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Influence of various hydrocolloids on cottage cheese cream dressing stability

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ABSTRACT

Commercial cottage cheese typically includes a cream dressing that provides flavor and texture. Various stabilizers are added to the dressing to mitigate separation and provide viscosity. However, there is little information on individual ingredient contributions to dressing stability. Therefore, the objective of this study was to determine how different hydrocolloids impacted cottage cheese cream dressing stability and flow behavior. Xanthan, guar, and locust bean gums were used alone and in combination as stabilizers. Dressing pH significantly impacted stability and viscosity. Temperature had little effect on flow behavior, which was shear-thinning for all formulations. Combinations of hydrocolloids were found to provide better stability than any single hydrocolloid alone, the improved stability was attributed to synergistic effects. Hence, a single stabilizing agent may not provide proper dressing stabilization. Stabilizing agents should be used in combination to prevent whey separation due to pH and temperature changes during the shelf life of cottage cheese.

1. Introduction

Cottage cheese is a soft, unripened cheese that has distinct, relatively uniform curd particles. It may be sold as dry curds; however, cottage cheese curds are usually mixed with a cream dressing. This cream dressing provides additional flavor and texture to the curds (Farkye, 2004). It is usually at least 40 percent of the final creamed cottage cheese product by weight (Clark, Costello, Drake, & Bodyfelt, 2009); full-fat cream dressing comprises cream, whole milk, cultured milk, and salt (Drake, Lopetcharat, & Drake, 2009). Cream dressing typically contains stabilizers, which provide viscosity, body, cling, and stability. Generally, stabilizer systems are a combination of gums, starches, emulsifiers, and phosphates.

An important quality marker of creamed cottage cheese for consumers is the amount of free whey present (Drake et al., 2009; Emmons & Price, 1960). The cream dressing should be homogenous and manifest no visible free whey, which presents as a clear-yellow serum layer on top of the cottage cheese curds. The presence of free whey is a result of expulsion of whey from the curd or from separation of whey from the cream dressing. Unstabilized cream dressing tends to separate over time, resulting in the appearance of a free whey layer. Another cause of cream dressing separation is disruption of the curd/dressing matrix, e.g., by using only a portion of the cottage cheese in a container. If the cream dressing is shear-sensitive, the shearing created by removing a portion of the creamed cottage cheese can result in cream dressing destabilization and whey separation. Disruption of the curd/dressing matrix can also result in movement of free whey that may have collected on the bottom of the container to the top of the container. In this case, the whey separation occurs before the container is opened, but is not immediately visible. Regardless of the cause, consumers find the appearance of free whey unappealing, as it gives the impression of a low-quality product.

To address the stability issues associate with cream dressing, cottage cheese manufacturers add various hydrocolloids to increase viscosity (Clark et al., 2009; Cooper & Watts, 1981), decreasing the likelihood of separation as described by Stokes' Law. Stability may also be improved by promoting favorable interactions between the different components of the dressing, such as the formation of a weak gel or steric repulsion. However, adding too high a quantity of stabilizers can result in cream dressing with an unpleasant slimy or pasty mouthfeel (Clark et al., 2009). Most of the studies on interactions between hydrocolloids and milk proteins have used

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model systems, such as gels and solutions of casein or whey proteins in combination with different polysaccharides. These studies have shown that the strength and type of interactions between milk proteins and polysaccharides are dependent on pH, ionic strength, temperature, concentration, and presence of other components in the solution or gel (e.g., carbohydrates, fat) (Çakır & Foegeding, 2011; Corredig, Sharafbafi, & Kristo, 2011; de Vries, 2002; Koksoy & Kilic, 2004; Langendorff et al., 2000; Syrbe, Bauer, & Klostermeyer, 1998).

There has been little study, however, on cottage cheese cream dressing and how the cream dressing components affect stability in the dressing system. In addition, although there has been considerable study on mechanical and sensory behaviors of cottage cheese curds, almost no studies have been published on mechanical and sensory behaviors of cream dressing. This lack of published information available on cottage cheese cream dressing poses a major challenge for a fundamental understanding of factors affecting cream dressing stability and mechanical properties. Therefore, the objective of this study was to determine the effect of different hydrocolloids on cottage cheese cream dressing stability and viscosity. This study focused on the cream dressing alone, taking the first steps to understanding the contribution of hydrocolloids to the stability of cottage cream dressing. Future work will examine cottage cheese cream dressing stability in a curd dressing-matrix, as the exchange of various curd and dressing components (e.g., salts, whey) can have additional impacts on curd stability.

