

Valorization of palm heart (*Chamaerops humilis*) and sambo (*Cucurbita ficifolia* B.) by-products for the development of gluten-free and low-calorie cookies

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INTRODUCTION & AIM

Palm hearts (Figure 1a) that do not meet export quality standards are typically used as animal feed, while sambo seeds (Figure 1b) are rarely consumed and often discarded. Both are promising raw materials for the development of high value-added food products.



Figure 1: a) Palm hearts (*Chamaerops humilis*) and b) sambo seeds (*Cucurbita ficifolia* B.)

This study aimed to develop gluten-free cookies by partially replacing oat flour and dairy fat with palm heart flour and sambo seed paste, respectively.

METHOD

Formulation and Processing

The base formulation is shown in Table 1.

Cookies were formulated using an all-in mixing method under good manufacturing practices.

Table 1: Base Formulation

Ingredient	%
Oat and palm heart flour	29.70
Sunflower and sambo seed paste	17.70
Erythritol	17.00
Egg	16.00
Vanilla extract	0.60
Cocoa powder	4.20
Chocolate chips	14.80

The dough was manually shaped and baked in a convection oven at controlled temperatures depending on each experimental run.

Figure 3: Process flow chart for making of cookies

Analytical Procedures

Proximate Composition: moisture, protein, fat, ash (AOAC standard methods)

Color Measurement: Using a colorimeter in CIELAB space

Texture Profile Analysis (TPA): Using a texture analyzer

Sensory Acceptability:

- Hedonic scale (9-point)
- Evaluated by a panel of untrained consumers (n = 74)
- Attributes: appearance, taste, texture, and overall liking

Experimental Design

A Response Surface Methodology (RSM) was applied to optimize the cookie formulation.

A 2² Central Composite Design (CCD) was used to evaluate:

- Independent variables:
 - Proportion of seed paste
 - Proportion of palm heart flour
- Responses (dependent variables):
 - Texture: fracture strength, hardness, gumminess
 - Color: L*, a*, b*
 - Moisture content

Statistical Analysis

ANOVA and regression analysis conducted using Statgraphics Centurion 19.

Significance level: $p < 0.05$

Model adequacy: Evaluated through R², lack-of-fit test, and residual analysis.

RESULTS & DISCUSSION



The optimized formulation (Figure 3) achieved an overall desirability of 0.70, incorporating 19.47% palm heart flour (relative to total flours) and 40.70% sambo seed paste (relative to total fat).

Figure 3: Cookies elaborated with Palm heart flour and sambo seeds paste

The product provided 14.0% protein, 30.0% fat, 6.4% crude fiber, 3.2% moisture, and 2.0% ash and exhibited a balanced texture profile (fracture strength: 0.3 N; hardness: 80 N; gumminess: 11).

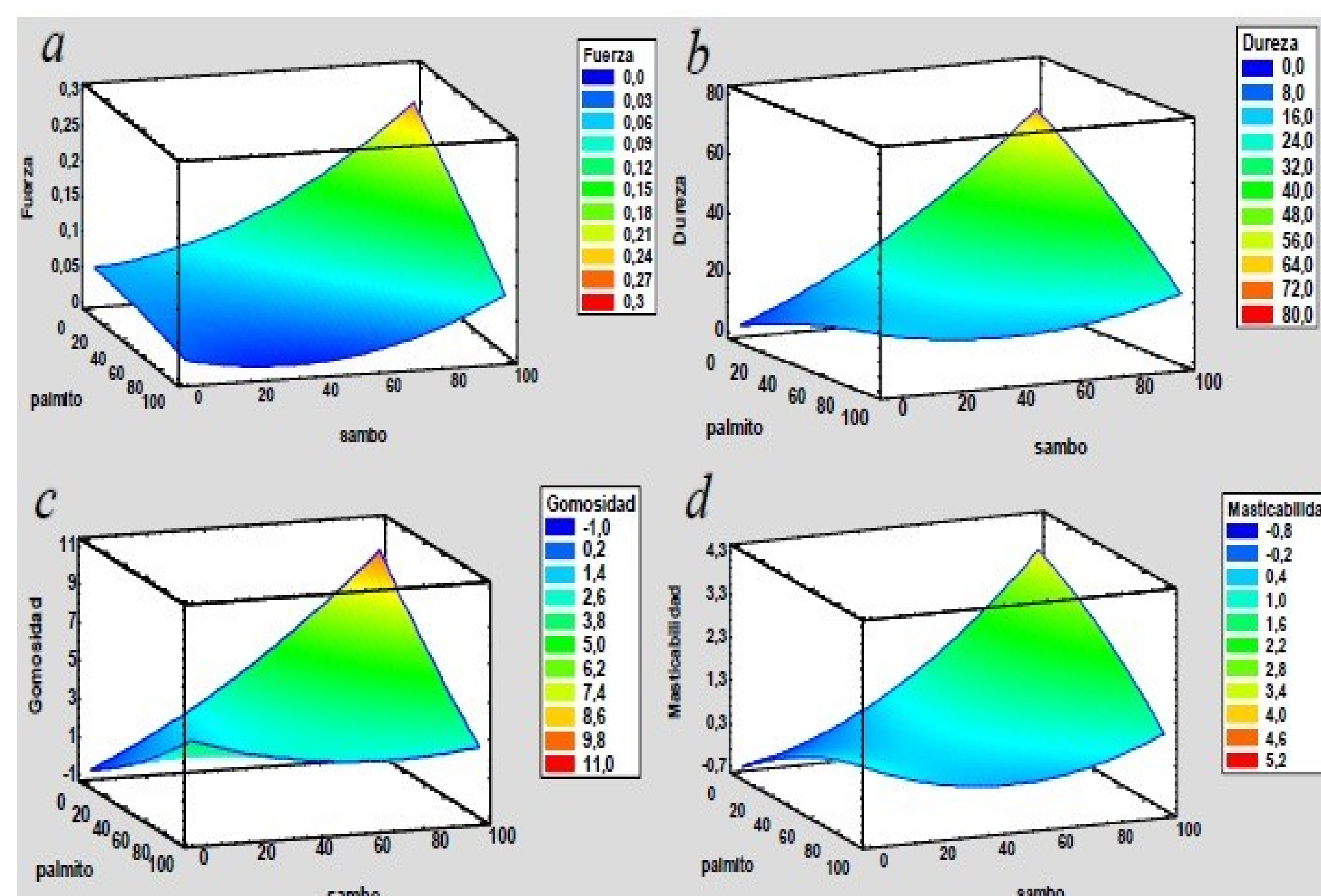


Figure 4: Effect of factors on texture variables: a) fracture strength, b) hardness, c) gumminess, and d) chewiness

Sensory acceptability was moderately high (7.17/9): flavor and aroma received the highest scores, whereas color was penalized due to the greenish hue imparted by the sambo paste. A significant interaction between ingredients strongly influenced textural attributes, underscoring the importance of formulation optimization to maximize overall acceptance.

CONCLUSION

Agro-industrial by-products such as palm heart flour and sambo seed paste can be effectively leveraged to formulate functional, sustainable, gluten-free cookies. Further studies should address amino acid and fatty acid profiles, mineral content, and advanced sensory analysis to enhance product characteristics and increase consumer acceptance.

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