



Formulation of Cream Cheese Powder with Kecombrang Extract: Effects on pH, Antioxidant Activity and Sensory Properties

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ABSTRACT

Background: The growing interest in functional dairy products has encouraged the development of innovative shelf-stable dairy ingredients with added health benefits. Cream cheese powder represents a promising functional food ingredient due to its versatility in food formulations and extended shelf life. However, conventional cream cheese powder lacks bioactive compounds which support functional claims. Torch ginger (*Etlingera elatior*), locally known as kecombrang, is rich in antioxidant compounds and has been widely studied as a functional plant-based ingredient. Despite its antioxidant potential, the application of kecombrang extract in dairy-based powdered products remains limited. Therefore, incorporating kecombrang extract into cream cheese powder offers an opportunity to enhance its functional properties, particularly its antioxidant activity, while formulating value added dairy products.

Methods: This study aimed to characterize the antioxidant activity, pH and sensory properties of cream cheese powder produced formulated with varying concentrations of kecombrang extract and maltodextrin and to determine the optimum formulation using design expert software with a simplex lattice design (SLD). The research was conducted in two phases. The preliminary phase involved defining the objective function as well as identifying the dependent variables (pH, antioxidant activity and sensory properties) and independent variables (kecombrang extract and maltodextrin concentrations) used in the optimization model. Cream cheese was converted into powder using the foam-mat drying method, with maltodextrin serving as the foaming and carrier agent. The second phase focused on formulation optimization to identify the best combination of kecombrang extract and maltodextrin based on the selected responses.

Result: The results demonstrated that substitution with kecombrang extract significantly influenced the functional and sensory characteristics of cream cheese powder. Optimization analysis revealed that the best formulation was achieved with the addition of 12.5% kecombrang extract and 10% maltodextrin. This formulation maintained the pH at approximately 6.0, increased antioxidant activity by up to 50% and achieved an overall sensory score of 3.8. These findings indicate that kecombrang extract can be effectively utilized to enhance both functional and sensory attributes of cream cheese powder, highlighting its potential as a functional dairy-based food ingredient.

Key words: Antioxidant activity, Cream cheese, Kecombrang, Maltodextrin, Powder, Sensory attributes.

INTRODUCTION

Functional foods offer benefits beyond basic nutrition. In addition to supplying essential nutrients (like carbohydrates, proteins, fats, vitamins and minerals), they contain biologically active compounds that help maintain normal body functions, improve health and may reduce the risk of certain diseases (Fadhurrohman and Susanto, 2024). A well-known dairy ingredient used in various food products, cheese powder occupied the global market with a value of approximately USD 571 million in 2022 and is projected to reach around USD 721 million by 2027, with a compound annual growth rate (CAGR) of about 6% according to Statista (Statista, 2025).

Cream cheese is one of the most popular type of processed cheese produced without fermentation (Suciati and Safitri, 2021). It is mostly spreadable which contains high moisture, fat and lack of compact protein matrix. Cream cheese has relatively short shelf life and high content of saturated fatty acids (Suciati and Safitri, 2021). Factors influencing shelf-life of cream cheese include ingredient composition, storage temperature and packaging. In cream cheese powder formulation, additional components such as skim milk solids, whey and flavor enhancers can be

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incorporated depending on product requirements (Naufalin et al., 2021). However, improving shelf life remains an important consideration. The incorporation of natural preservatives is one of the simplest strategies to extend the shelf life of cream cheese. Among natural preservatives, kecombrang (*Etlingera elatior*) extract is considered a promising source due to its bioactive compounds (Naufalin et al., 2021).

Kecombrang is widely distributed in Indonesia and has long been used by local communities both as a flavoring agent and for medicinal purposes. Belonging to the Zingiberaceae family, kecombrang flowers, fruits and stems are used as spices in traditional dishes such as urab, pecel and meat dishes (Naufalin *et al.*, 2019; Usmiati, 2020). In soft cheese products such as cream cheese, the selection of coagulants, including natural additives, is a key factor influencing texture, spreadability and sensory acceptance (Kisworo, 2022). Process engineering can also improve shelf life. One approach is particle size reduction through powdering. In this study, cream cheese was processed into powder, resulting in a product that is more stable at room temperature, has longer shelf life, is easier to use, lighter and more compact, facilitating storage and distribution (Naufalin *et al.*, 2021).

