



RESEARCH ARTICLE

Sesame ball (butchi) enriched with purple yam, purple sweet potato and moringa: An organoleptic study and nutrient analysis

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Abstract

The goal of this research was to develop and assess the consumer acceptability of sesame ball (butchi) enriched with purple yam, purple sweet potato and moringa, focusing on their organoleptic properties, nutrient content and cost-benefit analysis. The nutritious content of the sesame ball was increased by adding purple yam, purple sweet potato and moringa. Additionally, an organoleptic evaluation was conducted to assess the sensory attributes, including appearance, aroma, color, taste, texture and overall sensory quality; a 9 point hedonic scale was used in determining the level of acceptability. The study included three treatments and used varying amount of purple yam, purple sweet potato and moringa. Treatment 3 (75 % purple yam, purple sweet potato and moringa) has the highest overall acceptability followed by Treatment 2 (50 % purple yam purple sweet potato and moringa) and the least is Treatment 1 (25 % purple yam, purple sweet potato and moringa). Based on the findings, Treatment 3 is the most acceptable food product which proceeded to the nutrient content and proximate analysis. As the result, innovative food product is nutritious, making them a promising alternative for health-conscious individuals. The cost and return analysis of sesame balls provides high economic value when added with purple yam, purple sweet potato and moringa. The data revealed no significant variation in the level of acceptability of food products categorized by profile. Furthermore, the study discovered that sesame ball in the experimental treatments were both acceptable and healthy. Future research should look into the shelf life, market potential and health implications of these enriched sesame ball, as well as nutritional content optimization and product variety growth.

Keywords: enriched; moringa; nutrient analysis; organoleptic; purple yam; purples sweet potato; sesame ball

Introduction

Food is an essential aspect of life, making its safety a key societal concern. Food manufacturing is an important value adding sector of both local and the global economy in terms of job creation, food security and participatory community development (1). More so, the researcher developed a variation to provide a safe and healthy snack through additional option from the existing flavors of sesame ball. This product is commonly known as Butchi, are shaped into balls and rolled into sesame seeds before frying (2); it is a Chinese sweet delicacy prepared from glutinous rice flour, sugar and sesame seeds frequently described as sweet, golden in color, crispy outside and chewy on the inside.

Asia and Africa produce the most sesame seeds, followed by North America and Europe (3). Sesame seed is a valued crop acknowledged for its rich improving food quality, nutritional value and health benefits; a great source of nutrients, high in dietary fiber, supports digestive health and guards against chronic illnesses when added to food products (4, 5). According to their studies (6, 7); adding sesame seeds can produce variety of food products such as bread, bars, cookies, pasta, cereals and snacks.

Additionally, starchy roots and tuber crops give variety to the modern diet, it also provide a wealth of nutritional and health advantages (8, 9). In the Philippines, one of the most important high value crops include potatoes and purple yam which contributes to food self sufficiency, economic growth and consumer health and welfare. Purple yam is a healthy alternative to other carbohydrate containing foods because it contains antioxidant compounds to maintain human health (10, 11). Purple yam is one of the most widely farmed yam species (12); and a very good source of dietary fiber (13, 14); potential to be a valuable source of anthocyanins, starch and is high in dietary fiber (15, 16). Based on research, purple yam originated in Southeast Asia is a well-known species cultivated in the Philippines, similarly enjoyed worldwide (17, 18). The purple yam gained increasing value and popularity in food industry due to its aesthetically pleasing purple color in baked goods and food products (19). Purple yam consumption is encouraged because of its high levels of antioxidants, vitamins, potassium, fiber and healthy for digestion. Purple yam as a common staple food has vital role in ensuring food security in low income households (20). It is important that purple yams are cooked, boiled, steamed and

fried to provide necessary nutrition such as carbohydrate (21, 22).

Likewise, the inclusion of purple sweet potato added a distinctive flavor and color to the characteristics of the sesame ball (butchi). Anthocyanin content in purple sweet potatoes is regarded as a nutritious food; it also boost human health and protecting vital organs, cardiovascular system, gastrointestinal tract, reducing obesity and improving bone health (23). Additionally, high anthocyanin content in purple sweet potatoes has high stability compared to anthocyanins from other sources (24); especially when taken from the root or stem of purple sweet potatoes (25, 26). Purple sweet potato can be made as an ice cream to become more nutritious (27, 28); thus, purple sweet potato provides strong, distinct, diverse flavors and more appealing aroma to the consumers. Therefore, sesame ball (butchi) added with tubers or root crops add variety as well as nutrients.

