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Effect of honey powder on dough rheology and bread quality

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ABSTRACT

The effects of honey powder on dough rheology and bread quality were studied using sugar as controls. Farinographic studies showed that there were higher water absorption, shorter development time and stability time as honey powder increased, and small degree of softening were obtained for the dough containing 5% honey powder. Extensograph measurements showed that resistance to extension and R/E increased while energy value and extensibility decreased at level of 10% honey. Sensory evaluation showed that the largest total scores were obtained at level of 10% honey. Texture analysis showed that honey breads had low hardness, adhesiveness, gumminess, chewiness and high springiness, cohesiveness. The differences of the crust and crumb colour between honey breads and the control were significant ($P<0.05$). In conclusion, honey powder could be potentially a useful ingredient as a dough improver. Honey usage in the bread formulation supported an improvement in dough rheology, better sensory and texture properties of bread as compared to control formulation. Addition of 5%–10% honey powder significantly improved the baking quality of breads.

1. Introduction

Honey is a natural biological product that comprises of simple sugars (glucose and fructose: 70–80%), water (10–20%), and other minor constituents such as organic acids, mineral salts, vitamins, proteins, phenolic compounds, and free amino acids (Ouchemoukh et al., 2007). It is ordinarily liked by consumers for its nutraceutical value, characteristic flavor, sweetness, and texture (Subramanian et. al., 2007; Umesh Hebbar, & Rastogi, 2007). Honey can be used in bread formulation to increase overall quality of the product and to extend its shelf life. However, liquid honey is viscous and difficult to disperse in the dough, limiting its use in the food industry (Glabe, Anderson, & Goldman, 1970). By contrast, honey powder (dry honey) made from liquid honey can be dispersed easier, and so it has been more widely used in bread-baking industry for improving bread quality.

Bread is one of the most widely consumed food products in the world and bread making technology is one of the oldest technologies known. This technology has been evolving continuously as new materials, equipment and processes are being developed (Selomulyo & Zhou, 2007). The impacts of various ingredients on sensory and nutritional quality of bread have been widely studied (Barcenas & Rosell, 2005; Plessas et. al., 2005; Pherson, Bekatou, Nigam, & Koutinas, 2005). Addo (1997) examined the effects of honey on the rheological properties of frozen wheat flour dough and found that at 4–6% (flour basis) liquid or dry honey improved the rheological properties of frozen dough and the freshness of bread by increasing both the R/E values (Resistance to extension/Extensibility values) and moisture. Freshness is one of the characteristics that consumers most appreciate in bread (Fiszman et al., 2005). Fresh bread typically presents an appealing tan crust, pleasant roasted aroma, fine slicing characteristics, soft and elastic crumb textures, and a moist mouthfeel. The loss of bread freshness is characterized by increased crumb hardness and decreased flavour and aroma. In general, loss of moisture and starch retrogradation are accepted as the two main mechanisms leading to the firming of the crumb (Selomulyo & Zhou, 2007).

During the formulation of bakery products, honey powder is included in dough formulation in order to improve their nutritional, sensory and keeping quality. It also has a significant effect on dough rheological properties. Honey powder contributes to yellowy crumb and golden brown crust, increases fermentation or mixing tolerance of dough, and causes baked products to remain fresher and more moist. So enhancement of the fresh quality and/or inhibition of staling of bakery products can be achieved by using honey powder. The objective of this study is to investigate the effects of honey powder on dough rheology and bread quality, to understand its characteristics well and then to use it effectively. Quality parameters (volume, colour, texture, smoothness, springiness, and mouthfeel) of breads formulated with different honey powder levels are also compared.

2. Materials and methods

2.1. Materials

Commercial bread flour (Pang Thai 1650 high-grade Bread Flour) was provided by COFCO Industry Pang Thai Co.Ltd. (Qin Huang Dao,

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China). Honey powder (include 25% starch in it) was provided by Yancheng Huamei Honey Products Co. Ltd. (Yancheng, China). Bread improver (M III model) and dry baker's yeast were obtained from Meishan Mauri Yeast Co., Ltd. (Panyu, China). Butter oil substitute was provided by Chang Guann Co., Ltd. (Taiwan, China). Milk powder, sugar, eggs, salt and food bag were purchased at a local market. Chemicals used were of reagent grade.

2.2. Bread preparation

Bread samples were prepared using a straight dough method (GB/T 14611-93) with slight modification. The compositions of the selected dough formulation used in control bread comprised of 500 g flour, 240 g water, 90 g sugar, 40 g butter oil substitute, 20 g milk powder, 6 g dry baker's yeast, 6 g bread improver 5 g fine salt, and one egg (total about 50 g). For the fifteen bread samples containing honey powder, the dough formulation was identical with that of the control bread except that the sugar was replaced by honey powder. Sugar and honey contents varied from 1 to 15% on flour basis.