The manufacturers of preservative powder use the foam-mat drying method (foam drying technique). The foam drying technique's effectivity is determined by the drying speed, which can be done with the correct temperature setting and filler concentration. In this preservative powder formulation, a filler is needed, namely, maltodextrin. The use of this maltodextrin concentration is around 5-15%. This is consistent with the statement regarding the addition of maltodextrin in the range of 6-20% in the manufacture of apple powder products using the foam mat drying method, which is proven to reduce hygroscopic properties, stabilize empty cavities in the foam and increase granulation in powders (Prajapati *et al.*, 2023). Considering the drawbacks of the process, the use of additive concentrations above 15% can reduce the quality of preservative powders. Furthermore, the addition of more than 20% maltodextrin can decrease the polyphenol content in instant kombucha tea drinks. Since polyphenols function as antioxidants, their reduction may lower the functional value of the product (Naufalin *et al.*, 2021).

This study focuses on formulating cream cheese powder with natural preservatives to enhance products' shelf life. The functional value of combining cream cheese powder with kecombrang lies in the balance of taste, health benefits, culinary creativity and consumption practicality. Cream cheese provides a soft texture and rich savory taste, while kecombrang contributes a distinctive aroma, slight spiciness and fresh notes that enhance flavor complexity. Functionally, kecombrang contains antioxidants, flavonoids and antibacterial properties that support digestive health and immunity (Septiana *et al.*, 2017). Therefore, developing a functional food product in the form of cream cheese powder that can be incorporated into various foods is highly desirable and has strong potential for future functional food market development.

MATERIALS AND METHODS

Materials

Cream cheese was produced according to the modified method of Jeon *et al.* (2012). The raw materials for cream

cheese powder production included cow's milk, skim milk, kecombrang flower, creamer, *Lactococcus lactis* starter culture, rennet, salt, maltodextrin and distilled water. For chemical analysis, 2,2-diphenyl-1-picrylhydrazyl (DPPH) reagent (manufacturer) was used to evaluate antioxidant activity. The study was carried out in 2025 at the Laboratory of Food Technology, Faculty of Agriculture and the Faculty of Animal Science, Jenderal Soedirman University, Indonesia. All experimental procedures and analyses were performed under laboratory controlled conditions.

The tools used in this study consisted of equipment for cream cheese powder production and instruments for chemical analysis. The equipment used for the manufacture of cream cheese powder included a thermometer, stainless steel pan, stove, basin, spatula, juice extractor, filter, measuring glass, knife, aluminum foil, filter cloth, cutting board and digital balance. The instruments used for chemical analysis included a UV-Vis spectrophotometer (Thermo Scientific™ Genesys™ 10S UV-Vis, Madison, WI, USA) and a digital pH meter (Taffware Digital pH Meter, China).

Preparation of cream cheese

The milk as modified by mixing 50% cow's milk and 50% skim milk, then pasteurized at 65°C for 30 minutes. The mixture was cooled to 30°C. A *Lactobacillus* starter was added until the pH reached 4.5. The milk was then supplemented with 0.5% rennet while being heated. The milk coagulation process was allowed to proceed at

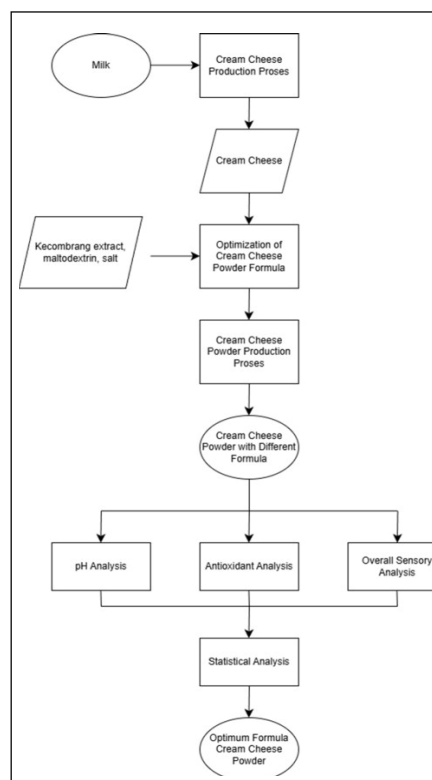


Fig 1: Flowchart of the method.

