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Introduction

Wheat-flour cookies lack nutrients, so most prefer baked goods with various functional additives. Cookies can be made by enriching them with various plant raw materials, which improves their nutritional value. Mulberry leaf powder additive was chosen to enrich the cookies (Fig. 1). Mulberry leaves are rich in protein, vitamins, micro-macro elements, and fiber.



Figure 1. Mulberry leaf powder (photo by D. Levickienė)

Therefore, the aim was to investigate the effect of freeze-dried mulberry leaf powder additives on the chemical and sensory properties of wheat flour butter cookies.

Materials and methods

The research was conducted in 2022-2023 at Vytautas Magnus University, the Agriculture Academy. In Lithuania, collected white mulberry leaves were frozen at $-35\text{ }^{\circ}\text{C}$, lyophilized, then milled and stored in sealed containers at $5\text{ }^{\circ}\text{C}$ in the dark until butter cookie preparation. The ingredients of the butter cookies: white wheat flour (550 C type), butter (82 % fat), sugar, eggs, and baking powder were purchased from the local market in Kaunas. Mulberry leaf powder amounts (0, 4, 8, and 12%) were used to replace the percentage of wheat flour, improving the nutritional value of the butter cookies (Fig. 2).

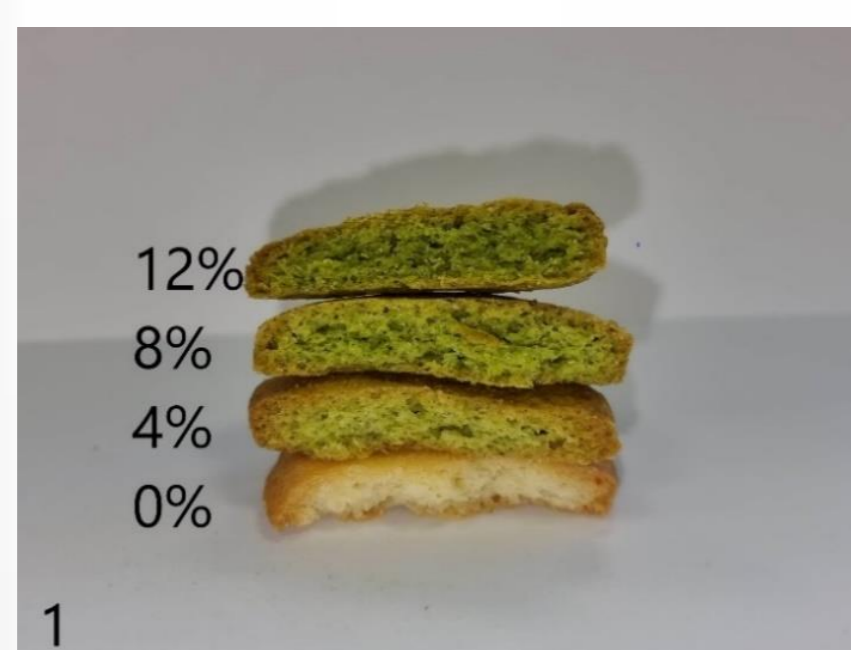


Figure 2. Butter cookies without additive (0 %) and with 4, 8, and 12% mulberry leaf additive (photo by S. Peleckaitė)

The amount of protein was determined by the Kjeldahl method using KJELDATHERM (Gerhardt, Königswinter, Germany), the amount of ash was determined by combustion at $550\text{ }^{\circ}\text{C}$ [23 (First Commission Directive of 15 June)], the amount of fiber was determined by the Association of Official Agricultural Chemists (AOAC) official methods, and the pH was measured using a pH meter (MeterLab PHM210, France) (LST ISO 1842:1997). All sensory evaluations of cookies were evaluated using a 5-point scale (the lowest score describes the worst quality, the highest the best quality).

The data were evaluated by ANOVA using STATISTICA 10 (StatSoft, Inc., USA). The statistical significance of differences between the means was estimated by Tukey test ($p < 0.05$).

Results

The use of 4, 8, and 12% mulberry leaf powder additives in butter cookies significantly increased the amounts of protein, ash, fiber, and pH content compared to the cookies without additives.

