Carbonated Yogurt—Sensory Properties and Consumer Acceptance


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ABSTRACT

Sweetened low fat (1%) plain yogurt and low fat Swiss-style strawberry and lemon yogurts were manufactured using cream, nonfat dry milk, sugar, stabilizer (a blend of modified food starch, carrageenan, and pectin), and skim milk. After addition of the yogurt cultures and Lactobacillus acidophilus and Bifidobacterium longum, yogurt samples were incubated at 43°C until desirable pH values of 5.0 or 4.2 were reached. Carbon dioxide (0.08 to 0.09 kg/cm²) was incorporated into the cooled, flavored yogurt by way of a sanitary hose. The yogurt was stored at 4°C for sensory evaluation by an expert panel on d 7, 21, and 45. A consumer panel evaluated carbonated and noncarbonated yogurts on d 21. The results of the study showed that the carbonation had no significant effect on the acceptability of yogurt during shelf-life. Also, the carbon dioxide treatment did not alter the sensory characteristics of yogurt as noted either by expert panelists or by consumers.

(Key words: carbonated yogurt, sensory properties, consumer acceptance)

INTRODUCTION

Yogurt is a flavorful and healthful food. In efforts to offer variety and competition in the market, carbonation of yogurt may attract new yogurt consumers. One sensory characteristic of flavored yogurt commonly sought by consumers is that the product should be distinctly refreshing. A refreshing flavor in yogurt implies no unpleasant aftertastes, a pleasant level of acidity, a pleasing balance of flavors, and a perceptible sensation of product sweetness. Typically, yogurt is characterized as a smooth, viscous gel with a characteristic taste of sharp acid and a green apple flavor (2). Some yogurts exhibit a heavy consistency that closely resembles custard or milk pudding. In contrast, other yogurts are purposely soft-bodied and are essentially drinkable (5, 6).

Today, consumers continually search for new and unique food products while trying to maintain healthy eating habits. Carbonated yogurt could help nutrition and novelty in the dairy foods market. Carbonation of a yogurt beverage reportedly improves its thirst-quenching quality and increases its refreshing characteristic (14). Carbonation provides tactual and fizzy sensations, which contribute to a novel mouthfeel.

Since 1974, per capita consumption of yogurt has steadily increased (9) as Americans have become more health conscious. In 1995, individual consumption of yogurt peaked at 2.32 kg and declined slightly in 1996. The decline in yogurt consumption could have been a result of the heavy influx of healthy snack foods into the marketplace. Marketers anticipate that the carbonation of yogurt may allow it to move more strongly into the snack food area. Because the versatility of yogurt allows the incorporation of many unique and acceptable flavors, this product can be exploited more fully to offer the consumer additional flavors and textures.

Choi and Kosikowski (4) produced a strawberry flavored yogurt drink that was carbonated. A panel of yogurt and soft drink consumers frequently (89.8%) endorsed the product. An equally sized panel of consumers, who neither liked yogurt nor soft drinks, reported a preference (77.2%) for the carbonated yogurt drink based on a hedonic scale evaluation (where 1 = dislike very much to 7 = like very much), which indicated the possibility of attracting customers who would normally not enjoy a traditional yogurt product. Yogurt readily accepts carbonation even though it is a semisolid food product (10). Ogden (10) has demonstrated that carbonated yogurt
has a refreshing taste. Thus, the objectives of the current study were 1) to ascertain the effect of carbonation on the perception of various flavor and texture properties in plain and flavored yogurts during storage and 2) to determine the acceptance of such a product by the consumer.

**MATERIALS AND METHODS**

**Yogurt Production**

The yogurt mix was composed of skim milk, cream, nonfat dry milk (low-heat Grade A nonfat milk; Danish Creamery Assoc., Fresno, CA), sugar, and stabilizer. The mix was adjusted to 1% milkfat with fresh cream (38% fat). To reach 11% milk SNF, skim milk powder was incorporated into the mix at the rate of 2%. Sucrose was added at 6% (wt/wt) to sweeten the mix. A commercial stabilizer (modified food starch, carrageenan, and pectin; Continental Colloids, Inc., West Chicago, IL) was used at the rate of 1.5% wt/wt.

