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Use of potassium chloride and flavor enhancers in low sodium Cheddar cheese

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ABSTRACT

We investigated use of potassium chloride (KCl) to maintain both the salty flavor and to replace the preservative effects of salt when reducing the sodium content in natural cheese. Because salt replacers can affect flavor because of inherent off-flavors, such as bitter and metallic, we examined the use of flavor enhancers for their ability to modulate some of these undesirable sensory effects. Stirred-curd Cheddar-style cheese was manufactured using 2 cheese-making procedures (different curd knife sizes and target salting titratable acidities), in duplicate. Curd was salted with sodium chloride (NaCl) or 60% reduced sodium blends of NaCl and KCl (2 different sources). Curd was also salted at a 60% reduced sodium rate with NaCl and KCl with added flavor enhancers. A hydrolyzed vegetable protein/yeast extract blend, a natural "potassium-blocking type" flavor, disodium inosinate, or disodium guanylate were each blended with the reduced sodium salt blend and added to curd at the salting step. The resulting blocks of cheese were aged for 5 mo and evaluated monthly for chemical, microbial, and sensory differences. At 5 mo of aging, we measured liking for the cheeses using a consumer panel. Overall, cheeses were well liked by the consumer panel, and the scores of reduced sodium cheese with 2 different KCl sources were not different from those of the full-sodium control. The addition of flavor enhancers to Cheddar curd had mixed results, with one improving the consumer flavor liking only slightly over KCl, and one (disodium inosinate) significantly reducing consumer flavor liking scores, presumably due to the amount of umami flavor it contributed. Potassium chloride replacement salts sourced from different manufacturers affected the chemical and flavor properties of cheese, and changes to pH and temperature targets may be necessary to yield cheese with the moisture and pH targets desired. The cheese-making procedure used also influenced flavors observed, which resulted in higher levels of brothy flavor in cheese made with smaller curd knives and a higher target salting titratable acidity. This effect resulted in lower consumer liking scores.
Key words: sodium reduction, cheese, water activity, KCl, salt replacer

INTRODUCTION

Sodium content in processed foods is considered to be a public health concern because of its potential to contribute to the development of hypertension in some individuals, which can be a precursor to conditions such as cardiovascular disease (Doyle and Glass, 2010; Cotugna and Wolpert, 2011; Appel et al., 2012). Cheddar cheese contains approximately 615 to 620 mg of sodium/100 g of cheese (Agarwal et al., 2011; USDA, 2011); therefor, one serving provides approximately 8% of the Food and Drug Administration's daily reference value (FDA, 2009). Cheddar cheese is also an ingredient in process cheese and in sauces, so effective techniques to reduce the sodium content could have significant health benefits.

Salt (NaCl), and its ratio to moisture content, is very important in natural cheese as it affects flavor, the activity of microbial cultures and non-starter microorganisms, and affects moisture removal during cheese manufacturing (Guinee, 2004; Upreti and Metzger, 2007). Mineral salt replacers can be added to maintain the enzymatic and microbial stability by maintaining the water activity ($\mathbf{a_w}$) of the cheese to that of full-sodium.

In a previous study, we investigated the effect of different mineral salt replacers in reduced sodium, stirred-curd Cheddar-style cheese at concentrations that maintained the same a_w as full-sodium control (Grummer et al., 2012). Cheese made with potassium chloride (KCl)-based salt replacers had the least negative effect on flavor compared with calcium and magnesium chloride. Cheeses made with the 2 different KCl sources tended to be slightly more bitter than full-sodium control cheese (though the differences were not significant).

To overcome the flavor issues commonly attributed to KCl, flavor enhancers (monosodium glutamate, hy-

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drolyzed vegetable protein, yeast extract, disodium inosinate, and disodium guanylate), sweeteners (sucrose, taumatin, and trehalose), and bitter blocking compounds are commonly paired with KCl in reduced sodium foods such as soups, frozen meals, processed meats, and seasoned dry snacks (Brandsma, 2006; Doyle and Glass, 2010; Henney et al., 2010). Flavor enhancers tend to contribute umami, brothy, and savory flavors to foods and can be used to create improved reduced sodium products (Reddy and Marth, 1991; Brandsma, 2006).