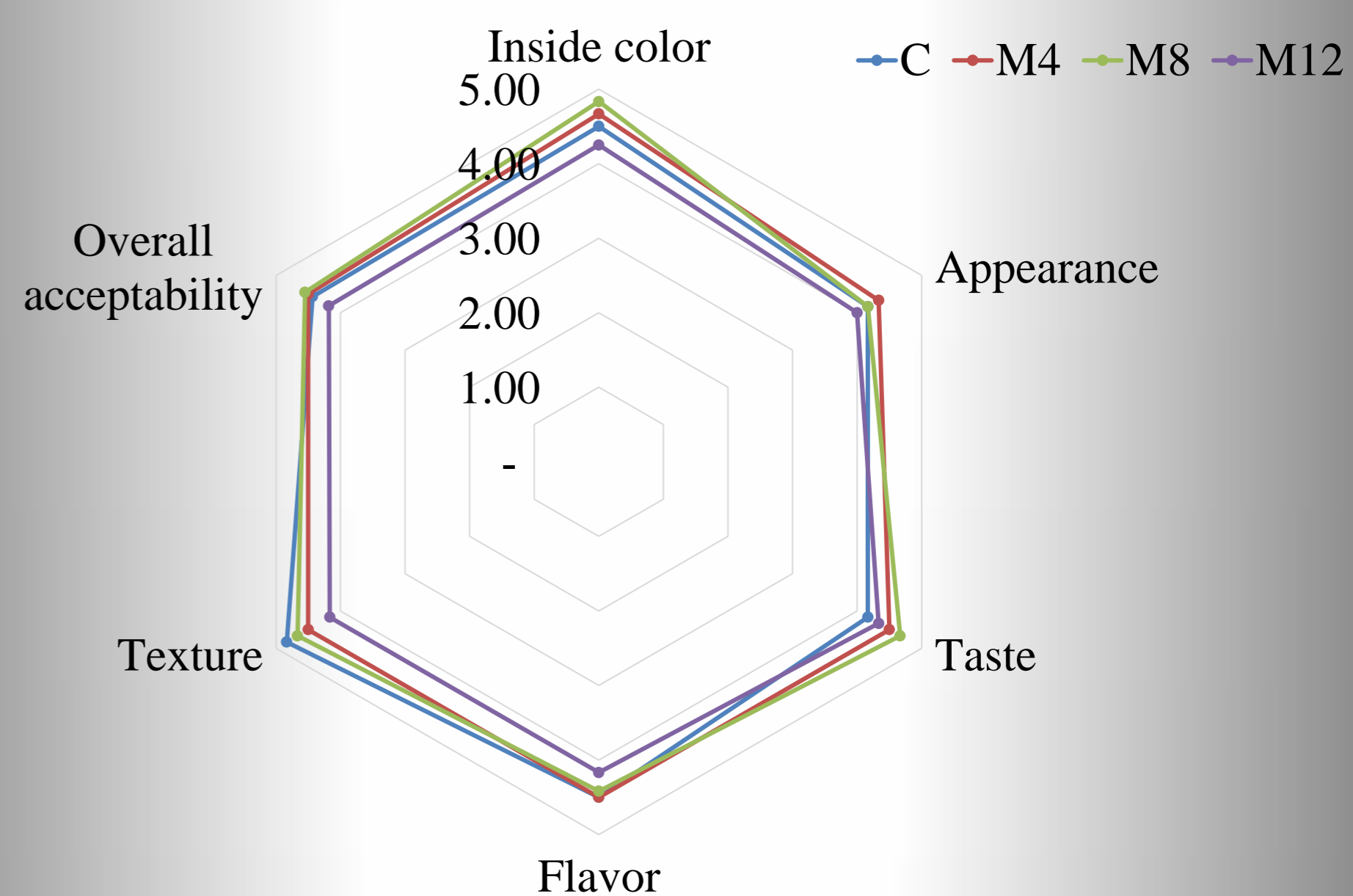
Table 1. Effect of mulberry leaf powder additive on the proximate composition in butter cookies, %

Treatments	Protein	Ash	Fibre	pH
C	5.75 b	0.94 d	12.54 d	6.81 c
M4	6.32 ab	1.42 c	14.27 c	7.02 b
M8	6.57 a	1.54 b	17.21 b	7.05 b
M12	6.77 a	1.73 a	20.34 a	7.57 a

Note: Different letters in the same column represent significant differences ($p < 0.05$).

C – cookies without mulberry leaf additive (control), M4 – cookies with 4% mulberry leaf additive, M8 – cookies with 8% mulberry leaf additive, M12 – cookies with 12% mulberry leaf additive.

Butter cookies with 8% mulberry leaf additive had the highest score of taste (4.67 points), while cookies without the additive had the worst taste (. The most attractive color was with 4% mulberry leaf additive. Assessing the overall sensory evaluation of butter cookies, with an 8% mulberry leaf additive cookies were rated - 4.55 points, with a 4% additive - 4.50 points, without an additive - 4.43 points, and with a 12% additive - 4.18 points.



Note: C – cookies without mulberry leaf additive (control), M4 – cookies with 4% mulberry leaf additive, M8 – cookies with 8% mulberry leaf additive, M12 – cookies with 12% mulberry leaf additive.

Figure 3. Effect of mulberry leaf powder additive on the sensory evaluation of butter cookies, points

Conclusion

The current study showed that the freeze-dried mulberry leaf powder additive significantly improved the chemical composition, such as protein, ash, and fiber of the butter cookies. Cookies with an 8% mulberry leaf additive were most liked by panelists.