

Formulation and comparative analysis of plant-based walnut milk yoghurt

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INTRODUCTION & AIM

- The plant-based dairy market is anticipated to reach a worldwide market value of USD 52.58 billion by 2028, growing at a compound annual growth rate (CAGR) of 12.5 % [1].
- Customers find plant-based dairy substitutes more enticing than traditional dairy products because they are: “free-from” lactose, cholesterol, and dairy allergens like casein; less concerning to them in terms of hormones and antibiotic residues; and labelled as vegan-friendly, with typically high levels of vitamins, minerals, other bioactive, phytochemicals, and extra benefits like dietary fiber or pre-/probiotic activity [2].
- Plant-based yoghurt is produced by fermenting plant-based suspensions, such as fruit pulp, cereals, nuts, and legumes, or water-based extracts, such plant-based milk [3].
- The primary challenges faced by companies that produce plant-based yoghurts are associated with the texture and visual aspects, as these products usually suffer from textural issues caused by phase separation.

This study aims to develop a plant-based walnut milk yoghurt as an alternative to dairy yogurt. The objectives of this research:

- development of the plant-based walnut milk yoghurt with an emphasis on yoghurt quality and processing techniques;
- improving the quality of the plant-based walnut milk yoghurt through physicochemical characteristics, antioxidant potential, color and texture parameters;
- optimization of the sensory acceptance of the plant-based walnut milk yoghurt, exploring the ingredients that influence product's texture, appearance, flavor and taste;
- providing the enhancing formulation for the plant-based walnut milk yoghurt.

METHOD

Experimental materials

Raw walnuts, pectin, sugar, cultures, vanilla extract, citric acid, emulsifier were procured from the local market in Chisinau, Moldova. All chemicals used within this study were purchased from Eco-Chimie and Sigma-Aldrich (Chisinau, Moldova). All the chemicals used were of HPLC or analytical grade. Distilled water was used throughout.

Design of experiment

Response Surface Methodology (RSM) was used to investigate the influence of three independent variables (Table 1) on experimental response data, including pH, acidity, color attributes (L*, a* and b*), total polyphenol content, DPPH antioxidant activity, texture parameters (hardness, adhesiveness, springiness, chewiness), sensory properties. The goal was to develop predictive models that maximize or minimize modellable response variables, and thereby optimizing amount of ingredients for walnut plant-based yoghurt alternatives making (Table 1).

Table 1. Variables for walnut plant-based yoghurt formulations

Variables	Units	Levels			
		Minimum	Maximum	Coded Low	Coded High
Walnuts/Water ratio	[c.u.]	0.07	0.39	0.14	0.33
Pectin	[g]	0.86	1.54	1.00	1.40
Emulsifier	[g]	0.01	0.18	0.05	0.15

Statistical Analysis

- All experiments were carried out at least in triplicate and expressed results in mean $\pm$ standard deviation.
- Design-expert software (v.13.0.5.0, USA) was used to design the experiments and statistical analysis of the findings.
- The statistical significance was determined by variance analysis (ANOVA).
- The significant differences between the mean values were accepted at the ($p \leq 0.05$) probability level with a confidence level of 95 %.

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RESULTS & DISCUSSION

Effects of different yoghurt formulations on the physicochemical characteristics

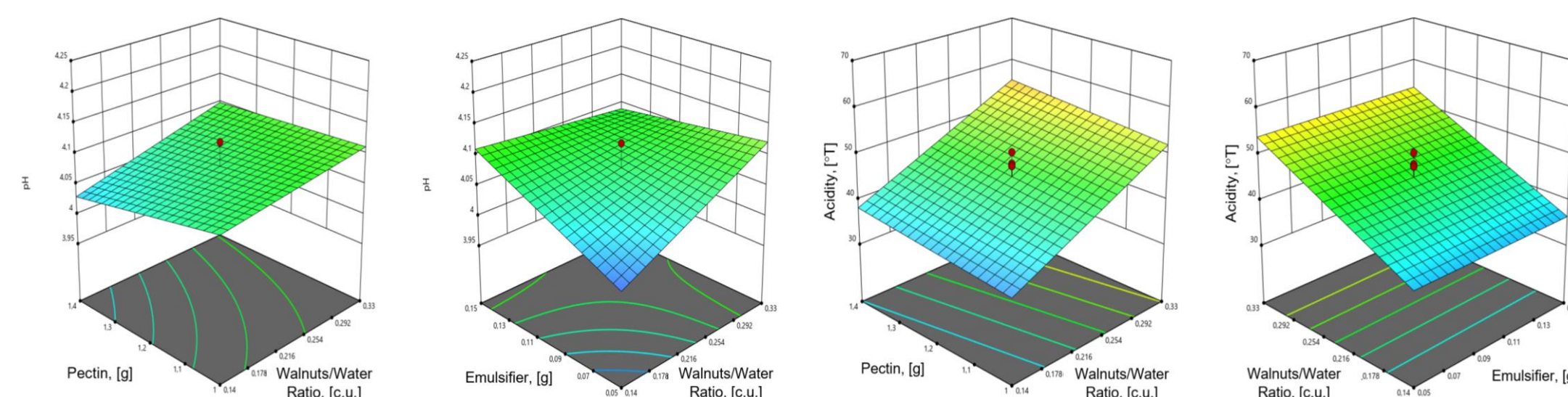


Fig. 1. Effect of different yoghurt formulations on the pH values

Fig. 2. Effect of different yoghurt formulations on the acidity values

Effects of different yoghurt formulations on total polyphenols and antioxidant potential