35°C for 60 minutes until an appropriate separation between the curd and whey was formed. The curd was then cut and reheated to 37°C to allow the matrix to bind properly. The resulting whey was removed and the curd was filtered using muslin cloth and pressed. Finally, the resulting curd was blended. The flowcart of the method is presented in Fig 1.

Making liquid extract of kecombrang flowers

The sorted leaves of kecombrang were washed with running water then cut into small pieces dried using a cabinet dryer for 24 hours with a drying temperature of 50°C until the dried kecombrang leaves are broken (Naufalin *et al.*, 2021). The dried leaves were then ground using a disc mill to obtain a homogeneous kecombrang leaf powder. The extraction method used in this research was the extraction method using extrator. Distilled water was added with a ratio of 1:28 w / v. The extraction process was carried out in accordance with the treatment of the micro wave power and the specified length of time. After that, the extract was filtered using a filter cloth to separate the filtrate and pulp, then filtered again using filter paper. After obtaining the filtrate, it was incubation for 12 hours. The flowchart of kecombrang flower extraxt production is shown in Fig 2.

Reconstitution property of powder

Cream cheese powder was produced through the foam-mat drying technique in order to preserve the characteristic flavor and extended shelf life of the final product. Initially, fresh cream cheese was homogenized to obtain a uniform consistency. Maltodextrin was incorporated as a carrier agent to improve stability, while egg albumin was used as a foaming agent. The mixture was then whipped until a stable foam was formed, characterized by adequate overrun and foam stability. The prepared foam was evenly spread onto trays in a thin layer to maximize the drying surface area. Drying was conducted at controlled temperature and air velocity conditions until the target moisture content was achieved. Foam-mat drying was selected because it operates at relatively low temperatures, thereby minimizing thermal degradation and preserving the sensory quality of cream cheese. Following the drying stage, the dehydrated foam was ground and sieved to obtain a fine, uniform powder. The final product was immediately cooled and packed in airtight, moisture-resistant containers to prevent rehydration and maintain storage stability. The resulting cream cheese powder retained the desirable tangy flavor and creamy characteristics of fresh cream cheese while offering advantages such as extended shelf life, ease of handling and wide applicability in bakery, confectionery and instant food formulations.

Cream cheese powder formula optimization

A mixture design approach was applied to optimize cream cheese powder in order to obtain the optimum formulation based on pH value, antioxidant activity and sensory

properties (overall statistical analysis). The optimization was conducted using a simplex lattice design (SLD) with an experimental design generated by Design-Expert software version 13. The optimization procedure consisted of several stages, including experimental design, response model analysis, optimization, verification and validation. The 100% cream cheese powder formulations are presented in Table 1. The factors evaluated in this study were kecombrang (*Etlingera elatior*) extract concentration and maltodextrin concentration. The lower and upper limits for kecombrang concentration were set at 7.5% and 12.5%, respectively, while maltodextrin concentration ranged from 10% to 15%. The optimization process focused on antioxidant activity as the response variable with the highest level of importance (***). The optimum treatment was determined based on the highest desirability value.

pH analysis

Calibrate the pH meter first with buffer pH 4 and pH 7. Cream cheese powder is rehydrated with distilled water and 20 ml is taken in a beaker glass then the pH meter electrode is dipped and wait until the pH reading of the sample is obtained stable.

Antioxidant analysis

The sample was prepared by mixing 1 gram of cream cheese with 0 mL of methanol, followed by centrifugation at 20,000 rpm for 10 minutes until a precipitate forms. 2 ml of test sample is placed in a tube reaction which already covered with aluminum foil and add 2 ml of DPPH solution and then incubated it for 30 minutes. The decrease in absorbance of the sample and blank was measured using a UV-Vis spectrophotometer at a wavelength of 517 nm (As).

