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TEXTURE PROFILE AND SENSORY ACCEPTANCE OF A SYNBIOTIC DIET AERATED MOUSSE CONTAINING *LACTOBACILLUS ACIDOPHILUS* LA-5, INULIN, AND FRUCTOOLIGOSACCHARIDE

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RESUMO – O objetivo deste estudo foi avaliar o efeito do *Lactobacillus acidophilus* La-5, inulina e fruto-oligosacarídeo sobre perfil de textura instrumental e aceitabilidade sensorial de uma musse simbiótica *diet* (SDM) durante o armazenamento por 112 dias a -18 °C em comparação com uma musse não simbiótica *diet* (NSDM) e outra simbiótica de controle contendo sacarose (CSM). As formulações foram avaliadas quanto a firmeza, adesividade, elasticidade, coesividade, gomosidade e aceitabilidade sensorial. Firmeza e gomosidade da SDM aumentaram e a coesividade diminuiu durante o armazenamento, enquanto adesividade e elasticidade mantiveram-se estáveis. NSDM apresentou menor aceitabilidade (5,77-6,50) após armazenamento que CSM (6,83-7,67) e SDM (6,67-7,03) provavelmente por seu maior conteúdo de leite em pó e pela ausência de inulina e fruto-oligosacarídeo. O armazenamento a baixa temperatura, apesar de acarretar mudanças significativas no perfil de textura instrumental da SDM, não influenciou suas características sensoriais, e a sucralose revelou-se um bom substituto da sacarose em musses.

ABSTRACT – This study aimed to evaluate the effect of *Lactobacillus acidophilus* La-5, inulin, and fructooligosaccharide on instrumental texture profile and sensory acceptance of a synbiotic *diet* mousse (SDM) during 112-day storage at -18 °C, compared to a non-synbiotic *diet* mousse (NSDM) and another one containing sucrose used as a control (CSM). Formulations were evaluated regarding firmness, adhesiveness, springiness, cohesiveness, gumminess and sensory acceptability. Firmness and gumminess of SDM increased and cohesiveness decreased throughout storage, while adhesiveness and springiness kept almost the same. NSDM showed lower acceptability (5.77-6.50) after storage than CSM (6.83-7.67) and SDM (6.67-7.03) likely due to its higher powdered milk content and absence of inulin and fructooligosaccharide. These results suggest that storage at low temperature, although causing significant changes in instrumental texture profile of SDM, did not influence its sensory acceptability, and that sucralose could be a good sucrose substitute in musses.

PALAVRAS-CHAVE: perfil de textura instrumental; características sensoriais; probiótico; prebiótico; musse.

KEYWORDS: instrumental texture profile; sensory performance; probiotic; prebiotic; mousse.

1. INTRODUCTION

A broad range of ready-to-eat dairy desserts is available to the consumer, which offer a wide variety of textures, flavours, and appearances and are regarded as attractive vehicles for the incorporation of probiotic cultures and other functional ingredients (Cardarelli et al. 2008). Amongst



the different kinds of dairy desserts, mousses are emerging as interesting food systems to study the effects of this uptake (Aragon-Alegro et al. 2007).

According to Hill et al. (2014), a consensus statement on the scope and the proper definition of probiotics was given recently by the International Scientific Association for Probiotics and Prebiotics: “live micro-organisms that, when administered in adequate amounts, confer a health benefit on the host”.

Prebiotics are currently defined as “selectively fermentable ingredients that allow specific changes in the composition and/or activity of gastrointestinal microbiota that allow benefits to the host” (Gibson et al. 2010).

Based on this background, the objective of this study was to evaluate the effect of low temperature (-18 ± 2 °C) storage for a period of 112 days on the instrumental texture profile and sensory acceptability of an aerated synbiotic *diet* mousse, compared to a non-synbiotic *diet* mousse and to a regular sucrose-containing synbiotic one used as a control.

2. MATERIAL AND METHODS

The aerated synbiotic *diet* mousse (SDM) was prepared as an adaptation of a low-calorie formulation developed by Buriti et al. (2010) and characterized by Komatsu et al. (2013), which will be referred here as control synbiotic mousse (CSM), only used to evaluate sensory acceptability.

Table 1. Proportions of the ingredients used in the production of the synbiotic *diet* mousse (SDM), non-synbiotic *diet* mousse (NSDM) and control synbiotic mousse (CSM).