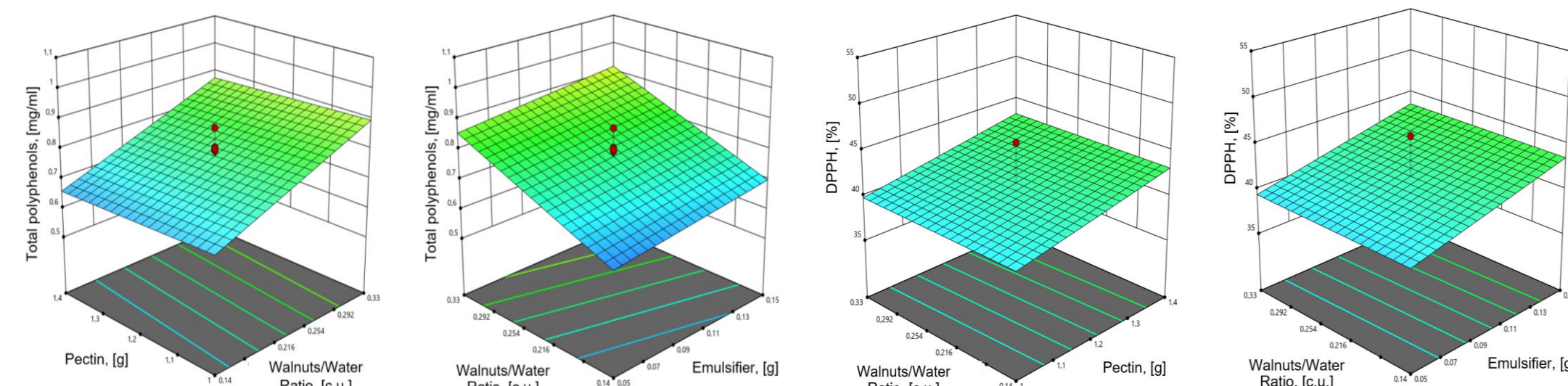


Fig. 3. Effect of different yoghurt formulations on the total polyphenols

Fig. 4. Effect of different yoghurt formulations on the DPPH antioxidant potential

