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# Sodium reduction and flavor enhancer addition in probiotic prato cheese: Contributions of quantitative descriptive analysis and temporal dominance of sensations for sensory profiling

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## ABSTRACT

Prato cheese, a typical ripened Brazilian cheese, contains high levels of sodium, and the excess intake of this micronutrient is associated with hypertension and cardiovascular diseases. A technological alternative to reduce the sodium content in foods is to replace NaCl with KCl and the addition of flavor enhancers. The present study aimed to combine quantitative descriptive analysis (QDA) and temporal dominance of sensations (TDS) to assess the sensory profile of reduced-sodium probiotic prato cheese with the addition of flavor enhancers. Five formulations of probiotic prato cheese were manufactured using 1% (wt/wt) salt as follows: C1 (100% NaCl), C2 (50:50 NaCl:KCl), C3 (50:50 NaCl:KCl + 1% arginine), C4 (50:50 NaCl:KCl + 1% yeast extract), and C5 (50:50 NaCl:KCl + 1% oregano extract). Both methods indicated that the addition of flavor enhancers modified the sensory profile of the reduced-sodium probiotic prato cheese ($P < 0.05$). The QDA revealed that flavor enhancers—in particular, yeast and oregano extract—increased the saltiness of samples C4 and C5, respectively, and that the other flavor enhancer, arginine (sample C3), most modified the attributes of prato cheese. The TDS dominance curves revealed that the addition of yeast extract (sample C4) had a positive effect on cheese flavor because it minimized the bitter taste perception resulting from the addition of potassium chloride. Overall, QDA and TDS used together provided interesting insights for establishing the sensory profile of reduced-sodium probiotic prato cheese.

**Key words:** prato cheese, probiotic, flavor enhancer, quantitative descriptive analysis, temporal dominance of sensations

## INTRODUCTION

The reformulation of food represents an alternative approach to creating healthier products (Ferrão et al., 2016). In this sense, the supplementation of cheese with probiotic bacteria represents the aggregation of value to a product that already has benefits inherent in its composition, such as essential nutrients (Santiago-López et al., 2018). Cheese has a good potential for delivery of probiotic microorganisms into the human intestine, and the production of probiotic cheeses with acceptable or satisfactory sensory characteristics is achievable (Karimi et al., 2012b). In addition, probiotics added to cheese yield a wide spectrum of enzymes able to affect the biochemical events that influence the development of texture, flavor, and compounds with health benefits (Albenzio et al., 2013).

There is a need to reduce sodium in food because a positive correlation has been found between high sodium (Na) intake and hypertension, osteoporosis, kidney stones, and cardiovascular diseases (Ayyash and Shah, 2011a). The reduction of sodium in cheeses represents a great challenge for the industry because salt has specific functions and influences taste, body, texture, and shelf life extension, being currently substituted by other salts, as KCl (Cruz et al., 2011). Indeed, the NaCl–KCl blend has been used successfully in various cheeses with no adverse effects on cheese quality (Karimi et al., 2012a). Another interesting alternative to reduce sodium in foods is the use of flavor enhancers (Cruz et al., 2011), which are compounds that activate specialized receptor cells within the oral cavity, helping to reduce sodium without sacrificing flavor (Brandsma, 2006).

Prato cheese is a typical ripened Brazilian cheese that is similar to Danish cheeses such as Gouda and Danbo. It has great representation in the Brazilian market and composes about 20% of all cheeses produced in the country (Silva et al., 2017). Studies on

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the physicochemical and microbiological aspects of reduced-sodium probiotic prato cheese with the addition of flavor enhancers have been carried out (Silva et al., 2017, 2018a,b). However, there is no study on the sensory profile of this product and the quality attributes that lead to a better acceptance.

Quantitative descriptive analysis (**QDA**) is a method for qualifying the type and quantifying the intensity of the sensory properties immediately after sensory stimulation (Stone and Sidel, 2004) and has been recognized as a tool for measurement and optimization of the sensory attributes of different dairy products (Janiaski et al., 2016; Ferrão et al., 2018). Temporal dominance of sensations (**TDS**) has been widely used as a temporal descriptive technique to provide information on the sequence and duration of dominant sensations (Galmarini et al., 2017). It focuses on the dominant attributes rather than quantifying attribute intensity, explaining the consumers' perception and accurately identifying the sensations that determine the hedonic perception.

