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Effect of long-term storage on baking powder functionality

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ABSTRACT

Six samples of double-acting baking powder in original commercial packaging were obtained from donors and two fresh samples were purchased. Samples had an age range of 0 to 29 years and were stored in cool (15-25 °C) and dry conditions. Moisture content of baking powder samples ranged from 1.5-3.2%. Total CO_2 ranged from 18.1-21.9% of sample weight and did not significantly decrease over storage time. Average biscuit heights ranged from 3.0-3.4 cm, with the control made without baking powder averaging 2.1 cm. The average volumes (calculated from the average measured heights and diameters) ranged from 66-79 cm^3, with the control averaging 47 cm^3. Average height and volume did not decrease over storage time. Mean L*a*b* color values for biscuits had ranges of 66.0-70.5, 4.0-7.4, and 25.9-31.2, respectively, with control biscuits averaging 70.6, 1.5, and 18.6, respectively. All baking powder samples produced acceptable biscuits, indicating that baking powder retains its functionality over time and can be included in applications requiring long-term storage.

INTRODUCTION

Baking powder is widely used to leaven baked products. Several researchers have studied the functionality of baking powder components as well as the effects of moisture on those components (Conforti et al 1997; Conn and Heidolph 1989; Gallay and Bell 1935; Halliday and Noble 1943). The industry standard for baking powder shelf-life is eighteen to twenty-four months, but little information is available on baking powder functionality when stored beyond this time. A longer shelf-life would prove beneficial in certain situations, such as personal food storage, disaster relief efforts, and space missions. The objective of this research was to determine the effect of long-term storage on baking powder functionality.

METHODS

Samples

Six samples of double-acting baking powder in original commercial packaging were obtained from donors and two fresh samples were purchased. Samples had and age range of 0 to 29 years and were stored in cool (15-25 C) and dry conditions.

Percent Moisture and Carbon Dioxide Evolved

Moisture content was determined gravimetrically using an Ohaus MB 200 moisture balance set at 90 °C for 10 minutes (Ohaus, Pine Brook, NJ). The amount of CO_2 evolved was measured by reacting the powder with 100% phosphoric acid and quantization using a gas extraction line (Fig. 1 and Fig. 2). Total CO_2 levels were measured according to the procedure of McCrea (1950).

Biscuit Dimensions

Biscuits were made and compared using AACC method 10-31B. Height, weight and diameter of 8 biscuits per baking powder sample were measured (Fig. 3) and volume was calculated from these values.

Biscuit Crumb Color

Surface crumb color was measured using a Hunter Lab Colorflex Spectrophotometer (Hunter Lab, Reston, VA) to obtain L*a*b* values.

Sensory Quality

Biscuits were made following the AACC method 10-31B for each of the six samples of baking powder. A 50-member consumer panel evaluated appearance, aroma, flavor, texture, and overall acceptability of the biscuits using a 9-point hedonic scale. They also rated acceptance for everyday use and emergency use.

Data Analysis

Data were analyzed for significance using the Statistical Analysis System (SAS Institute, Cary, NC). PROC GLM was used for the moisture, CO_2, biscuit dimensions, and crumb color data. A mixed model analysis of variance (PROC MIXED) was used for the sensory data. Significant differences were defined by $p<0.05$.

RESULTS

Percent Moisture and CO_2 Evolved

Percent moisture ranged from 1.5-3.2% (Table 1). Total CO_2 ranged from 18-21.9% of sample weight and did not significantly decrease over time. It is interesting to note that the sample with the highest moisture had the lowest total CO_2.

Table 1. Total Percent CO_2 evolved and Percent Moisture of baking powder samples up to 30 years old. Superscript letters indicate significant differences. Same letters indicate no difference (p>0.05).

Sample (age in years)	Total CO_2 (%)	Moisture (%)
0	20.53[a]	1.92[de]
1	21.60[a]	2.35[c]
4	20.80[a]	2.63[b]
13	18.85[b]	3.23[a]
23	20.95[a]	1.70[e]
24	20.50[a]	1.95[d]
30	21.95[a]	1.45[f]

Figure 1. Gas extraction line

Figure 2. Using gas extraction line

Biscuit Dimensions

Figure 3 shows a representative biscuit made from each baking powder sample. The average biscuit volumes ranged from 66-79 cm^3 (Table 2), while the control biscuit (made without any baking powder) averaged 47 cm^3, indicating that all of the baking powder samples leavened the biscuits significantly better than those made without leavening.

