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RESEARCHES REGARDING THE CHEMICAL LEAVENING AGENTS' ROLE IN QUALITY OF BAKERY PRODUCTS

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Abstract

There are many different chemical leavening agents available to the baker. These include baking soda (sodium bicarbonate), ammonium bicarbonate, potassium bicarbonate, baking powder (baking soda, calcium phosphate and sodium aluminum sulfate) and leavening acids. Generating CO_2 and neutralizing sodium bicarbonate is the primary role of leavening acids, but, is important not to forget the secondary role and effects of them. Taking into consideration these facts, the objectives of experiments was to establish the connection between quantity and quality of leavening agents and the quality of bakery products.
***Keywords**: cake, leavening acid, bicarbonate, baking powder*

Introduction

Chemical leaveners are used to give cookies, cakes, and other baked goods their characteristic textures. They produce gas from the reaction that takes place when a carbon dioxide source and an acid are mixed together and come into contact with water. The gas forms bubbles that are trapped in the batter or dough and then expand during baking to form the holes that are retained in the finished product.

The timing of the release of CO_2 is critical in establishing uniform cell structure. Upon heating, the CO_2 will release and expand, resulting in the increased volume and desirable texture characteristic of good tasting, high quality baked goods (Manthey, 2002).

Baking soda is the most common carbon dioxide source. It is low in cost, high in purity, easy to handle, and leaves no after taste. Flour and other ingredients are slightly acidic, so baking soda will release

some carbon dioxide if added by it but will produce more when more acid is added.

Baking powder contains baking soda, one or more leavening acids, and a filler. The leavening acids are added in their powdered form as salts which do not react until they dissolve in water. The filler stabilizes the product by keeping the baking soda and leavening acid separate and standardizes it to the desired strength.

Leavening acids are selected primarily on the basis of reactivity—how fast they react and at what temperatures. Reactivity depends mostly on solubility, which in turn depends on chemical composition, particle size, and special treatments such as coating

Single-acting baking powders contain a single leavening acid and can be slow acting or fast acting. Slow-acting types are the most common and use a slow-acting acid like SALP (sodium aluminum phosphate) that reacts very little until heated in the oven. Fast-acting types are less common but use a fast-acting acid such as monopotassium tartrate (cream of tartar) to provide gas production at low temperatures immediately after addition (Brodie, 2006).

Double-acting baking powders contain a mixture of a fast-acting leavening acid like MCP (monocalcium phosphate monohydrate) and a slow-acting leavening acid like SAPP (sodium acid pyrophosphate). They react partially at low temperatures and partially at high temperatures to provide uniform leavening throughout processing (Brodie, 2006).

Taking all into consideration we could say that the key to superior chemical leavening is the selection of the correct type and grade of bicarbonate and acid for the baked good and the baking process being used.

Experimental

The objectives of the experiments were to have a better understanding of leavening agents' role in batter and cakes quality and also to apply the mixing techniques-multistage-method.

In order to obtain some available experimental data like control sample, wheat cake flour from Kansas State University Laboratory Mill was used. The technological characteristics of flour are shown in table 1.

Table1. Analytical parameters of Cake flour

Moisture (%)	Ash (%)	Wet gluten (%)	Protein (%)	Hydration capacity (%)	Zeleny index (ml)
13.42	0.38	271.1	8,5	64.6	36

The analytical flour quality was determined according to the international standard methods (ash content – ICC104/1, wet gluten – ICC105/2, protein content – ICC106/2, hydration capacity with Farinograph - ICC115/1 and Zeleny index – ICC116/1).

Three types of leavening agents based on their properties and level of usage were chosen:

- Single - Acting Baking Powder provided by Lallemand, Inc., Montreal, Canada, and based on sodium bicarbonate, MCP and corn starch like filer
- Baking soda, from Arm and Hammer brand purchased at the local grocery store
- Regent^{R}12XX (MCP, monocalcium phosphate monohydrate) provided by Innophos, Inc., Cranbury, New Jersey, U.S.A.

Each of these leaveners was tested by making yellow cakes using different amounts of them.