Moringa leaves are a good source of protein, vitamins, minerals and omega 3 and fatty acids which addressed nutritional issues (29, 30). Moringa leaves used to boost the nutritious value of food products and functional ingredient in various dishes (31-33). Additionally, it has medical benefits that fights malnutrition, particularly among infants and nursing mothers (34). Moringa leaves are also used to formulate jelly candies, bakery products and crackers (35-37); this promotes a healthy food products, promising balance of dietary ingredients and nutritional benefits for consumers.

Nowadays, the infusion of sesame ball (butchi) is already a more attractive and provides nutritious quality of the food product. This additional variety of food product appeals to a healthier diet and nutrients for everyone's consumption, hence, provide a better quality of food to the consumers from this delicious sweet treat. The purpose of the study is to evaluate the consumer acceptability of sesame ball (butchi), determine its nutrient content and proximate analysis and to determine each economic value of enriched sesame ball.

Materials and Methods

The product preparation of sesame ball (butchi) consider the factors such as adding rootcrops, cooking techniques and packaging methods to ensure the successful creation of a marketable and appealing product. The primary source of raw ingredients composting of powdered purple yam, purple sweet potato and moringa were all available from the local market produced by the farmers in the province of Quirino. The food product was prepared at the QSU food laboratory facility as a venue for the preparation and production of the sesame ball (butchi). Additionally, after determining the most preferred and acceptable sesame ball (butchi) which is treatment 3 using more amount of purple yam, purple sweet potato and moringa, it was also analyzed for its nutrient content to ensure that the food product provides nutritional value and health benefits to all types of consumers. The conduct of a comprehensive proximate analysis of the nutritional composition of the preferred sesame ball (butchi) was held at the Chemistry Laboratory, College of Health Sciences in QSU-Difun Campus andres Bonifacio, Difun, Quirino. The processing techniques of the raw ingredients is shown in Fig. 1.

The sesame ball (butchi) enriched with purple yam, purple sweet potato and moringa used three (3) treatments: Treatment 1

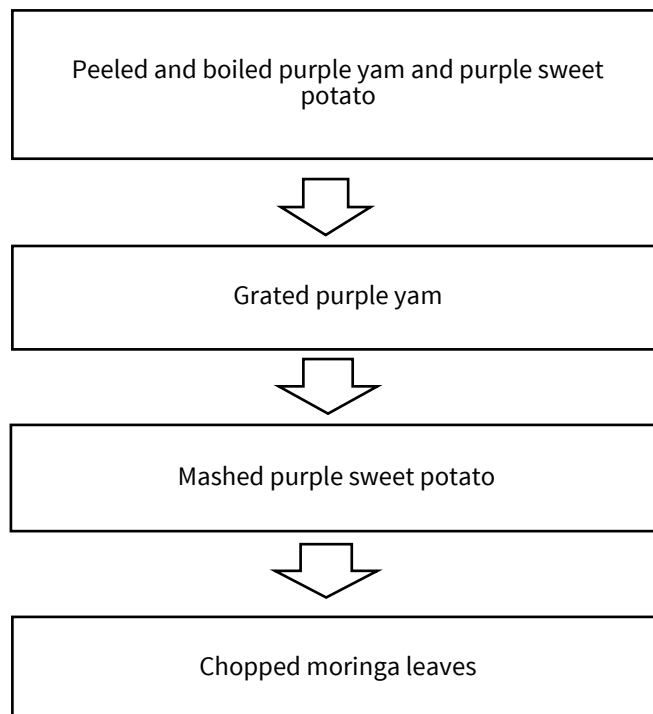


Fig. 1. Processing techniques of the raw ingredients.

