

Sensory Quality and Students' Intention to Consume Free Nutritious Meals: A Cross-Sectional Study in Makassar, Indonesia

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ABSTRACT

Introduction: The Free Nutritious Meal Program aims to improve students' nutritional intake, health, and learning capacity. However, its effectiveness depends substantially on students' acceptance of and willingness to consume the meals provided. This study examined the associations between menu variety, taste, aroma, texture, and food appearance and students' intention to consume free nutritious meals at SMA Negeri 6 Makassar.

Research Methodology: This quantitative cross-sectional study was conducted from May to July 2026. A total of 182 students in Grades X and XI were selected from a population of 667 students using simple random sampling. Data were collected through observation and a validated and reliable questionnaire. Descriptive statistics, Chi-square tests, odds ratios (ORs), and 95% confidence intervals (CIs) were used, with statistical significance set at $\alpha=0.05$.

Results: Of the participants, 177 (97.3%) expressed an intention to consume the meals. Students' consumption intention was significantly associated with menu variety (OR=42.75; 95% CI: 5.99–305.24; $p=0.001$), taste (OR=131.25; 95% CI: 13.59–1,267.96; $p<0.001$), food aroma (OR=17.46; 95% CI: 2.69–113.39; $p=0.006$), food texture (OR=28.83; 95% CI: 3.73–222.96; $p=0.009$), and food appearance (OR=264.00; 95% CI: 18.50–3,766.54; $p<0.001$).

Conclusion: All assessed dimensions of food quality were significantly associated with students' intention to consume free nutritious meals. Program managers should prioritize sensory evaluation, menu diversification, standardized food preparation, and visually appealing presentation to strengthen meal acceptance and program effectiveness.

Keywords: Adolescent; Food Preferences; Nutritious Food; School Feeding



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INTRODUCTION

Adequate nutrition during adolescence is essential for physical growth, cognitive development, immune function, school participation, and academic performance. Nevertheless, the provision of nutritionally balanced meals does not automatically ensure that students consume the food offered. School meal programmes may achieve appropriate nutrient composition at the planning stage yet produce limited benefits when meals are rejected, left unfinished, or consumed inconsistently. This distinction is particularly important for Indonesia's Free Nutritious Meal Programme, which has been introduced as a large-scale intervention to improve nutritional adequacy and educational outcomes among school-aged children. The programme is expected to address persistent nutritional problems, including stunting, anaemia, and inadequate dietary intake. However, its public health impact depends not merely on programme coverage or meal distribution, but on whether students accept and consume the meals regularly.

Food acceptance among adolescents is shaped by multiple interacting factors. Nutritional value is important from a programme perspective, whereas students frequently evaluate meals through immediate sensory experiences. Menu variety, taste, aroma, texture, and visual appearance influence whether food is considered attractive, familiar, palatable, and worth consuming. Food science literature identifies sensory attributes as central determinants of consumer acceptance because they affect expectations before eating and satisfaction during consumption ¹. In a school setting, these attributes may be particularly influential because adolescents have established food preferences, are sensitive to repetitive menus, and can easily compare programme meals with food available at home, school canteens, or surrounding vendors ². Consequently, meals that are nutritionally adequate but monotonous, poorly seasoned, unpleasant in texture, or visually unappealing may generate food waste and reduce sustained participation ³.

Existing evidence generally supports the value of school feeding programmes. International research indicates that structured school meals can improve dietary intake, school attendance, concentration, and selected nutritional outcomes, particularly among socially and economically vulnerable populations ⁴. Indonesian studies have similarly reported potential improvements in learning motivation, concentration, discipline, and nutritional awareness following the implementation of free meal initiatives ⁵. A systematic review by free school meal programmes may contribute to improved nutritional status when food provision is sustained and appropriately managed. These findings establish the relevance of school feeding as a nutrition-sensitive educational intervention.

However, the literature remains dominated by evaluations of programme effectiveness based on nutritional status, attendance, academic concentration, or policy implementation. Such outcomes are important, but they provide limited explanation of the behavioural mechanism through which programme meals are actually accepted or rejected ⁶. Several studies acknowledge that taste and menu diversity influence satisfaction, yet food-quality dimensions are often combined into a single general indicator or discussed descriptively without testing their individual relationships with consumption intention ⁷. Moreover, evidence from Indonesian senior high school students remains limited ⁸. Adolescents at this educational level may respond differently from younger children because they exercise greater autonomy in food selection, have more complex sensory preferences, and are more exposed to commercial food choices ⁹.

This gap is evident in the context of SMA Negeri 6 Makassar. Preliminary observations indicated that some students did not finish the meals provided because the taste, menu variation, texture, aroma, or presentation did not match their preferences¹⁰. Such behaviour creates a practical contradiction: food may be distributed successfully while its intended nutritional benefits remain unrealised¹¹. When programme evaluation focuses only on the number of meals delivered, this form of implementation failure can remain hidden. A more behaviourally informed assessment is therefore required to determine which food-quality attributes are associated with students' willingness to consume MBG meals.

