humidity (this is the situation 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, Barham and Johnson 1951, Lee et al 1959, Al-Noori et al 1984, Al-Saidy 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 effect 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. Ziemke (1977) found that concentrated raisin syrup is multifunctional in a full range of baked products. It acts in flavoring and sweetening and as an antistaling agent.

There is lack of agreement in the literature concerning the role of sugar and sugar sources (honey, fruit syrups, corn syrups, etc.) as antistaling agents. Barham and Johnson (1951) reported that crumb firmness was affected by sugar concentration and time of storage. Bohn (1959) indicated that baked 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 agent 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.

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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 28% 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 and analysis. Date paste was prepared by soaking Ruzeise 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, 5.69; 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 (trade 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 46-10). Ash was determined 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 alveograms were obtained by following the method described by Chen and D'Appolonia (1985). Gassing properties (total gas production, total gas retention, and rate of gas production) of the wheat flour date paste mixtures were measured using the Chopin zymotachigraph. Zymotachigrams (in triplicate) were obtained by following the technique described in the Chopin zymotachigraph instruction booklet. Dough ingredients used in testing the effect of adding date paste on the gassing properties of bread flour were as follows: wheat flour, 250 g (date paste substituted for 4-12% of wheat flour); sucrose, 3%; salt, 2%; and yeast, 1%. All the above ingredients were added on 14% flour moisture basis. Water was added at 75% of the dry weight of the flour except for the 8 and 12% date paste treatments where it was reduced to 70%. Doughs were fermented up to 210 min, and the dough temperature was maintained at 27 ± 1°C.

Test Baking

Doughs and bread were prepared according to the Chorleywood

bread process (CBP) as described by Jain (1975). The baking formula included flour, 1,000 g; salt, 18 g; fresh compressed yeast, 25 g; fat, 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 $11 \text{ W} \cdot \text{hr}^{-1} \cdot \text{kg}^{-1}$ of dough. Dough was divided into 460-g pieces and molded using a small commercial molder. 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 $10\times$ 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; 94:6; 92:8, 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) indicated that the partial replacement of wheat flour by date paste or sucrose