Quantitative descriptive analysis and TDS can provide complementary information about the sensory interactions in foods (Labbe et al., 2009; Bruzzone et al., 2013; Devezeaux de Lavergne et al., 2015; Braghieri et al., 2016). The combination of QDA and TDS in a sequential approach can be used in a commercial context and enables a fuller profile of the product category (Ng et al., 2012). The present study aimed to evaluate the effect of sodium reduction and the addition of flavor enhancers on the dynamic and static sensory profile of probiotic prato cheese using both the TDS and QDA methods.

## MATERIALS AND METHODS

### Cheese Processing

Prato cheese was produced by a traditional manufacturing method as described by Silva et al. (2017). The experiment was conducted using 120 L of whole pasteurized milk (65°C/30 min). Milk was cooled to 32 to 34°C, and the frozen lactic and probiotic bacteria cultures were added directly to the milk and incubated for 40 min. Then, calcium chloride (80 mL/120 L of milk), annatto dye (36 mL/120 L of milk), and coagulant (Ha La 1175, Chr. Hansen, Valinhos, SP, Brazil) sufficient to coagulate the milk within 35 to 50 min were added. The curd was cut into 1-cm cubes and submitted to slow, continuous mixing for 15 min, which was followed by removal of part of the whey (30%) and further heating to 42°C by progressively adding hot water (25 L at 80°C) to increase the temperature by 1°C every 3 min. This temperature was maintained for 40 min, and then the whey was drained off. Five portions were separated [probiotic control with 100% of NaCl and 4 formulations with partial substitution of NaCl by KCl (50%)], and the ingredients corresponding to each formulation were added in a dry way by manual homogenization: 1 NaCl:1 KCl (wt/wt); 1 NaCl:1 KCl (wt/wt) and 1% (wt/wt) arginine (Vetec, Rio de Janeiro, Brazil); 1 NaCl:1 KCl (wt/wt) and 1% (wt/wt) yeast extract from *Saccharomyces cerevisiae* (Bionis YE GMX 18, Biorigin, Lençóis Paulistas, SP, Brazil); and 1 NaCl:1 KCl (wt/wt) and 1% (wt/wt) of oregano extract. Therefore, the experimental design comprised 5 different cheese formulations made with 1% salt as follows: NaCl + *Lactobacillus casei* (**C1**), 1:1 NaCl:KCl (wt/wt) + *L. casei* (**C2**), 1:1 NaCl:KCl (wt/wt) + 1% arginine (wt/wt) + *L. casei* (**C3**), 1:1 NaCl:KCl (wt/wt) + 1% yeast extract (wt/wt) + *L. casei* (**C4**), and 1:1 NaCl:KCl (wt/wt) + 1% oregano extract (wt/wt) + *L. casei* (**C5**).

### Descriptive Analysis

The samples were analyzed using QDA as described by Stone et al. (2012). The assessors were recruited among students and employees of the Federal Fluminense University Faculty of Veterinary Medicine (6 women and 4 men, aged 25–40 yr).

In the terminology development phase, the assessors elicited 20 descriptors after consensus. The main descriptors used for evaluating appearance were brightness and color. For the attribute aroma, the descriptors were sour, sweet, buttery, fine herbs, and typical, and the descriptors buttery, fine herbs, and typical were used to characterize the flavor of the samples. For taste, the descriptors were salty, sweet, sour, and bitter, and aftertaste was described using bitter aftertaste and buttery aftertaste. The descriptors used to evaluate texture were hardness, cohesiveness, fracturability, and adhesiveness.

After the terminology development phase, the panelists were trained over five 2-h sessions for the evaluation of reduced-sodium probiotic prato cheese. The training sessions consisted of evaluating the experimental prato cheeses using the descriptive terms developed to describe and quantify the attributes appearance, texture, aroma, flavor, taste, and aftertaste.

The samples were evaluated in triplicate over four 2-h sessions according to a balanced design. All attributes were rated on a 150-mm unstructured line scale anchored at the extremities with "not detected" and "high." Both the definitions of descriptive terms (Table 1) and the reference materials were routinely reviewed by the panelists before evaluation of the samples. This procedure was repeated until a panel consensus was achieved. Each sample was served monadically, and