(25 % purple yam, purple sweet potato and moringa), Treatment 2 (50 % purple yam, purple sweet potato and moringa) and Treatment 3 (75 % purple yam, purple sweet potato and moringa). The procedures in making sesame ball (butchi) composed of the preparation of the materials, tools and utensils that are thoroughly clean and sanitize, the procedures were made as follows (Fig. 2):

- Prepare and measure all the ingredients using the weighing scale.
- Combine all the dry ingredients then add the grated purple yam, mashed purple sweet potato, chopped moringa leaves and egg.
- Mix well the ingredients until it forms a dough ball.
- Scoop a small amount of dough and fill with cubed-cheese inside then mold the dough one-by-one.
- Roll the dough in the sesame seed until well coated.
- Deep fry the formed sesame ball, cool and set-aside.
- Wrap and label the sesame ball.

Research design

This study used experimental research design to determine the acceptability level of sesame ball (butchi) enriched with purple yam, purple sweet potato and moringa among respondents. The quality attributes of the newly developed food product was assessed as to the appearance, aroma, color, taste, texture and overall sensory quality (38).

In addition, a nine-point hedonic was used to determine the Hedonic characteristics of the sesame ball (39). The nine-point hedonic scale will ensure quality and consumption preferences to produce new items that better suit consumer preferences and expectations (40). The mean scores of the nine-point hedonic scale were verbally interpreted using the range of scores (Table 1).

Data analysis

The study employed both descriptive and inferential statistics to



(a) Prepare and measure all the ingredients using the weighing scale.



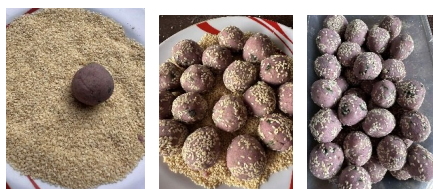
(b) Combine all the dry ingredients then add the grated purple yam, mashed purple sweet potato, chopped moringa leaves and egg.



(c) Mix well the ingredients until it forms a dough ball.



(d) Scoop a small amount of dough and fill with cubed-cheese inside then mold the dough one-by-one.



(e) Roll the dough in the sesame seed until well coated.



(f) Deep fry the formed sesame ball, cool and set-aside.



(g) Wrap and label the sesame ball.

Fig. 2. Procedures in making sesame ball (butchi).

Table 1. Hedonic scale

Scale	Descriptive interpretation
1.00-1.49	Dislike extremely
1.50-2.49	Dislike very much
2.50-3.49	Dislike moderately
3.50-4.49	Dislike slightly
4.50-5.49	Neither like nor dislike
5.50-6.49	Like slightly
6.50-7.49	Like moderately
7.50-8.49	Like very much
8.50-9.00	Like extremely

attain the main objective of the study. The frequency and percentage were used to describe the distribution and profile of the selected respondents of the study. Mean and standard deviation were used in describing the evaluated treatments in terms of the criteria set and the overall acceptability of the prepared treatments. The ANOVA (Analysis of Variance) were used to compare and contrast between and among three treatments based on the acceptability criterion. This statistical approach was employed to assess variations both within and between the treatments, providing a robust analysis of the impact on acceptability. Percentage (Return on Investment or ROI) was used to determine and describe the economic profitability of sesame balls.

$$\text{ROI} = \text{Net profit/Expenses} \times 100\% \quad (\text{Eqn.1})$$

Product tasting procedures

The research study involved a total of 50 respondents composed of faculty and students of Quirino State University-Diffun Campus, who served as evaluators for the sensory taste of the food product for more convenient distribution and retrieval of questionnaires. The respondents were briefed and evaluated prior to the product tasting of the sesame ball (butchi) enriched with purple yam, purple sweet potato and moringa to ensure that they could properly evaluate the sensory characteristics of the food product. The researcher distributed the survey questionnaires to the respondents together with the food product for the tasting evaluation. A total of 2 days was spent in the distribution and retrieval of the survey form. Informal interviews were also done to verify and clarify the responses of respondents. The respondents were also subjected to evaluation prior to the conduct of product tasting. The conduct of sensory evaluation was done up close with the chosen panelist to optimize sensory testing efficiently.

Results and Discussion

This section presents the data gathered which are systematically displayed in table form. The data were analyzed and interpreted

through appropriate statistical procedures. The results and discussion of the study are presented in the following order: organoleptic properties of the three prepared treatments, sensory evaluation, level of acceptability, nutritional value of the selected best treatment and the economic value of sesame ball.