Figure 3: Biscuits made with each sample of baking powder; numbers represent age (in years) of baking powder sample used to make each biscuit.

Table 2. Mean heights, diameters, weights, and volumes of biscuits made from baking powder samples up to 30 years old. Superscript letters indicate significant differences. Same letters indicate no difference (p>0.05).

Sample (age in years)	Mean Height (cm)	Mean Weight (g)	Mean Volume (cm^3)
0	3.12[b]	28.80[b]	68.74[cd]
1	3.04[b]	28.70[b]	65.93[d]
4	3.19[ab]	30.00[ab]	69.61[c]
13	3.11[b]	28.70[b]	68.74[cd]
23	3.11[b]	28.80[b]	75.65[b]
24	3.29[a]	30.20[ab]	74.73[b]
30	3.32[a]	31.60[ab]	79.21[a]
Control	2.11[c]	33.20[a]	46.71[e]

Biscuit Crumb Color

The mean color values ranged from 66.0-70.5 for L*, 1.5-8.7 for a*, and 18.6-32.4 for b* (Table 3). The higher L* value indicates a lighter color, higher a* means more red hues than green, and higher b* means more yellow hues than blue. The biscuits made without leavening were lighter overall and had more green and blue hues than the biscuits made with any age baking powder.

Table 3: Average crumb color values for biscuits made with baking powder samples up to 30 years old. Superscript letters indicate significant differences. Same letters indicate no difference (p>0.05).

Sample (age in years)	L* values	a* values	b* values
0	68.2[abc]	5.3[abc]	27.2[ab]
1	67.9[abc]	5.9[ab]	27.9[ab]
4	69.4[abc]	5.6[ab]	27.4[ab]
13	70.5[ab]	4.0[bc]	25.9[ab]
23	66.0[c]	7.4[a]	31.2[a]
24	66.3[c]	7.0[ab]	30.5[a]
30	66.5[bc]	5.8[ab]	27.9[ab]
Control	70.6[a]	1.5[c]	18.6[b]

Sensory Quality

All of the biscuit samples received over 95% acceptance for eating in an emergency situation, indicating that all of the baking powder samples made acceptable biscuits. All of the biscuits received over 65% acceptance for eating in an everyday situation (Fig. 4).

Hedonic scores for appearance, aroma, texture, flavor, and overall acceptability were in the "like slightly" to "like moderately" categories (Table 4). Although there were some statistical differences between samples, there were no trends relating to samples age.