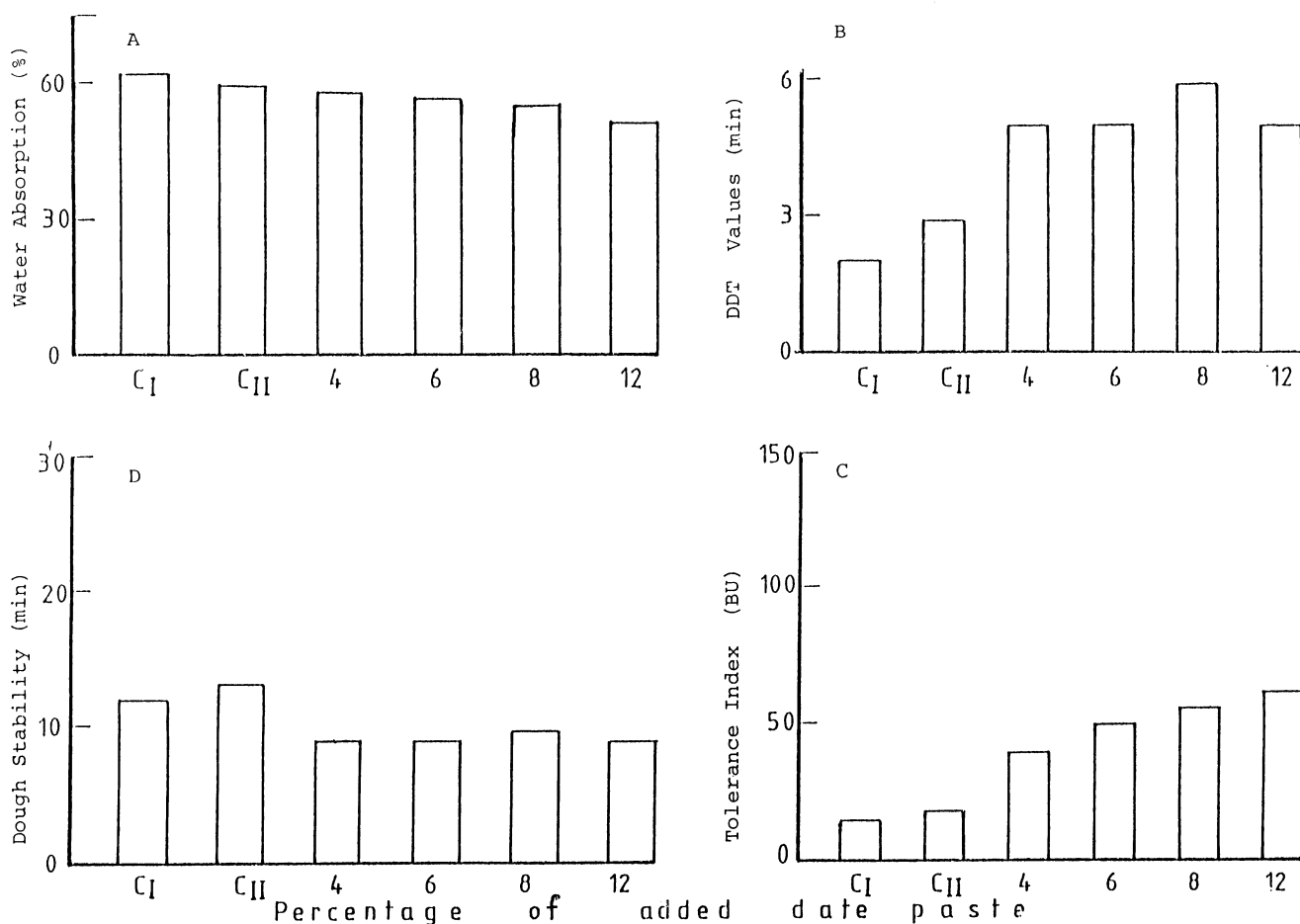


Fig. 1. The effect of adding date paste on the farinograms of Sovereign flour: A, water absorption; B, dough development time (DDT); C, dough stability; and D, tolerance index. CI = sugar-free control; CII = control with 3% sucrose.