Ingredient (g 100g ⁻¹)	SDM	NSDM	CSM
Skim milk ¹	61.7	61.7	59.3
Powdered skim milk ²	4.0	14.0	4.0
Sucrose ³	-	-	11.0
Sucralose ⁴	1.1	1.1	-
FOS ⁵	6.0	-	6.0
Inulin ⁶	4.0	-	4.0
Pasteurized and frozen guava pulp ⁷	20.0	20.0	12.5
Stabilizer/emulsifier ⁸	2.8	2.8	2.8
Lactic acid ⁹	0.4	0.4	0.4
<i>Lactobacillus acidophilus</i> La-5 ¹⁰	0.05	-	0.05
Total	100.0	100.0	100.0

¹Paulista (Danone, Guaratinguetá, SP, Brazil); ²Molico (Nestlé, Araçatuba, SP, Brazil); ³Sucralose (Línea Sucralose, São Paulo, SP, Brazil); ⁴União (Cosan, Limeira, SP, Brazil); ⁵Beneo P95 (Orafti, Oreya, Belgium); ⁶Beneo HP (Orafti, Oreya, Belgium); ⁷Icefruit-Maisa (Icefruit Comércio de Alimentos, Tatuí, SP, Brazil); ⁸Cremodan Mousse 30 (Danisco, Cotia, SP, Brazil); ⁹Purac (Purac Sínteses, Rio de Janeiro, RJ, Brazil; 85g/100g food-grade solution); ¹⁰Strain La-5 (Christian Hansen, Hoersholm, Denmark).

For the preparation of both SDM and CSM, we used a commercial freeze-dried DVS probiotic culture of *Lactobacillus acidophilus* La-5, which was stored frozen (-18 ± 2 °C). Powdered skim milk and fructooligosaccharide (FOS) were dissolved in ultra-high temperature skim milk on the day before the product preparation in order to make the dissolution of these ingredients easier. The resulting pre-mixture was stored under refrigeration at 4 °C until the addition of the remaining ingredients. One portion (40 mL) of this pre-mixture was sterilized and employed, on the next day, for the activation of the probiotic culture for 120 min at 37 °C (Komatsu et al. 2013).



The other ingredients listed in Table 1 were added and mixed until complete mass uniformity in a 6 kg-mixer, model UMMSK-12 (Geiger, Pinhais, PR, Brazil). The resulting mixture was pasteurized in the same mixer at 85 °C for 5 min, allowed to cool to 40 °C and supplemented with milk containing the activated probiotic culture. Then, the mixture was kept in refrigerator for subsequent aeration at a temperature between 10 and 15 °C in a 20 L-planetary mixer (model 20, Irmãos Amadio Ltda., São Paulo, SP, Brazil), during which its volume increased by 80-85%. Afterwards, the mousse was transferred to a manual filler (model IQ81-A, Intelimaq Máquinas Inteligentes, São Paulo, SP, Brazil), and then packed in polypropylene plastic pots for food with 75 mm diameter, 42 mm height and 100 mL capacity (Tries Aditivos Plásticos, São Paulo, SP, Brazil), which were sealed with aluminum cover in a sealer, model 1968 (Delgo Metalúrgica, Cotia, SP, Brazil).

2.1 Texture profile of mousses

Texture profile analysis (TPA) was carried out in samples collected during a storage period of 112 days by double compression test at room temperature, using an aluminum cylinder with 25 mm diameter (P25) fixed to a texture analyzer, model TA-XT2 (Stable Micro Systems, Haslemere, UK), and employing a distance of 10 mm and a penetration speed of 1 mm/s. To avoid any interference of freezing with firmness analysis (Muse and Hartel, 2004), diet mousses were transferred from the freezer to a refrigerator where they remained for 6 h at 4±1 °C before testing. The following texture parameters were determined: firmness, cohesiveness, adhesiveness, springiness and gumminess. Data were collected through the Texture Expert for Windows software, version 1.20 (Stable Micro Systems).

Samples of mousses stored at -18±2 °C were collected in quintuplicate, thawed at 4 °C and analyzed for instrumental texture parameters the day after their manufacture and after 7, 35, 56, 84 and 112 days.

2.2 Sensory evaluation of mousses

The protocol followed for sensory analysis of mousses was approved by the Research Ethics Committee of the Faculty of Pharmaceutical Sciences of São Paulo University, São Paulo, SP, Brazil (protocol n° 663.138, CAAE n° 30539214.6.0000.0067). The sensory evaluation was conducted on samples of the three mousses stored at -18 °C for 7, 35, 56, 84 and 112 days, thawed at 4°C 2 h before the start of testing and distributed among participants randomly.

Sensory acceptability tests were performed using a structured 9-point hedonic scale (1 = dislike extremely; 9 = like extremely) for overall acceptability (Hough, 2010). Volunteers were also asked to indicate what was the sensory characteristics they liked most and least.