Effects of different yoghurt formulations on the color and texture parameters

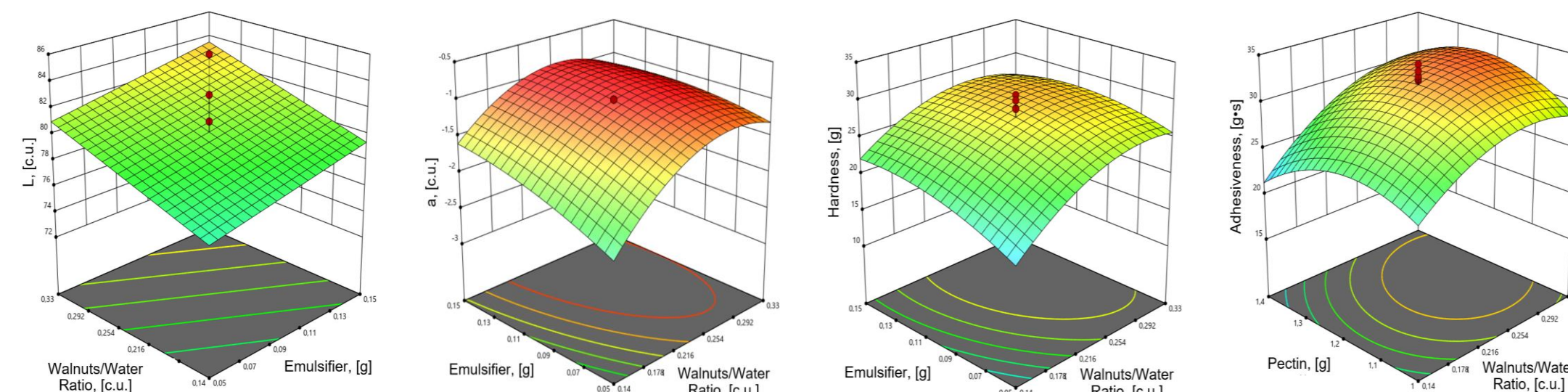


Fig. 5. Effect of different yoghurt formulations on the colour L* parameter

Fig. 6. Effect of different yoghurt formulations on the colour a* parameter

Fig. 7. Effect of different yoghurt formulations on hardness

Fig. 8. Effect of different yoghurt formulations on adhesiveness

Effects of different yoghurt formulations on sensory attributes

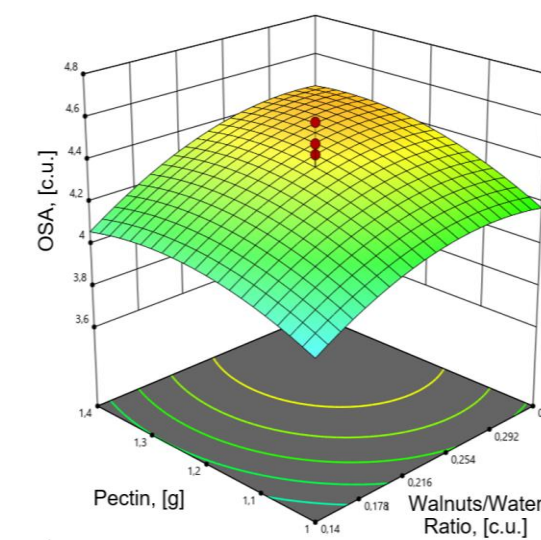
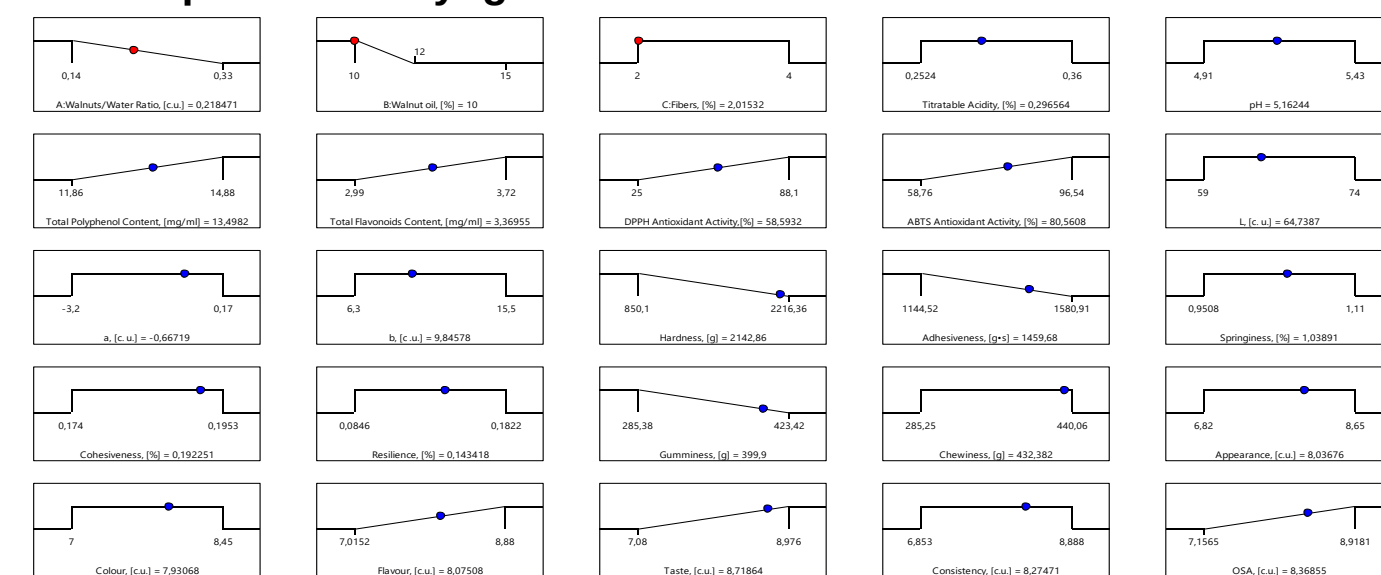


Fig. 9. Effect of different yoghurt formulations on the Overall Acceptability

The overall desirability function based on individual optimal response shown as shaded circle in panels for producing walnut plant-based yogurt



CONCLUSION

The phenolic profile of optimized walnut milk yoghurt attested to a total polyphenol content of 257 mg GA/100g and a total flavonoid content of 93 mg QE/100g. Walnut milk yoghurt increased the in vitro DPPH and ABTS antioxidant activity by 76.89% and 89.93% compared with commercially available animal yogurt. Walnut milk yoghurt recorded the lowest L* index and the highest a* and b* indexes, at 47.34, 13.47, and 0.19, respectively. The reference sample exhibited the highest L* index and the lowest a* and b* indexes, measuring 67.23, 11.98, and 0.05, respectively. Walnut milk yoghurt had high scores for all sensory attributes (≥ 8.78) compared with those for animal yoghurt. This study highlights the benefits of plant-based yoghurt and provides a scientific basis for further production of walnut milk yoghurt.

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