In order to obtain high nutrition value products with good volume and porosity some ingredients like salt, sugar, shortening, emulsifier, milk solids and flavors were used.

All the experiments are made in the research laboratory of American Institute of Baking, Manhattan, Kansas, U.S.A.

Results and Discussions

In order to observe the influence of different amounts and combination of leavening agents on batters and cakes quality 5 samples using the following formulas (table 2) were made.

It was very important to check specific gravity of cake (optimum 0.8-0.85) after 2nd and 3rd stage, to determine the proper mixing time required and record the specific gravity with the final batter temperature and also with viscosity (figure 1).

Table 2. Formulating sheet

1st STAGE					
Ingredients, grams	Control cake	No Baking Powder	High Baking Powder	High pH	Low pH
Sugar	840	840	840	840	840
Cake shortening	280	280	280	280	280
Emulsifier	14	14	14	14	14
Salt	21	21	21	21	21
Baking Powder	38.5 (5%)	0	84 (12%)	21 (3%)	21 (3%)
Baking soda	-	-	-	17.5 (2.5%)	-
Regent^{R}12XX	-	-	-	-	17.5 (2.5%)
Not-fat Dry Milk	70	70	70	70	70
Yellow Color (Goldex)	14	14	14	14	14
Cake flour	700	700	700	700	700
Whole eggs	420	420	420	420	420
Water	70	70	70	70	70
Mixing procedures: Start mixing **1minute in 1st speed** adding the eggs quickly. Scrape down bowl with a plastic scraper. Continue mixing for **4 minutes in 1st speed**					
2nd STAGE					
Ingredients, grams	Control cake	No Baking Powder	High Baking Powder	High pH	Low pH
Water	266	266	266	266	266
Mixing procedures: Mix **1 minute in 1st speed** gradually adding the water in 3 parts avoiding splashing and lumps. Scrape down bowl and continue mixing for approximately **4 minutes in 1st speed**					
3rd STAGE					
Ingredients, grams	Control cake	No Baking Powder	High Baking Powder	High pH	Low pH
Water	315	315	315	315	315
Flavor (vanilla, lemon)	12.5	12.5	12.5	12.5	12.5