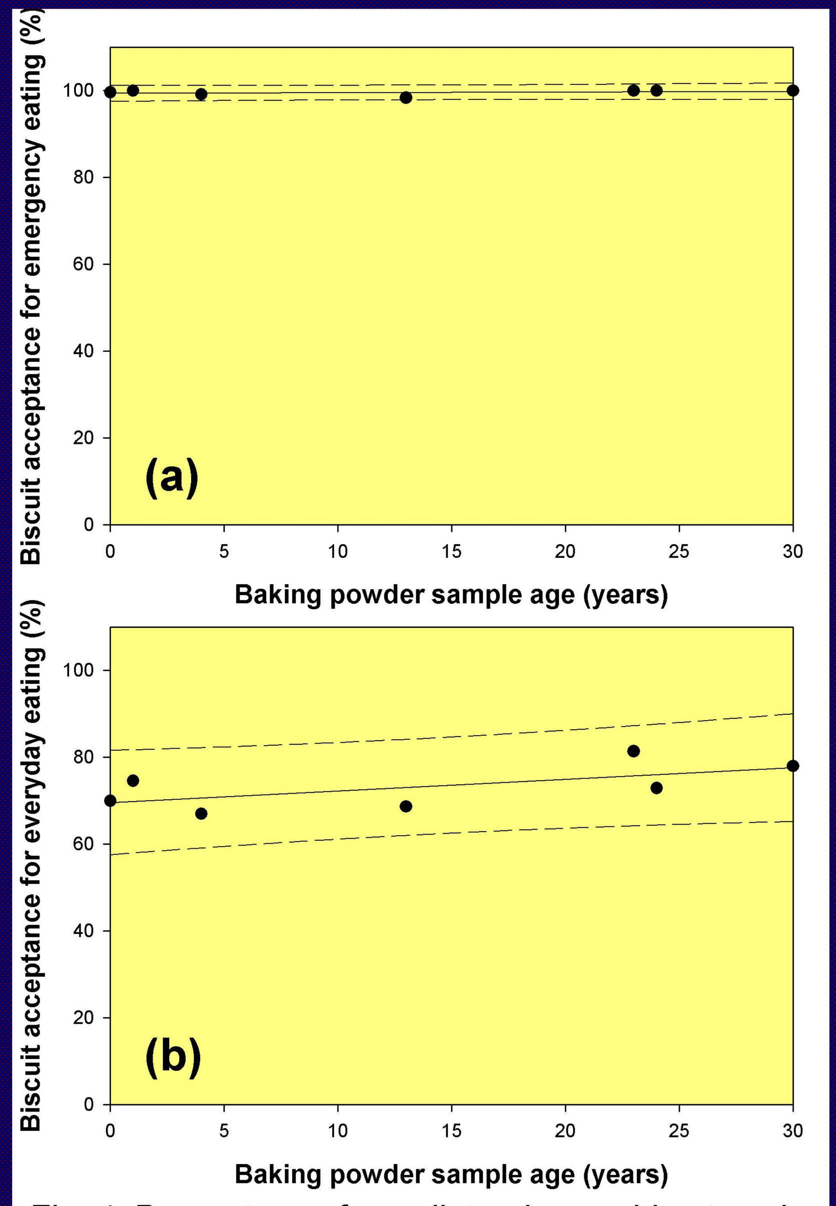

Fig. 4. Percentage of panelists who would eat each baking powder biscuit sample in (a) an emergency situation or (b) an everyday situation. Dashed lines represent 95% prediction intervals.

Table 4. Mean hedonic scores from sensory evaluation of biscuits using baking powder samples up to 30 years old. Superscript letters indicate significant differences. Same letters indicate no difference (p>0.05).

Sample (age in years)	Appearance	Aroma	Flavor	Texture	Overall
0	7.14[bc]	6.75[c]	6.56[b]	6.94[ab]	6.78[c]
1	7.15[bc]	6.92[abc]	6.68[b]	7.11[a]	6.95[abc]
4	6.85[c]	6.46[d]	6.65[b]	6.74[b]	6.71[c]
13	6.99[bc]	6.42[d]	6.60[b]	7.03[ab]	6.89[bc]
23	7.55[a]	7.19[a]	7.08[a]	7.19[a]	7.26[a]
24	7.20[b]	6.81[bc]	6.77[ab]	6.97[ab]	6.79[c]
30	7.17[bc]	7.08[ab]	6.92[ab]	6.77[b]	7.11[ab]

CONCLUSIONS

The functionality of double-acting baking powder stored up to 29 years in non-abusive conditions in residential storage does not significantly decrease as measured by total CO_2 evolved, average biscuit volumes, biscuit crumb color, and consumer evaluations.

Under optimal storage conditions, it appears that baking powder retains its functionality as a leavening agent for many years and can be included in applications requiring long-term food storage.

REFERENCES

AACC Official Methods. 1993. Baking Quality of Biscuit Flour. Method 10-31B.

Conn JF and Heidolph BB. 1989. Starch moisture effect on baking powder stability. Singapore, Singapore Institute of Food Science & Technology (Food Product Development Symposium). p 371-373.

Conforti FD, Charles SA, and Duncan SE. 1997. Evaluation of a carbohydrate-based fat replacer in a fat-reduced baking powder biscuit. J Food Qual. 20:247-56.

Halliday EG and Noble IT. 1943. Food Chemistry and Cookery. Chicago: University of Chicago Press. 346p.

Gallay W and Bell AC. 1935. The effect of various starches on the stability of baking powders. Can J Res. 14B:205-215.

McCrea JM. 1950. On the isotropic chemistry of carbonates and a palaeotemperature scale. J Phys Chem. 18:849-57.

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