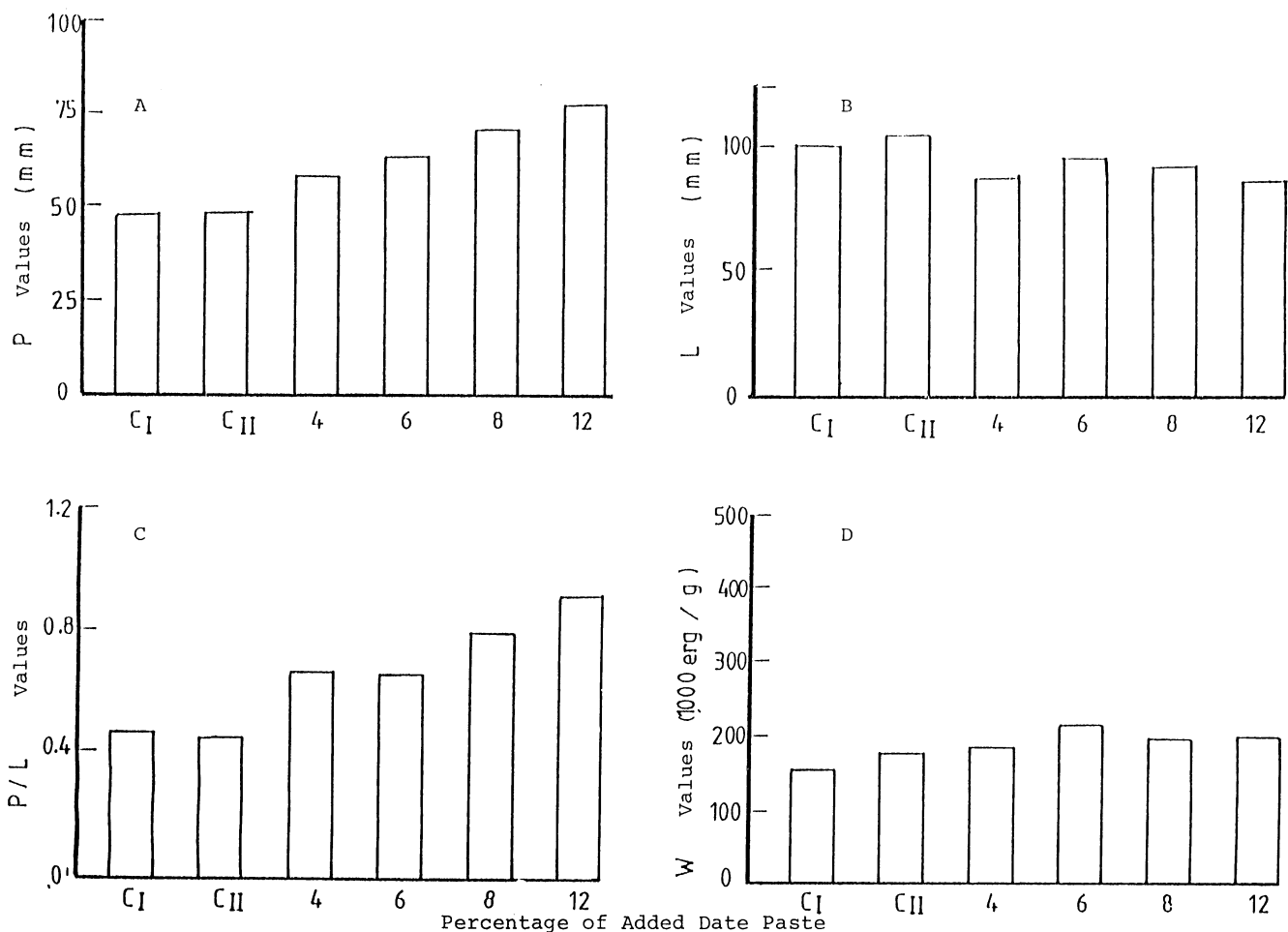


Fig. 2. The effect of adding date paste on the alveograms of Sovereign flour: A, maximum overpressure (P); B, extensibility (L); C, curve configuration ratio (P/L); and D, deformation energy (W). CI = sugar-free control; CII = control with 3% sucrose.

modified the bread dough properties and caused a marked increase in the dough development time, maximum overpressure, and deformation energy. It is clearly evident that the 4% 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, 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 nonwheat 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 (6–10°C, $P < 0.05$). Evidence has already been published (Varriano-Marston et al 1980, Spies and Hosney 1982, Bhatti 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 dough 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

of the sugar-free control loaf.

Similar to the results for bread physical properties, those for sensory evaluation (Fig. 7) also indicated that the bread supplemented with 4% date paste bread was similar to the sugar-free control in all quality characteristics except crust color, which was slightly negatively affected by addition of date paste.

Bread Storage Studies

The compressibility results (Fig. 8) show that after 48-hr storage, the sugar-free control and sucrose control breads showed a considerable increase in the compressibility values. In contrast,

bread 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%) aiding the retention 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 (Riisom 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 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.