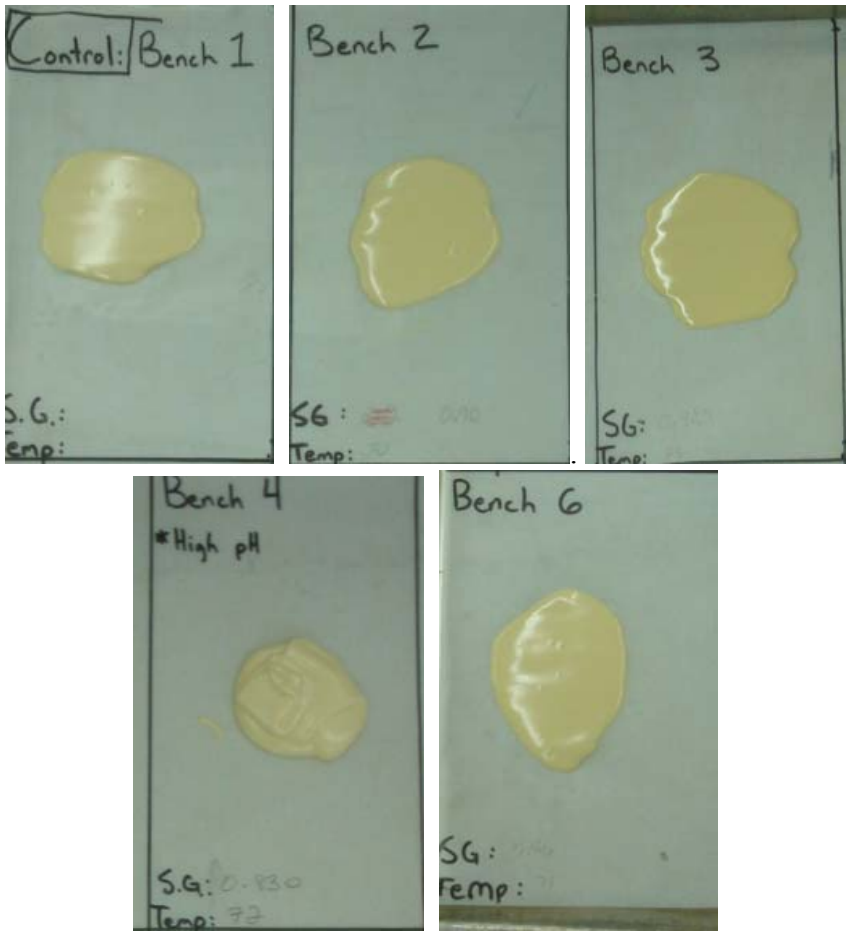

Figure 1. Evolution of viscosity of batter cakes during the 2nd and 3rd stage
1-control cake, 2-cake without baking powder, 3-cake with high baking powder, 4-cake with excess soda, 5-cake with excess acid

We can observe that the viscosities of the samples are almost the same with an exception (sample 4) which is a little grainier. The specific gravity (S.G.) has a direct relationship to volume, grain and texture of cakes and could be also a measure of incorporated air cells

After mixing was completed, 6 cakes pan from each of samples were prepared. Every cake had 370 grams. All cakes were loaded at one time to better control congestion at the oven. Oven temperature was 182°C and time of baking was approximately 24 minutes.

After baking, the cakes were put on the rack for cooling, and after 15-20 minutes the cakes were removed from the cake pans. Also we split them for a complete sensory exam (figure 2).

Figure 2. Cake sections for sensory analyze

Influence on cakes volume. If we analyzed these five cakes we can observe the fact that each of four samples with chemical leavening agents had a good final volume. On the other side the sample without baking powder had a poor volume, almost the same like batter before baking. We can also make the right connection between final cake's volume and specific gravity of this sample (~1) which was more then optimal (0.8).

Influence on cakes texture and mouth feel. Regarding these aspects we can observe (figure 3) that the sample with high baking powder have more open porosity and a more grainy aspect.

In case of sample with excess Soda (Baking powder with Baking soda) it is obvious the brown color and the very open porosity. Also this sample had a taste like a soap film on the tongue.

The same enhance of color could be observed in the case of cake with high baking powder. The explanation could be the *p*H.

Figure 3. Cake textures

The cake's *p*H was checked with Leavening indicator chart (figure 4) and the following values were obtained: Control cake = 6.5, High *p*H cake = 8.5 and Low *p*H cake = 5.0.

a **b** **c**

Figure 4. *p*H check
a-control cake, b- cake with excess soda, c-cake with excess acid

Taking into consideration these facts became obvious the important role of cake's *p*H on color crust and flavor. And, of course, the level of *p*H is controlled by leavening acids. In these conditions we could say that is very important to select the proper leavening acid based on type of products and characteristic and when we want carbon dioxide released. And, of course, it's very important how much acid we will use in accordance with amount and type of soda used and the neutralization value of the leavening acid. If too little leavening acid is added, less gas is produced and the residual baking soda raises the pH

of the finished product. If too much leavening acid is added, gas production remains the same but will leave a bitter aftertaste in the finished product.

Conclusions

Analyzing the obtained results from the study about the possible effects of chemical leavening agents on cakes quality we can drop the following conclusions:

- generating CO_2 and neutralizing sodium bicarbonate is the primary role of leavening acids, but, is important not to forget the secondary role and effects of them;
- ***Taste*** is influenced by the choice of leavening acid and ratio of leavening acid to baking soda;
- ***Texture*** is also influenced by the choice of amount of leavening agent. Each leavening acid has a unique reaction profile that determines performance. The reaction profile and the stage of baking are the keys to texture in baked goods.
- ***Crumb color*** is influenced by the pH of the finished product. A low pH from low baking soda levels gives whiter crumb color. A high pH from high baking soda levels gives a darker crumb color that is desirable in chocolate products'

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