Organoleptic properties/sensory characteristics of the three prepared treatments of sesame ball (butchi)

The organoleptic properties of the three prepared treatments of the enriched sesame ball in terms of appearance, aroma, color, taste, texture and overall sensory quality using a nine-point Hedonic scale.

Sensory evaluation of Treatment 1 (T1) (25 % purple yam, purple sweet potato and moringa) illustrates the mean ratings obtained: In terms of appearance, it garnered the highest mean rating of 8.34, followed by aroma and texture with a mean of 8.24. while taste parameters obtained a mean rating of 8.18 and the least is 8.12 which all interpreted as “Like very much”. Overall, the sensory evaluation of enriched sesame ball for T1 garnered 8.22 which has a verbal interpretation of “Like very much”. This implies that T1 appears to be well-accepted by consumers, as it received positive ratings across all evaluated organoleptic properties. The overall mean rating of 8.22 indicates a strong preference for the enriched sesame ball utilizing the purple yam, purple sweet potato and moringa, reinforcing the idea that the product is acceptable to consumers (41, 42) (Table 2).

Sensory evaluation of Treatment 2 (T2) (50 % purple yam, purple sweet potato and moringa) reveals the mean ratings gathered: With respect to appearance, it obtained the highest mean of 8.38, next is color with 8.30, followed by the taste and texture with 8.28 and the least is in terms of aroma with 8.26 and are all verbally interpreted as “Like very much”. The overall sensory evaluation for T2 of enriched sesame balls is 8.30 which is interpreted as “Like very much”. The results imply that T2 seems to be well-received and acceptable to consumers, with positive ratings across all organoleptic properties that also ensures food security (43, 44) (Table 3).

Sensory evaluation of Treatment 3 (T3) (75 % purple yam, purple sweet potato and moringa) shows the garnered mean ratings of this product: It is obtained by the texture as the highest mean rating of 8.54 verbally interpreted as “Like extremely”. This is followed by taste with 8.50, the appearance and color garnered 8.40, while the least is aroma with a mean rating of 8.30 and all are verbally interpreted as “Like very much”. The overall sensory evaluation for T3 of enriched sesame balls is 8.43 which is interpreted as “Like very much”. Based on the results, this implies that sesame ball enriched with purple yam, purple sweet potato and moringa in T3 are acceptable and well-liked by consumers

Table 2. Sensory evaluation of T1

Sensory evaluation items	N	Mean	SD	Verbal interpretation
Appearance	50	8.34	1.099	<i>Like very much</i>
Aroma	50	8.24	1.188	<i>Like very much</i>
Color	50	8.12	1.100	<i>Like very much</i>
Taste	50	8.18	1.240	<i>Like very much</i>
Texture	50	8.24	1.188	<i>Like very much</i>
Overall sensory quality	50	8.22	0.87937	<i>Like very much</i>

1.00-1.49 Dislike extremely; 1.50-2.49 Dislike very much; 2.50-3.49 Dislike moderately;

3.50-4.49 Dislike slightly; 4.50-5.49 Neither like nor dislike; 5.50-6.49 Like slightly;

6.50-7.49 Like moderately; 7.50-8.49 Like very much; 8.50-9.00 Like extremely

Table 3. Sensory evaluation of T2

Sensory evaluation items	N	Mean	SD	Verbal interpretation
Appearance	50	8.38	0.923	<i>Like very much</i>
Aroma	50	8.26	0.986	<i>Like very much</i>
Color	50	8.30	1.035	<i>Like very much</i>
Taste	50	8.28	1.213	<i>Like very much</i>
Texture	50	8.28	1.196	<i>Like very much</i>
Overall sensory quality	50	8.30	0.86496	<i>Like very much</i>

1.00-1.49 Dislike extremely; 1.50-2.49 Dislike very much; 2.50-3.49 Dislike moderately;

3.50-4.49 Dislike slightly; 4.50-5.49 Neither like nor dislike; 5.50-6.49 Like slightly;

6.50-7.49 Like moderately; 7.50-8.49 Like very much; 8.50-9.00 Like extremely

Table 4. Sensory evaluation of T3

Sensory evaluation items	N	Mean	SD	Verbal interpretation
Appearance	50	8.40	0.857	<i>Like very much</i>
Aroma	50	8.30	1.147	<i>Like very much</i>
Color	50	8.40	0.833	<i>Like very much</i>
Taste	50	8.50	0.789	<i>Like very much</i>
Texture	50	8.54	0.813	<i>Like extremely</i>
Overall sensory quality	50	8.43	0.54362	<i>Like very much</i>