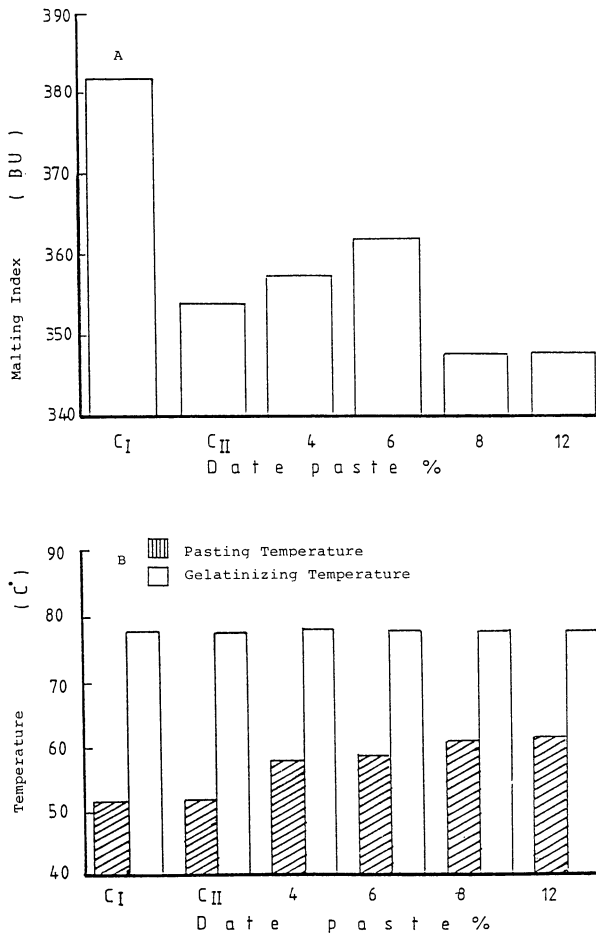


Fig. 3. Effect of adding date paste on the amylograms of Sovereign flour: **A**, malting index; **B**, pasting and gelatinizing temperature. CI = sugar-free control; CII = control with 3% sucrose.

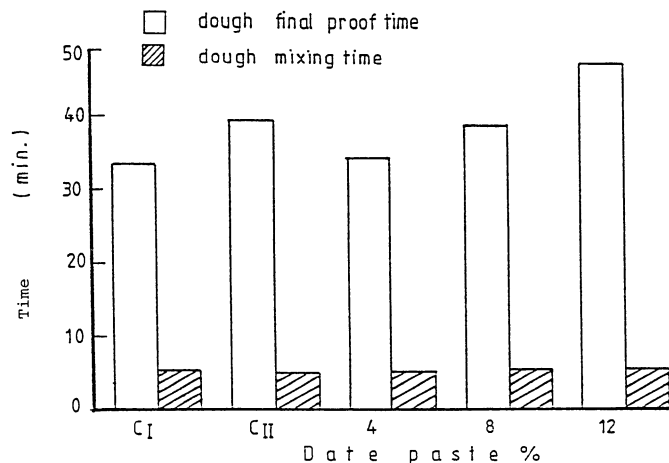


Fig. 5. Effect of adding date paste on the dough physical properties. CI = sugar-free control; CII = control with 3% sucrose.

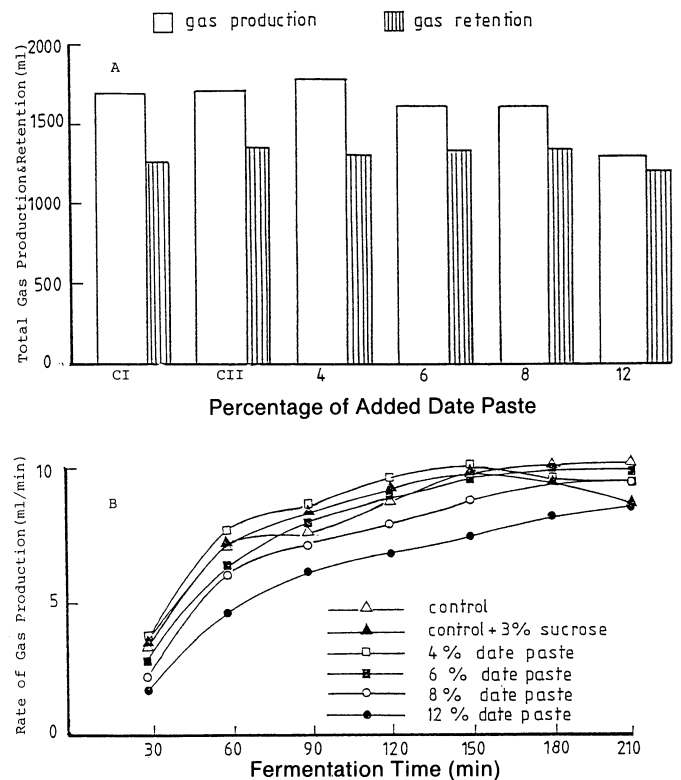


Fig. 4. Effect of adding date paste on the zymotachigrams of Sovereign flour: **A**, total gas production and retention; **B**, rate of gas production.