Thirty untrained adults participated in each of the five sensory analysis sections, giving a total of 150 consumers, of which 50.0% were female and 50.0% male, with age between 18 and 60 years (mean age of 24.4±7.4 years). Healthy volunteers were mostly undergraduate and graduate students and São Paulo University employees. Criteria of exclusion included: people with history of allergic manifestation, food intolerance or chronic diseases such as diabetes, hypothyroidism, hyperthyroidism, hypertension or others, flu or indisposed people, people making medical treatment or having a cold, and people that came into contact with strong smelling materials, foods or cosmetics less than 1 h before.

2.3 Statistical analyses

Variance homogeneity for each set of data was verified by means of the tests of Hartley, Cochran and Bartlett. Results were compared by the analysis of variance (ANOVA) using the Tukey's

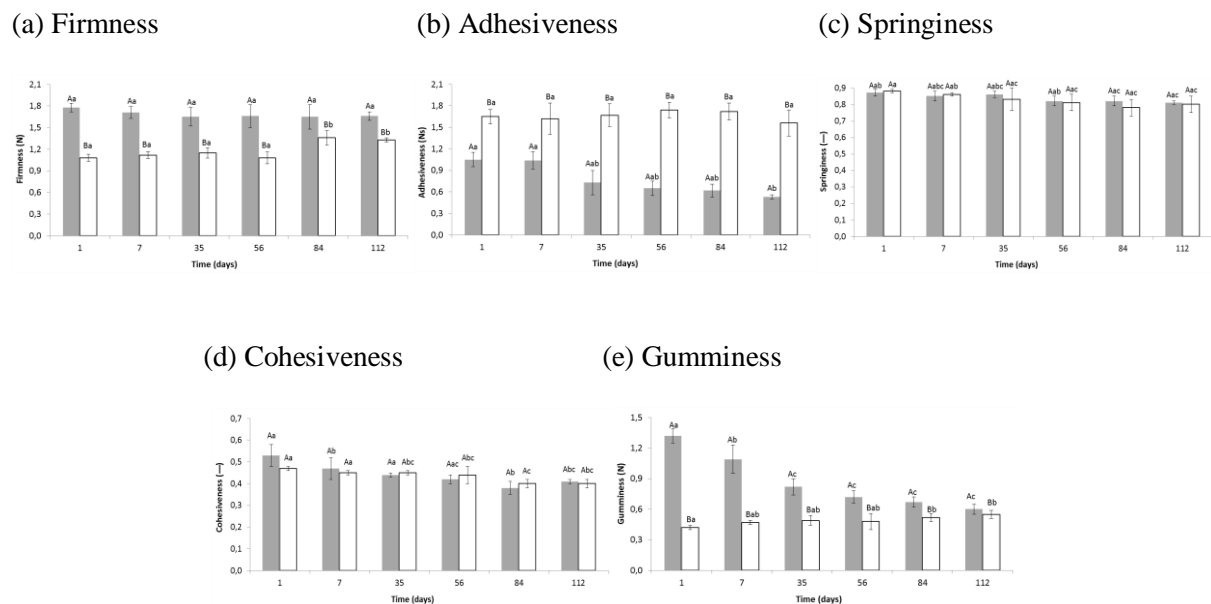


test, considering a significance level of $p < 0.05$. When this normal distribution was not found, the Kruskal-Wallis nonparametric test was employed, followed by Dunn's test.

3. RESULTS AND DISCUSSION

The instrumental texture profile of the synbiotic and non-synbiotic mousses stored at $-18\text{ }^{\circ}\text{C}$ is shown in Figure 1. One can see that firmness and gumminess of SDM increased and cohesiveness decreased significantly throughout storage ($p < 0.05$), while adhesiveness and springiness kept almost the same ($p > 0.05$). On the other hand, firmness and springiness of NSDM did not vary significantly during storage ($p > 0.05$), while gumminess, cohesiveness and adhesiveness gradually decreased along the time ($p < 0.05$).

Figure 1. Texture profile analyses of the non-synbiotic *diet* mousse (NSDM) and the synbiotic *diet* mousse (SDM) along storage at $18 \pm 2\text{ }^{\circ}\text{C}$ for up to 112 days.



(■) NSDM, (□) SDM. ^{A,B} Different uppercase letters indicate statistically significant differences ($p < 0.05$) between the two *diet* mousse formulations for the same storage time. ^{a,b} Different lowercase letters indicate statistically significant differences ($p < 0.05$) among different storage times for the same mousse formulation.

According to Table 2, which summarizes the results of sensory analysis, there was no statistically significant difference ($p > 0.05$) between the average scores attributed to SDM and CSM throughout the whole storage period at low temperature.