All ingredients were mixed in a stainless steel container and were heated to 50°C. The mix (78 kg) was homogenized at 10.395 and 3.43 MPa using a two-stage homogenizer (15). The mixes were heated to 85°C and were held for 30 min in a 189-L stainless steel vat (Walker, Newlisbon, WI) (11, 14). The mixes were cooled to 43°C in an ice-water bath and then were inoculated with a direct-set yogurt culture containing strains of *Streptococcus thermophilus* and *Lactobacillus delbrueckii ssp. bulgaricus* (Chr. Hansen Laboratory, Inc., Milwaukee, WI). During the incubation period, the temperature of the vat did not drop below 39°C. This is not an uncommon occurrence in an industrial setting. *Lactobacillus acidophilus* direct-vat set culture (LA-K; Chr. Hansen Laboratory, Inc., Milwaukee, WI) was added directly to the mix according to the manufacturer’s recommendation. *Bifidobacterium longum* (ATCC 15707) was grown in sterilized milk, and a sufficient amount was added to attain a concentration of $10^7$ cells/g of the yogurt mix. To investigate the effect of pH on survival of *L. acidophilus* and *B. longum*, yogurt was fermented to pH 5.0 and the more typical pH 4.2. After incubation, the coagulum was stirred and cooled to 15°C. Strawberry or lemon fruit flavoring (Fantasy Flavors Inc., Wheaton, IL) was added at the rate of 2% (wt/wt). The yogurt was carbonated by bubbling carbon dioxide into the bottom of the container via a sanitary hose. During the 30 min of carbonation, the samples were stirred frequently to obtain uniform carbonation. The solid yogurts were immediately packaged in 340-g polyethylene bottles (PET; Siligan, Seymour, IN), tightly capped, and stored at 4°C.

**Measurement of Carbonation**

A piercing device (Model D-T Number 6001; Zahm and Nagel Co., Buffalo, NY) was used to monitor carbon dioxide content. After the headspace pressure and temperature were measured for randomly chosen sample bottles from each batch, the pressure and temperature readings were converted with a conversion chart (18) into volume of carbon dioxide gas dissolved in water.

**Sensory Evaluation**

**Panelists.** Ten trained panelists were recruited from Mississippi State University (Mississippi State). They were selected on the basis of training and experience in the use and evaluation of plain and flavored yogurt. Panelists were between the ages of 21 and 56; 4 were female, and 6 were male.

**Panel training.** Trained panelists were used, which made group discussions or additional training sessions unnecessary. There were 30 evaluation sessions that each lasted about 15 min. Panelists evaluated 20-g portions of each yogurt. Panelists used a quality rating score card for evaluation of flavor and texture of yogurt samples. All perceived criticisms were marked appropriately.

**Sensory evaluation procedures.** Stored yogurt samples were evaluated for flavor and texture after the elapse of 7, 21, and 45 d. Yogurt flavors of plain, lemon, and strawberry were evaluated. A 10-point scale was used to measure flavor where 1 = poor quality to 10 = excellent quality. A list of common yogurt characteristics and defects was also used to allow the panelists an opportunity to comment on the flavors perceived in each sample. A five-point scale was used for texture where 1 = poor quality to 5 = excellent quality. Consumer preference was measured at d 21 by the multiple paired preference test (8).

Panelists were seated in individual booths. Samples and ballots were passed through from an adjoining preparation room. Water was used for rinsing between samples. All yogurt samples were portioned into individual, plastic-covered coded cups and were presented to panelists on a tray at the beginning of the evaluation.

**Consumer Acceptance Panel.** Preference of carbonated versus noncarbonated plain and flavored yogurt samples by consumers was determined by multiple paired preference test and involved the use of a 72-member consumer panel that comprised Missis-
TABLE 1. Mean (± SE) flavor and texture scores for carbonated versus noncarbonated yogurt over all time periods and yogurt types as determined by a trained panel.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Flavor score</th>
<th>Texture score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>SE</td>
</tr>
<tr>
<td>Carbonated yogurt</td>
<td>7.48&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.055</td>
</tr>
<tr>
<td>Noncarbonated yogurt</td>
<td>7.36&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.054</td>
</tr>
</tbody>
</table>

<sup>a</sup>Means within a column without a common superscript differ (P < 0.05).

Data Analysis

A 3 x 3 x 2 x 2 factorial arrangement of treatments in a completely randomized design with repeated measures was utilized. Data were taken at three time periods for analysis. Differences among treatments were evaluated by analysis of variance. All analyses were performed using SAS (12). The least significant difference test was applied for multiple comparisons. When any measured trait interacted with day, an approximate t value was calculated to determine the least significant difference with the appropriate error terms (13). For the consumer preference test, the critical value of differences between rank sums was determined using Table 1 of Basker (1).

RESULTS AND DISCUSSION

Sensory properties of foods offer quality control criteria. With regard to sensory properties, yogurt may be evaluated for flavor, body or texture, and appearance (16). In a study by Choi and Kosikowski (4), carbonation of yogurt at 0.5 kg/cm<sup>2</sup> improved the organoleptic qualities of sweetened, fruit-flavored yogurt beverages. Carbonation provided refreshing and thirst-quenching characteristics for yogurt beverages (14).