Flour, fine sugar, honey powder, milk powder were uniformly mixed in a stirrer (SM-5D model, Sinmag Machine Co. Ltd., Wuxi, China) using a dough hook, followed by the addition of yeast and bread improver. The dough was prepared in the stirrer for 1 min at 40 rpm, and 10 min at 70 rpm after egg and water were added. Final dough temperature was 28 °C. The dough was rested in bulk for 10 min, divided into pieces of 100 g, rounded by hand (ball shape), and submitted to an extra fermentation period of 10 min (intermediate proof). The dough was then kneaded, put in well-greased pans, proofed at 37 °C and 85% relative humidity for 2 h and baked in an electric oven set at upper temperature 170 °C and down temperature 220 °C for 20 min. Bread was removed from the pans and cooled at 25 °C for 1 h before testing.

2.3. Analysis of dough

2.3.1. Farinograph measurements of dough

Properties of dough were investigated using a farinograph-E (Brabender, Duisburg, Germany) according to a standard method (GB/T 14614-2006, China). The 300 g mixing bowl was used and the mixing was at the standard speed of 63 rpm at 30 °C. Water absorption, development time, stability time, degree of softening (12 minute after maximum), and mixing tolerance index of the samples were recorded.

2.3.2. Extensograph measurements of dough

Brabender extensograph-E (Brabender, Duisburg, Germany) was used to study the effects of honey powder on the energy value, resistance to extension, extensibility and R/E value in 45 min according to a Chinese national standard (GB/T 14615-2006, China).

2.4. Analysis of bread

2.4.1. Physical properties of bread

Loaf weights and volumes were measured 1 h after removal from the oven. Loaf was weighed using an electronic balance and loaf volume was measured using the rapeseed displacement method (Plessas et al., 2005). The specific volume was calculated by dividing loaf volume by loaf weight. The moisture content of samples was determined by AACC 44-15A standard method (American Association of Cereal Chemists, 2000). The data reported were the averages of three replicates of each formulation.

2.4.2. Sensory evaluation of bread quality

The sensory evaluation was performed using a descriptive profile test based on a Chinese national standard (GB/T 14611-93, China). A panel consisting of 9 trained university students from the School of Food Science in Jiangnan University performed the sensory evaluation of bread samples. The total mark of sensory evaluation for one sample was 100 points including volume 35, crust colour 5, crust texture 5, crumb colour 5, crumb texture 25, smoothness 10, springiness 10 and mouthfeel 5. The intensity of attributes was scored by a scale of 1 (extremely low) to highest score of index point (extremely high). The vocabulary of the descriptions and the intensity level of references for all attributes were generated through consensus. Sensory evaluation was made after storage of 1, 2, 3, 4 and 5 days at 22 ± 2 °C and 75 ± 5% RH. Bread was sliced utilizing a Sinmag slice machine (Wuxi, China). Each bread slice was served on a plate and covered with odorless plastic film. The experiment was conducted and based on randomized complete block design and a new random number was assigned to each bread treatment at each testing session to prevent bias. Each panelist evaluated 16 breads in one occasion. The tasted samples were disgorged and plain water was used for rinsing the palate between samples. Tests were replicated 3 times.

2.4.3. Texture of crumb

Texture profile analysis (TPA) of bread was done using a TA.XT 2i model texture analyzer (Stable Micro System Co. Ltd., Surrey, England) equipped with a 5 kg load cell 1 day after baking. A cylindrical probe of 25 mm in diameter was attached to the crosshead. The instrument test parameters were set as following: the pre-test speed: 2.0 mm/s; crosshead speed: 1 mm/s; post-test speed 10.0 mm/s; rupture test distance 1%; distance 50%; and time 5.00 s. Bread loaves were cut into slices of 15 mm thick each and the ends were discarded. Textural properties (hardness, adhesiveness, springiness, chewiness, gumminess, cohesiveness, and resilience) of bread slices were evaluated as per Bourne (2002). All the tests were conducted in triplicate, and average values were reported.

Bread slices were compressed twice to give a TPA from which three primary textural parameters (Pons & Fiszman, 1996) were obtained: hardness (bread firmness), springiness, and cohesiveness, as calculated by the texturometer software. Hardness values 1 and 2 were the maximum peak forces (g) during the first and second cycles, respectively. Cohesiveness was the ratio between the second cycle area and the first cycle area, and adhesiveness was the negative force area recorded during the first cycle, representing the work necessary to pull the compression plunger away from the sample. Springiness was defined as the height in mm the food sample recovered during the time that elapsed between the end of the first cycle and the start of the second cycle. Gumminess was the product of hardness 1 and cohesiveness. Modulus was the slope of the rising curve during the first cycle. Means and standard deviations for TPA parameters were calculated and used for correlation analysis.

2.4.4. Crust and crumb colour

Crust and crumb colours were determined using a Konica Minolta CR-400 chromameter (Konica Minolta Co., Ltd, Osaka, Japan). Crust colour was measured at the surface of bread crust and crumb colour was measured at the center part of crumb after the bread was cut into half pieces. Averages of three measurements of L (brightness), a (redness), b (yellowness) values and ΔE (the total colour difference) were recorded.

2.5. Statistical analysis

Analysis of variance (ANOVA) was conducted using the SPSS 12.0 General Linear Model procedure (SPSS inc., USA). The calculated mean values were compared using Duncan's multiple range test with significance level of $P < 0.05$ (Anil, 2007).

3. Results and discussion

3.1. Farinograph results

The farinograph results of doughs were given in Table 1, showing several interesting observations. First, water absorbtion ( ) decreased