The low powdered skim milk content (4%) and the presence of both probiotic and prebiotics (inulin and FOS) in SDM may have been responsible for its low firmness, low gumminess and high adhesiveness (Figure 1), resulting in better acceptability ($p < 0.05$) in comparison with NSDM (Table 2) during the entire storage period.

In addition, firmness of NSDM kept almost the same along the whole storage period ($p > 0.05$), whereas that of SDM increased significantly ($p < 0.05$) after 84-days storage, likely due to some change in mousse structure related to metabolic activity. It is worth remembering in this regard that a relatively constant firmness throughout storage is a desirable property in any food product, since, in



this case, one can assume that the stored product continues keeping features similar to those of the recently prepared product (Maruyama et al. 2006).

Table 2. Mean scores of sensory acceptability (standard deviation) attributed to non-synbiotic *diet* mousse (NSDM), synbiotic *diet* mousse (SDM) and control synbiotic mousse (CSM) stored at -18 ± 2 °C for up to 112 days.

Storage (days)	Mousse formulation		
	NSDM	SDM	CSM
7	5.9 (1.4) ^{Aa}	6.9 (1.1) ^{Ba}	7.5 (0.9) ^{Ba}
35	6.0 (1.5) ^{Aa}	7.0 (1.4) ^{Ba}	7.7 (1.0) ^{Ba}
56	6.4 (1.5) ^{Aa}	6.8 (1.6) ^{Aba}	7.6 (1.3) ^{Ba}
84	6.5 (1.3) ^{Aa}	6.7 (1.3) ^{Aa}	6.8 (1.6) ^{Aa}
112	5.8 (2.2) ^{Aa}	6.7 (1.5) ^{Aba}	7.5 (0.9) ^{Ba}

^{A,B} Different uppercase letters in the same line indicate significant differences ($p < 0.05$) between mousses for the same storage period. ^{a,b} Different lowercase letters in the same column indicate significant differences ($p < 0.05$) among different storage times for the same mousse formulation.

SDM adhesiveness was significantly higher (Figure 2, $p < 0.05$) than that of NSDM, probably because of the highly hygroscopic nature of both FOS and inulin contained in the former mousse (Tonon et al. 2009). For the same reason, whereas DNSM adhesiveness showed a statistically significant decrease at the end of storage, that of the synbiotic mousse remained unchanged ($p > 0.05$) (Figure 2).

Both mousses had statistically coincident values ($p > 0.05$) of springiness and cohesiveness and exhibited very similar time behaviors of these two parameters, in that they were stable for 84 and 56 days of storage, respectively, and then suffered significant decrease compared to the starting product ($p < 0.05$).

The well-known aggregating effect not only of inulin but also of FOS is evident in the behavior of gumminess, which decreased significantly ($p < 0.05$) during NSDM storage, whereas it increased ($p < 0.05$) during the one of SDM that contained both.

Apart from the presence of the probiotic and prebiotic ingredients in SDM, these results suggest that sucralose may be a good substitute for sucrose in dairy products, since its presence did not affect the sensory acceptance of the final product, thus confirming previous observations (Brito and Bolini, 2010). Similar results were reported by Morais et al. (2015), who observed very similar characteristics in dairy desserts supplemented with sucralose, sucrose or other sweeteners such as aspartame, neotame and stevia.

The mean scores attributed to CSM, ranging from 6.8 to 7.7, were lower than those reported by Buriti et al. (2010) for the same guava mousse (7.6-8.0) stored in exactly the same way but having lower content of guava pulp (12.5%) and inulin (2.0%), which suggests some influence of these contents in the taste of the final product.

4. CONCLUSION

This study evaluated the influence of low temperature (-18 ± 2 °C) and time of storage on the instrumental texture profile and the sensory acceptability of a synbiotic *diet* mousse (SDM) compared to a non-synbiotic *diet* mousse (NSDM) and to a sucrose-containing synbiotic mousse (CSM). As regards the instrumental texture of SDM, firmness and gumminess increased and cohesiveness decreased throughout storage, while adhesiveness and springiness kept almost unvaried. On the other hand, DNSM firmness and springiness of did not vary significantly, while gumminess, cohesiveness and adhesiveness gradually decreased along the time. In addition, sensory acceptability was good throughout storage, with average scores from 6.67 to 7.03 for SDM, 5.77 to 6.50 for NSDM



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and 6.83 to 7.67 for CSM. The low powdered skim milk content and the presence of both probiotic and prebiotics (inulin and FOS) in SDM may have been responsible for its better acceptability compared with NSDM.

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