Published studies have not investigated the use of flavor enhancers as a means to improve the sensory characteristics of reduced sodium cheese. Studies in cheese suggest that flavors such as umami play a role in the flavor profile of cheese, as demonstrated in Drake et al. (2007), where naturally occurring glutamic acid was reported as the largest contributor to umami taste in Cheddar and Swiss. Drake et al. (2007) and Young et al. (2004) found umami intensity to increase with cheese age and to correlate positively with aged Cheddar cheese flavor attributes such as sulfur and brothy. Shakeel-Ur-Rehman et al. (2003) studied the effect of adding yeast extract at the salting step on nonstarter lactic acid bacteria in reduced fat Cheddar cheese and noted that cheese with yeast extract was perceived to have a more mature flavor than cheese without it. They also noted differences in flavor due to the addition of yeast extract, including higher sulfur, nutty, and fruity flavor intensities, as well as lower brothy flavor intensity.

We hypothesized that, by maintaining the a_w of full-sodium Cheddar through the use of KCl in low sodium cheese, chemical and microbiological properties such as proteolysis and lactic acid bacterial counts would be equivalent. We also hypothesized that, by modifying the cheese-making procedure to reduce the moisture content of the curd, we could use less KCl with the same sodium content and improve the flavor of the cheese. We expected that the use of KCl would increase the bitterness of the cheeses and decrease consumer liking, however.

We hypothesized that the use of flavor enhancers would shift the sensory attributes of low sodium cheeses closer to the sensory attributes of full-sodium cheeses and increase consumer liking of these reduced sodium treatments. The objective of this research, therefore, was to produce 60% reduced sodium Cheddar cheese by using 2 different cheese-making procedures to allow reduced use of KCl—with the addition of flavor enhancers to improve sensory attributes—and to monitor cheese over the shelf-life by sensory, chemical, and microbiological methods.

MATERIALS AND METHODS

Flavor Enhancer Screening

Due to the large number of flavor enhancers available for use, screening them at various use levels before use in cheese production was desirable to minimize costs and time. Full-fat, stirred-curd Cheddar cheese was manufactured at the University of Minnesota's Joe Warthesen Food Processing Center (St. Paul), as described in Grummer and Schoenfuss (2011). Curd was either salted at the regular salting level with NaCl (pressed cheese contained 665 mg of Na/100 g and 89 mg of K/100 g), or at a reduced sodium level with both NaCl and KCl (Premier Potassium Chloride 8799, Cargill Inc., Minneapolis, MN). The reduced sodium cheese contained 386 mg of Na/100 g and 707 mg of K/100 g, a reduction of approximately 42% sodium from our full-sodium cheese. These 2 cheeses were aged 5 mo before being used in flavor screening.

The reduced sodium cheese was finely grated with a Waring Commercial WFP14 food processor (Conair Corp., Torrington, CT), and then 30 g of grated cheese was added to a Waring Commercial WSG30 spice grinder (Conair Corp.) before adding flavor enhancers at manufacturer recommended concentrations. An additional 15 g of cheese was added to the grinder and contents were hand-stirred for 10 s and then blended for approximately 30 s, in 5-s intervals, until the mixture was homogeneous and slightly pasty. The mixture was removed from the grinder, rolled into a tight ball, and vacuum packaged with a Multivac vacuum packager (Koch, Kansas City, MO). Samples were stored at 4°C for 2 d before evaluation. The re-formed cheese had taken on the shape of a small block (approximately $8 \times 4 \times 2$ cm), and had knit together into a cuttable sample. The samples were cut into 1-cm cubes for evaluation. In total, 16 flavor enhancers were screened; the concentration of the flavor enhancers screened and source information is listed in Table 1.

Seven panelists familiar with food sensory evaluation evaluated the samples blindly with a full-sodium control sample as a reference. Two of the panelists had manufactured and evaluated cheese and dairy products for over 20 yr, 3 panelists were graduate students working on dairy product research projects, and 2 panelists were students that had worked on projects involving sensory evaluation. All were familiar with the sensory terms used to describe the cheese but were not trained to quantify these flavors for this screening. Samples were evaluated for characteristics such as buttery, beefy, brothy/umami, unclean, fruity, and process cheese-like. Eight enhancers were selected, by consensus, for further evaluation at different use levels.