The mean flavor scores for carbonated and noncarbonated flavored and plain yogurts are shown in Table 1. For time periods and yogurt types, the carbonated yogurt had an overall mean flavor score (on a 10-point scale) of 7.48 versus a score of 7.36 for noncarbonated yogurt; these means were not different (P > 0.05).

Carbonation did not affect (P > 0.05) the texture scores of the samples. The overall mean texture score (on a five-point scale) of noncarbonated yogurt was 3.01, slightly higher than the overall mean score of 2.93 for the carbonated yogurt (Table 1).

The amount of carbon dioxide added to the yogurt ranged between 0.08 and 0.09 kg/cm<sup>2</sup>. Table 2 shows the effect of carbonation on flavor and texture scores of yogurt during a 45-d storage period. These results demonstrate that the interactions between carbonation and flavor and carbonation and texture scores of yogurts over this 45-d-period were not significant (P > 0.05). Carbonation did not affect (P > 0.05) flavor or texture scores of yogurts containing different flavors (Table 3). In other words, perception of various flavor and texture properties in plain and flavored yogurts was not influenced by carbonation.

Hotchkiss (7) stated that the addition of carbon dioxide had no negative effects on sensory charac-
TABLE 3. Mean (± SE) flavor and texture scores for carbonated versus noncarbonated yogurt by flavor type as determined by a trained panel.

<table>
<thead>
<tr>
<th>Flavor</th>
<th>Carbonation</th>
<th>Flavor Score X</th>
<th>Flavor Score SE</th>
<th>Texture Score X</th>
<th>Texture Score SE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lemon</td>
<td>Yes</td>
<td>7.99*a</td>
<td>0.06</td>
<td>3.37*a</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>7.83*a</td>
<td>0.01</td>
<td>3.47*a</td>
<td>0.07</td>
</tr>
<tr>
<td>Strawberry</td>
<td>Yes</td>
<td>7.44*a</td>
<td>0.06</td>
<td>2.92*a</td>
<td>0.07</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>7.39*a</td>
<td>0.05</td>
<td>2.96*a</td>
<td>0.06</td>
</tr>
<tr>
<td>Plain</td>
<td>Yes</td>
<td>7.00*a</td>
<td>0.10</td>
<td>2.50*a</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>6.85*a</td>
<td>0.09</td>
<td>2.56*a</td>
<td>0.07</td>
</tr>
</tbody>
</table>

*aMeans within a column without a common superscript differ (P < 0.05).

Characteristics of cottage cheese. He reported that panelists liked the carbon dioxide in the product because of its perceived fresher or cleaner taste. The effect of carbonation and sweetener type on sensory properties of sweetened blueberry-flavored milks was examined by Yau et al. (17). The flavored milk was carbonated to a final pressure of 1.4 to 1.5 kg/cm² in a pilot-scale carbonation tank with filler device. Results showed that carbonation of milk increased the sensory ratings of overall intensity, sweetness, and blueberry flavor.

Several factors could have contributed to the seemingly lack of influence of carbonation on the flavor and texture scores. In earlier studies (4, 17), the consistency of the product being carbonated was less viscous because the products were milk beverages and drinkable yogurt versus the typical yogurt manufactured in the present study. This difference in consistencies might have had an effect on the ease of carbonating the product. Also, the use of a pressurized carbonation tank with an automatic filler would likely increase the levels of attainable carbonation that could be maintained throughout the bottling process. In addition, the minimal amount of handling in the previous studies during the carbonation and filling process would aid in lengthening the shelf-life as compared with filling the bottles by hand. Tamime and Robinson (15) reported on the addition of sodium and calcium carbonates to achieve carbonation in a yogurt drink. It was noted that the use of calcium carbonate resulted in a slower, more steady carbonation process. Otherwise, the product reportedly would go flat within a short period of time.

Although texture, color, and appearance of yogurt are important quality characteristics, the flavor of the product is generally considered the most critical and important indicator of consumer acceptance (2). Results of the consumer acceptance test showed that the preference of yogurt samples was not influenced by the addition of carbon dioxide to the yogurt (Figure 1). Although no differences (P > 0.05) existed among yogurts (plain, strawberry, and lemon) with respect to flavor, texture, or overall acceptability, the carbonated version of each flavor was preferred by an almost equal or greater number of panelists. Results of both the expert panel and consumer panel were comparable.

CONCLUSIONS

The results of this research showed that there was no significant difference between carbonated and noncarbonated yogurts with regard to flavor and texture scores on d 7, 21, and 45. Refinement of the packaging and carbonating procedure may improve flavor and body or texture.

Figure 1. Percentage of consumer panelists (n = 72) who preferred a carbonated or noncarbonated yogurt with plain, lemon, or strawberry flavor. Bars with the same letter (a) are not different (P > 0.05).
REFERENCES