1.00-1.49 Dislike extremely; 1.50-2.49 Dislike very much; 2.50-3.49 Dislike moderately;

3.50-4.49 Dislike slightly; 4.50-5.49 Neither like nor dislike; 5.50-6.49 Like slightly;

6.50-7.49 Like moderately; 7.50-8.49 Like very much; 8.50-9.00 Like extremely

based on their organoleptic properties. These findings can be valuable for product development and marketing, consumer acceptance of organic products and making purchasing decisions emphasizing the strengths of T3 in order to meet consumer preferences and expectations (45,46) Table 4).

Compare the sensory evaluation of the three treatments of the enriched sesame ball (butchi) in terms of appearance, aroma, color, taste, texture and their overall mean sensory quality

The three prepared treatments were compared statistically via repeated measures ANOVA.

This highlights the result of comparison of the sensory evaluation of the three treatments of the enriched sesame balls in terms of appearance, aroma, color, taste, texture and their overall mean sensory quality. Results reveal that there is no significant difference was exhibited in all criterion between and among the three treatments (Table 5).

Determine if significant difference exist in the level of acceptability of the three treatments of sesame ball in terms of profile

Comparative statistical result for two selected variables on the criterion for organoleptic properties and overall sensory evaluation.

This presents the significant difference in the level of acceptability of the three treatments when grouped by profile.

Table 5. Result of repeated measures ANOVA

Criterion	T1-T2-T3		
	T1/T2	T1/T3	T2/T3
Appearance	0.830	0.714	0.906
Aroma	0.194	0.791	0.828
Color	0.303	0.204	0.569
Taste	0.605	0.118	0.219
Texture	0.780	0.153	0.203
Overall sensory quality	0.494	0.162	0.301

*p < 0.05, n = 50

The p-values provided in the table were 0.793, 0.861, 0.921, 0.438, 0.363 and 0.991 respectively in terms of sex. While 0.97, 0.334, 0.542, 0.219, 0.373 and 0.306 respectively with respect to age for the three treatments. Since the p-values were greater than 0.05, there isn't enough statistical evidence to reject the null hypothesis for all of the treatments.

Thus, based on the p-values provided, the analysis concludes that there are no statistically significant differences in the acceptability of sesame ball among the three treatments when participants are grouped by their sex and age. This suggests that in terms of acceptability, the different proportions of sesame ball in the treatments do not have a significant impact based on the profile of the respondents. This implies that respondents evaluated the sesame ball have the same perception and acceptability on the new food product (47, 48) (Table 6).

The nutritional value of the selected best treatment of the enriched sesame ball (butchi)

In the context of this study, T3 has been chosen for future product development. This selection is grounded in its superior overall acceptability and the favorable outcomes observed in its organoleptic properties as per the defined criteria.

The result of nutrient analysis of sesame balls enriched with purple yam, purple sweet potato and moringa explains that the food product has a moisture content of 18.63 %. Moreover, the

Table 6. Comparative statistical result for two selected variables on the criterion for organoleptic properties and overall sensory evaluation

Criterion	Profile	
	Sex	Age
Appearance	0.793	0.957
Aroma	0.861	0.334
Color	0.921	0.542
Taste	0.438	0.219
Texture	0.363	0.373
Overall sensory quality	0.991	0.306

*p < 0.05, n = 50

enriched sesame balls have 8.87 g total protein, 18.2 g lipid, 5 g ash, 2.2 g fiber, 55.97 g carbohydrate and 661 Kcal metabolized energy were all analyzed in every 100 g of the product sample (Table 7).

Based on study, moisture content has a significant impact on the physical, chemical and textural properties of any food product. It is a metric used to determine how long food products should last and fluctuations in moisture significantly affect this metric (49). On the other hand, it was clarified on the assessment of the finished products prior to the approval for storage (50).

It was identified that sesame is a rich source of lipids (51, 52); it was also claimed that lipids also have a significant impact on food texture, or mouthfeel, which influences how appealing food is to consumers (53).