Sensory properties (Overall)

Sensory properties were assessed based on key quality parameters, including color, aroma, taste, texture and overall

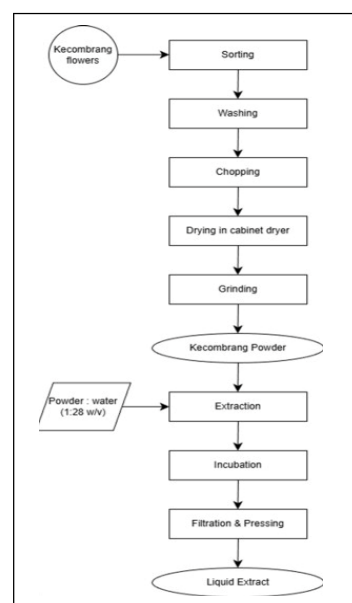


Fig 2: Flowchart of extract kecombrang flowers production.

acceptability, as these represent critical indicators of consumer perception and product quality. The analysis was conducted after rehydration of the cream cheese powder to reflect intended form of consumption. The sensory evaluation was performed to compare the different formulations generated through the simplex lattice design (SLD) and no separate control sample was included at this optimization stage. A total of 30 pre-screened panelists participated in the evaluation. The panelists were students aged 20 to 23 years who had received basic training in sensory evaluation. Each sample (5 gram) was presented in randomized order and labeled with unique three-digit codes to minimize bias. Sensory evaluation was performed using a five-point hedonic scale, where 1 = strongly dislike, 2 = dislike, 3 = neither like nor dislike, 4 = like, 5 = strongly like (Wahjuningsih *et al.*, 2024).

RESULTS AND DISCUSSION

Characteristic of fresh milk

The production of high-quality cream cheese powder requires raw milk with suitable physicochemical characteristics to ensure optimal processing performance and desirable product attributes. The quality of milk as the main raw material significantly affects the production of cream cheese, especially in terms of texture formation and product yield (Tahlaiti *et al.*, 2020). The composition of milk, including its fat, protein, lactose, mineral content and acidity, plays a decisive role in determining the texture, flavor and stability of the final product (Boumediene *et al.*, 2025). The results of this analysis are presented in Table 2, which provides an overview of the fat, protein, solid-not-fat (SNF), salt, pH, lactic acid and other key indicators that define the quality of the milk employed in cream cheese powder production.

The fat content of 3.29% provided a sufficient lipid matrix to deliver creaminess and mouthfeel characteristics after rehydration. Fat globules also function as flavor carriers, allowing volatile compounds to be retained during both fermentation and drying, thereby enhancing the overall sensory profile of the final product. Similarly, the protein content of 2.81% played a critical role in curd formation during the initial cream cheese production and contributed to the structural stability of the foam generated prior to drying. Casein proteins, in particular, facilitate emulsification and foam stabilization, which are essential for achieving uniform drying and preventing collapse of the foam mat structure (Effendi *et al.*, 2019).

The solid-not-fat (SNF) fraction, recorded at 7.69%, contained lactose and mineral components that further influenced drying behavior and powder quality. Lactose acts as a natural carbohydrate carrier that supports the encapsulation of flavor compounds, while also contributing to the glassy matrix formation during drying, thereby reducing stickiness and improving powder flowability. In addition, the salt concentration of 0.63% contributed to the ionic balance of the milk, supporting protein interactions and influencing flavor perception in the rehydrated cream cheese powder.

Physicochemical parameters such as freezing point (-0.481°C) and density (28.31 kg/m^3) confirmed the purity of the milk and the absence of dilution, ensuring a consistent raw material for processing. The near-neutral pH of 6.96 indicated that the milk was fresh and stable prior to fermentation, which is crucial for controlled acidification during cream cheese production. Following fermentation, the lactic acid concentration of 4.22% provided a mild acidity that enhanced microbial stability while also imparting the characteristic tangy flavor of cream cheese. This acidity, combined with the alcohol degree weight (7.11%), suggests the presence of bioactive metabolites that may contribute to the functional properties of the product (Komansilan, 2020).

Optimization cream cheese powder formulation

The results of the optimization study on cream cheese powder with the addition of kecombrang (*Etlingera elatior*) extract and maltodextrin showed that both factors significantly influenced antioxidant activity, pH and sensory attributes increasing the concentration of kecombrang extract enhanced antioxidant activity but decreased pH, while maltodextrin contributed to improved sensory acceptance. The concentration kecombrang extract and maltodextrin factors was observed an interaction between treatments on the pH values, antioxidant activity and sensory scores response of cream cheese powder (Table 3).

Antioxidant activity ranged from 40% to 52%, with the highest value observed at the formulation containing 12.5% kecombrang extract and 10% maltodextrin. These results indicate that increasing the concentration of kecombrang extract generally enhances antioxidant capacity of the

Table 1: Formulation cream cheese powder.