2. Materials and methods

2.1. Materials

Raw milk and food-grade sodium chloride were obtained from the Washington State University Creamery. Cream (approximately 40% milkfat) and spray-dried sweet whey powder were obtained from Darigold (Seattle, WA, USA). Xanthan gum (Keltrol T622) and locust bean gum (GENU Gum type RL-200Z) were donated by CPKelco (Atlanta, GA, USA) and guar gum (Procol U) was donated by Polypro International Inc. (Minneapolis, MN, USA). Glucono-delta-lactone was purchased from Sigma Chemical Co. (St. Louis, MO, USA). Other laboratory chemicals were purchased from Fisher Scientific (Fair Lawn, NJ, USA).

2.2. Cottage cheese dressing preparation

The experimental design used for the cottage cheese dressings is shown in Table 1. Raw milk (3.85 kg) was mixed with cream (0.65 kg) in a 37.5 L metal can (25.4 cm diameter, 61 cm in height) to obtain a dressing base containing approximately 9% fat. The dressing base was placed in a steam chest (50.8 cm long × 116.8 cm wide × 66 cm high) and heated to 71.1 °C. Sodium chloride (101.25 g) was mixed thoroughly with the desired amounts of xanthan gum, guar gum, and locust bean gum, then added to the heated dressing base and stirred until well-mixed. The dressing was then held for 30 min at 71.1 °C for pasteurization. Pasteurized dressing was homogenized in a two-stage homogenizer (APV-Gaulin model 400/200 M6-3TPS; Charlotte, NC, USA) at 3.45/11.7 MPa. The homogenized dressing was collected in a clean 37.5 L metal can and transferred to 1 L sanitized plastic storage bottles. The dressing was cooled in a blast cooler at 4 °C and stored at 4 °C until testing.

2.3. Proximate analysis

Sample moisture content was analyzed in triplicate by drying in a forced-air oven, according to the method of the Horwitz and Latimer (2010). Ash content was determined in triplicate by a standard method for fluid dairy products (Wehr & Frank, 2004). Fat content was determined in duplicate using the Babcock method for fluid cream samples (Wehr & Frank, 2004). Protein content was determined via Dumas combustion using a rapid MAX N exceed (elementar, Hanau, Germany). Approximately 300–500 mg of each sample was weighed into a preweighed crucible and the precise weight of the crucible and sample recorded. Combustion was performed at 900 °C with an oxygen gas flow rate of 200 mL min^{-1} and dosing time of 100 s. Thermal conductivity detection was used to quantify the amount of nitrogen in each sample, with argon used as a carrier gas. Carbohydrate content was estimated by difference.

2.4. Rheological measurements

All rheological testing was performed on a DHR-3 rheometer (TA Instruments, New Castle, DE, USA) using a 1° cone (60 mm diameter) with a temperature-controlled Peltier plate. Shear rate sweeps were performed from 0.1 to 100 s^{-1}, then from 100 to 0.1 s^{-1} to check for hysteresis between the viscosity curves. Samples were measured at 8 and 25 °C no later than 72 h after preparation. Prior to testing, samples were equilibrated at the testing temperature (8 or 25 °C) for 10 s, presheared at 10 s^{-1} for 20 s to ensure the same shear history, and equilibrated at zero shear for 30 s. All testing was conducted in triplicate.

2.5. Preparation of samples for stability study

A storage study was conducted to investigate the stability of the dressings as a function of pH (5.5, 5.0, and 4.5) and amounts of added whey (1:2, 1:4, and 1:8 cream dressing to whey ratios, w/w). The whey was added to mimic whey expulsion from the curd. Ratios were selected to evaluate the limit of the dressing formulations to accommodate added whey. Dressing pH was adjusted using glucono-delta-lactone (GDL). After addition of GDL to the dressing, samples were stirred at approximately 300 rpm on a stir plate for 10 min to ensure thorough mixing, covered with parafilm, and stored at 4 °C overnight. Samples were equilibrated to room temperature (22 ± 2 °C), then the pH of each sample was measured and, if needed, adjusted to at most ±0.05 units from the target pH (5.5, 5.0, or 4.5) with 1.0 M HCl or 1.0 M NaOH. A whey solution was prepared by adding 20 g of sweet whey powder to 133 g of deionized water, stirring for 1 h at room temperature, and storing overnight at 4 °C to allow complete dispersion. The whey solution was equilibrated to room temperature (22 ± 2 °C), then added to the pH-adjusted samples in dressing/whey ratios of 1:2, 1:4, and 1:8. Samples were placed in 50 mL plastic storage tubes, capped, and shaken well to mix the dressing and whey. Control samples with no added whey were also prepared for each formulation at each pH.

2.6. Stability during storage

Samples prepared for the stability study were stored at 4 °C for 14 d. Images of the samples were taken after 1 d, 7 d, and 14 d of storage (the day of sample preparation was considered to be day 0). The amount of whey separation in each sample was recorded. Stability scores for the dressings were calculated using the following formula:

$$\text{Weighted score} = \frac{1(NSS) + 2(SSS) + 4(CSS)}{\text{total count of samples}} \quad (1)$$

where, NSS is the count of samples showing no separation, SSS is the count of samples showing slight separation (whey layer