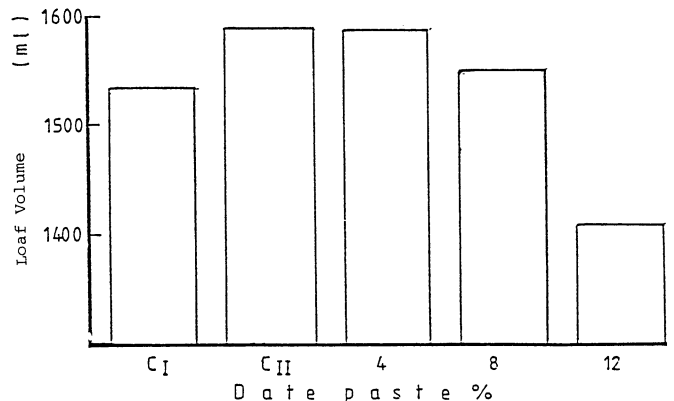


Fig. 6. Effect of adding date paste on loaf volume. CI = sugar-free control; CII = control with 3% sucrose.

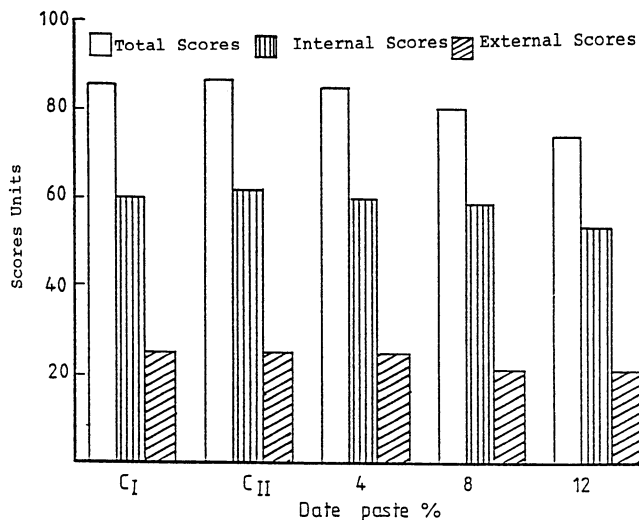


Fig. 7. Effect of adding date paste on loaf scores. CI = sugar-free control; CII = control with 3% sucrose.

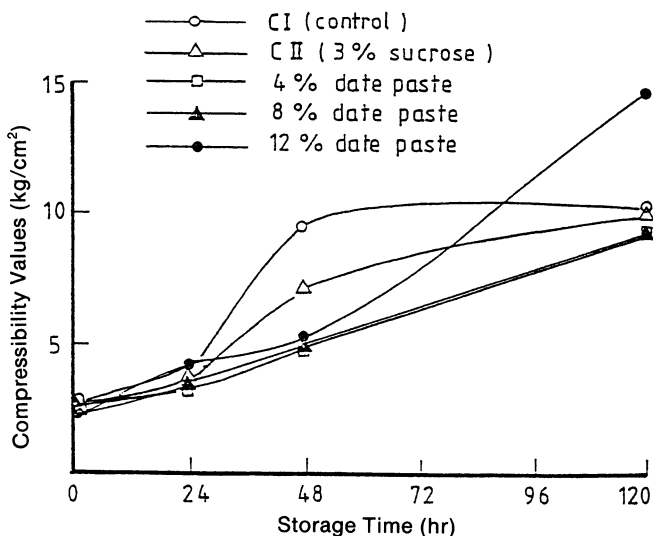


Fig. 8. Effect of adding date paste on the staling of bread.

CONCLUSION

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

bread.

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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