Component	Total (%)
Cream cheese	70
Maltodextrin	22.5
Kecombrang extract	
Salt	1
Creamer	6
Tween 80	0.5
Total	100

Table 2: Lactoscan content.

Parameter	Value	Description
Fat	3.29	Fat content
SNF (%)	7.69	Solid non fat
Salt (%)	0.63	Salt content
Pro (%)	2.81	Protein
Frp (C)	0.481	Freezing point
DEN (kg/m ³)	28.31	Density
Temp (C)	28.91	Temperature
pH	6.96	Acidity level
LAC	4.22	Lactose content
ADW	7.11	Added water

prepared product due to presence of bioactive compounds such as flavonoids, polyphenols and alkaloids in it, which act as free radical scavengers. Similar findings were reported by Naufalin *et al.* (2023), where higher levels of herbal extract addition improved the antioxidant activity of dairy-based functional products. The figure of antioxidant activity is shown in Fig 3.

The pH values were relatively stable, ranging from 6.0 to 6.74, suggesting that the addition of kecombrang extract did not significantly alter the acidity of the cream cheese powder. This stability may be attributed to the buffering capacity of milk proteins and maltodextrin, which can resist drastic changes in hydrogen ion concentration. The figure of pH values is shown in Fig 4.

Sensory scores ranged from 2.44 to 3.84 on the hedonic scale, with the highest acceptance also found in the formulation containing 12.5% kecombrang extract and 10% maltodextrin. This indicates that the combination of optimal extract and foaming agent levels improved consumer preference, particularly in terms of flavor balance and overall acceptability.

Overall, the findings suggest that the combination of 12,5% kecombrang extract and 10% maltodextrin represents the best formulation, providing the highest antioxidant activity (52%), stable pH (6.0) and favorable sensory evaluation (score 3.84). These results confirm that kecombrang extract has potential as a natural preservative and functional ingredient to augment both the health-promoting and sensory properties of cream cheese powder.

Validation of model

Based on the fit summary analysis, the linear model was significant and met the assumptions for ANOVA. The model adequately described the effect of formulation variables on pH response, with no significant lack of fit, indicating good agreement between the experimental and predicted values. The high coefficient of determination demonstrated that the variability in pH was well explained by the model. The close agreement between adjusted and predicted R² values further confirmed the model's reliability and predictive capability. In addition, the Adequate Precisin (AP) value indicated a strong signal to noise ratio, suggesting that the model is suitable for navigating the design space.

The low coefficient of variation reflected high data homogeneity and the VIF values confirmed the absence of multicollinearity among the independent variables. The verification and validation cream cheese powder are presented in Table 4.

For the antioxidant activity response, the model demonstrated a statistically significant effect of the formulation variables. The coefficient of determination indicated that the model was able to explain a substantial proportion of the variability in antioxidant activity. However, the large discrepancy between the adjusted and predicted R² values suggests limited predictive capability, indicating that the model may not accurately estimate antioxidant responses outside the experimental points. Despite this limitation, the adequate signal to noise ratio and acceptable data variability indicate that the model remains statistically valid within the studied design space.

In contrast, the sensory response was not significantly influenced by the formulation variables and the relatively low coefficient of determination suggests that sensory variation was not well explained by the model. This implies that additional uncontrolled factors or panel variability may have contributed to the sensory outcomes. Although the model showed marginal adequacy, it was not sufficiently robust to reliably predict sensory attributes.