The findings reveal that the sesame ball (butchi) enriched with purple yam, purple sweet potato and moringa are nutritious and safe when consumed based on the results presented on the nutrient contents of the food product. Purple sweet potatoes, yams and other tuber crops, as well as moringa produces snack foods have high nutritional content such as protein, carbohydrate, ash, water, total energy and energy from fat (54).

Economic value of sesame ball (butchi) enriched with purple yam, purple sweet potato and moringa

Result of the economic value of sesame seed ball using the three treatments

This shows the economic assessment revolves around the production of enriched sesame ball using three different treatments: Treatment 1 (T1: 25 % purple yam, purple sweet potato and moringa), Treatment 2 (T2: 50 % purple yam, purple

sweet potato and moringa) and Treatment 3 (T3: 75 % purple yam, purple sweet potato and moringa) incurs varying total costs, with the T3 costing being the highest at Php 111.00, followed by T2 of Php 105.50 and T1 for Php 100.00 (Table 8).

The yield or the quantity of enriched sesame balls produced per preparation varies across the treatments. The T3 yields the highest at 55 pieces, followed by the T2 with 52 pieces and the T1 with 50 pieces.

Irrespective of the treatment, the price per piece remains constant at Php 4.00. Consequently, this leads to gross profits of Php 200.00, Php 208.00 and Php 220.00, respectively.

After deducting the respective total costs, the net profit for each treatment is calculated. The T1 yields a net profit of Php 100.00, the T2 results in a net profit of Php 102.50 and the T3 leads to the highest net profit at Php 109.00.

The Return on Investment (ROI) is a crucial metric for assessing the efficiency of the investment made in the production process. In this context, the T1 boasts the highest with respect to ROI of 100 % but the lowest in net profit due to the number of yields of production compared to T3 with the highest net profit due to greater yield. Hence, these percentages signify the returns gained relative to the initial investment. Conversely, the T3 treatment, incurring the highest total cost and yields the economic value. Engaging in this kind of business will surely give back the profit and benefit to the entrepreneurs.

In addition to quality and taste, it was found that one of the most crucial considerations when buying food brands or packages was followed by cost and healthful/nutritious qualities (55). According to research, food products aim to add economic

Table 7. Result of nutrient analysis of sesame ball (butchi) enriched with purple yam, purple sweet potato and moringa

Sample description	Method employed	Result
Moisture content	Moisture analyzer	18.63 %
Total protein	Biuret method	8.87 g in every 100 g of the sample
Total lipid	Folch	18.2 g in every 100 g of the sample
Total ash	Raghumamalu	5 g in every 100 g of sample
Total fiber	Raghumamalu	2.2 g in every 100 g of the sample
Total carbohydrate	Raghumamalu	55.97 g in every 100 g of the sample
Metabolized energy (ME)	Randive	661 Kcal/100 g of the sample

Table 8. Result of the economic value of sesame ball (butchi) using the three treatments

	T1 (25 % purple yam, purple sweet potato and moringa)	T2 (50 % purple yam, purple sweet potato and moringa)	T3 (75 % purple yam, purple sweet potato and moringa)
Per preparation (Total cost)	100.00	105.50	111.00
Yield	50.00	52.00	55.00
Price per piece	4.00	4.00	4.00
Gross profit	200.00	208.00	220.00
Net profit	100.00	102.50	109.00
Return of investment	100 %	97.16 %	98.20 %

value (56); and have the most significant potential to yield economic value (57).

Conclusion

This study was conducted to evaluate the consumers' acceptability of sesame ball (butchi), including the nutrient content and return on investment. The addition of purple yam, purple sweet potato and moringa was highly accepted by the consumers due to its delicate sweetness and brilliant color, while moringa provided an earthy flavor. Subsequently, there is no significant difference in the sensory evaluation of the three treatments using the different parameters when grouped by profile. The return on investment is favorable for the treatment 1 due to low ingredient costs while T3 has the highest yield and net profit. Meanwhile, further research and development can be pursued, such as examining the shelf life and storage stability that impacts longevity under various storage environments; conducting broader market testing to identify customer demands and taste preferences; and adjusting the amounts of purple yam, purple sweet potato and moringa to meet a healthier eating choices.

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Compliance with ethical standards

Conflict of interest: The author does not have any conflict of interest to declare.

Ethical issues: None

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