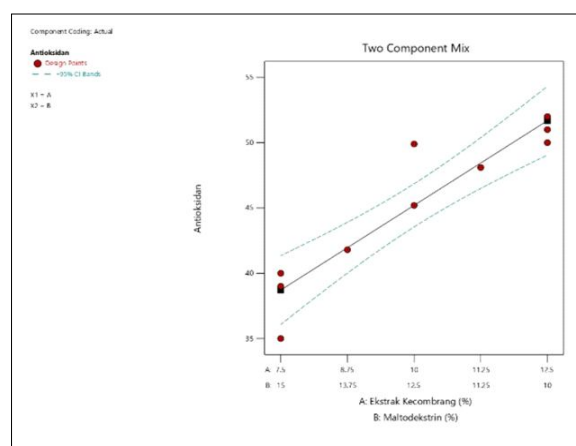


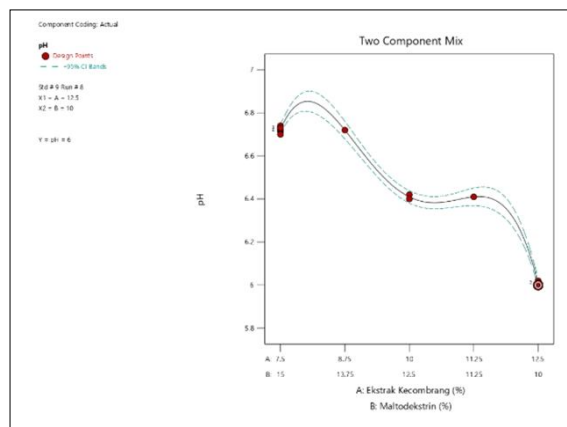
Fig 3: Results antioxidant values.

Table 3: Optimization process.

Run	Extract kecombrang (%)	Maltodextrin (%)	Antioxidant activity (%)	pH	Sensory
1	12.5	10	50.1	6	3.56
2	9.16667	13.333	44.8	6.6	3.84
3	10.8333	11.6667	45.2	6.4	3.28
4	8.75	13.75	41.8	6.72	3.4
5	12.5	10	52	6.02	3.4
6	7.5	15	40	6.74	3.64
7	12.5	10	50	6.01	3.84
8	10	12.5	49.9	6.42	3.44
9	7.5	15	41	6.73	3.84
10	11.25	11.25	48.1	6.41	2.44

Table 4: Verification and validation.

Response	P-value		R2	Adj R2	Pred R2	AP	CV%	VIF
	Model	Lack of fit						
pH	<0.0001	0.9542	0.99997	0.9994	0.99991	142,75	0.1121	1,1
Antioxidant	0.0002	0.1102	0.99	0.99	0.99	11	4.04	1
sensory	0.0534	0.2381	0.8005	0.6409	-0.1002	6.4394	7.18	1.1

**Fig 4:** Results pH values.

Based on the optimization results generated using Design Expert software, the optimum formulation consisted of 12.5% kecombrang extract and 10% maltodextrin. Under these conditions, the product exhibits stable pH, enhances antioxidant activity and improved sensory acceptance compared to other formulations. The pH model demonstrated strong reliability and predictive accuracy, while the antioxidant model showed statistical significance but limited predictive strength. Although the sensory model was weak, the selected optimum treatment consistently produced higher sensory scores. Validation experiments confirmed that the predicted responses were close to be observed values, supporting the suitability of the model for determining optimal formulation conditions.

Sensory analysis

Overall, cream cheese powder exhibited a satisfactory level of consumer acceptance based on color, appearance, taste and overall acceptability. The hedonic scores ranged from 2.40 to 3.84, indicating panelist evaluations from slightly like to like. These results suggest that the developed cream cheese powder formulations have potential consumer acceptability, although variations in preference were observed among the tested formulations.

Based on the sensory evaluation, three samples were identified as the most preferred by consumers, namely samples 2, 7 and 9. These samples exhibited relatively higher hedonic scores than the other formulations across most of the evaluated sensory attributes. The higher level of panelist preference for these samples may be attributed to their more attractive color characteristics, finer and more homogeneous powder appearance and a more balanced and acceptable flavor profile. In addition, a non-caking

powder texture and an aftertaste consistent with typical cream cheese characteristics could have further contributed to improved sensory acceptance. An appropriate concentration of kecombrang extract may impart a distinctive aroma and flavor that enhances the sensory profile without being excessively intense or unfamiliar to consumers. Meanwhile, maltodextrin may play an important role in improving powder appearance and texture, resulting in a more stable product with enhanced visual acceptability.

CONCLUSION

As per the obtained findings from this study, the incorporation of kecombrang flower extract (*Etlingera elatior*) into cream cheese powder effectively enhanced its functional and sensory attributes. Using simplex lattice design (SLD), the optimal formulation was determined at 12.5% kecombrang extract and 10% maltodextrin. Under these conditions, the pH remained stable at approximately 6.0, the antioxidant activity reached approximately 50% inhibition and the sensory evaluation reached a score of 3,8.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

This study involved a sensory evaluation conducted with voluntary panelists. Prior to participation, all respondents were informed about the objectives and procedures of the study and their consent was obtained. The evaluation posed no health risks, as it involved only the assessment of food samples under normal consumption conditions.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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