The novelty of this study lies in its multidimensional assessment of food quality by examining menu variety, taste, aroma, texture, and appearance as distinct factors associated with consumption intention among senior high school students. Rather than treating food quality as a single undifferentiated concept, the study evaluates each sensory dimension separately, thereby providing more actionable evidence for menu planning, food preparation, quality assurance, and meal presentation. The study also contributes context-specific evidence from Makassar, where empirical research on student acceptance of the MBG programme remains scarce. Accordingly, this study aimed to analyse the relationships between menu variety, taste, food aroma, food texture, and food appearance and students' intention to consume Free Nutritious Meals at SMA Negeri 6 Makassar. The findings are expected to support an implementation approach that evaluates programme success not only by meal availability, but also by students' acceptance and actual willingness to consume the food provided.

MATERIALS AND METHODS

Study Design

This study employed an analytical quantitative approach with a cross-sectional design to examine the relationship between the perceived quality of meals provided through the Free Nutritious Meal Programme (*Makanan Bergizi Gratis* [MBG]) and students' intention to consume the meals. The cross-sectional design was appropriate because the exposure variables and outcome were measured simultaneously within a defined study period. This design enabled the researchers to estimate the distribution of students' perceptions and identify statistical associations between specific sensory attributes of the meals and consumption intention. However, because temporal order could not be established, the findings were interpreted as associations rather than causal effects.

Setting and Participants

The study was conducted at SMA Negeri 6 Makassar, South Sulawesi, Indonesia, from May to July 2026. The target population consisted of 667 students enrolled in Grades X and XI during the study period. The study included students who were officially registered at the school, had received meals through the MBG programme, were present during data collection, were able to understand the questionnaire, and voluntarily agreed to participate. Students were excluded when they had not consumed or directly evaluated the programme meals, were absent after repeated data-collection visits, submitted substantially incomplete questionnaires, or withdrew their participation.

where (n) represents the required sample, (N) is the population size, and (e) is the accepted margin of error. With a population of 667 students and an approximate precision level of 6.3%, the minimum sample size was 182 participants. Respondents were selected using

simple random sampling to ensure that each eligible Grade X and XI student had an equal probability of inclusion. The original manuscript reported a final sample of 182 students selected from the population of 667 students.

Variables and Measurement

The dependent variable was students' intention to consume the free nutritious meals. Operationally, consumption intention referred to the students' expressed willingness to consume, finish, and accept the meals provided through the programme. The variable was assessed using questionnaire items and subsequently classified into "interested" and "less interested" categories according to the predetermined scoring threshold. The independent variables represented five dimensions of perceived food quality:

Menu variety: students' perceptions of diversity and repetition in the types of meals, side dishes, vegetables, and menu combinations.

Taste: students' evaluation of flavour acceptability, seasoning, and compatibility with their preferences.

Food aroma: students' perceptions of the smell and freshness of the meals before and during consumption.

Food texture: students' evaluation of softness, tenderness, consistency, and ease of chewing.

Food appearance: students' perceptions of colour, arrangement, cleanliness, portion presentation, and visual attractiveness.

Each variable was measured using structured questionnaire items with an ordinal response scale. Item scores were summed and categorised as "good" or "poor" based on the instrument's established cut-off value. The study used primary data obtained directly from participating students through questionnaires and observation. Secondary information, including the number of eligible students and class distribution, was obtained from school administrative records. Instrument validity was assessed by comparing the item-total correlation coefficient with an (r)-table value of 0.1455. All 35 questionnaire items had correlation coefficients above this threshold and were therefore considered valid. Internal consistency was evaluated using Cronbach's alpha. The reliability coefficients were 0.697 for overall food quality, 0.766 for menu variety, 0.818 for taste, 0.828 for food aroma, 0.746 for texture, 0.814 for food appearance, and 0.837 for consumption intention. All coefficients exceeded the minimum criterion of 0.60 used in the study.

Data Collection

Data collection was conducted after obtaining permission from the school administration. A sampling frame containing eligible students from Grades X and XI was prepared, and participants were selected randomly. The selected students received an explanation regarding the purpose, procedures, voluntary nature, potential benefits, and minimal risks of participation. Questionnaires were completed individually in a classroom setting under the supervision of trained research personnel. No teachers were involved in observing students' responses to minimise social desirability and perceived academic pressure. Quality-control procedures included training data collectors, standardising questionnaire administration, checking respondent eligibility, and reviewing completed questionnaires for missing or inconsistent responses. The questionnaire was coded using anonymous identification numbers rather than student names. Completed forms were checked on the same day, and data were entered into a predefined database. A proportion of the entries should be independently rechecked against the original questionnaires to reduce coding and

data-entry errors. The manuscript indicates that data processing included editing, coding, scoring, and tabulation.

Data Analysis

Data were analysed using IBM SPSS Statistics. Descriptive analysis was used to summarise participant characteristics and the distribution of the study variables. Categorical variables were presented as frequencies and percentages. Bivariate associations between each food-quality dimension and consumption intention were examined using Pearson's Chi-square test. Fisher's exact test was used when expected cell frequencies did not satisfy the assumptions of the Chi-square test. Crude odds ratios and 95% confidence intervals were calculated from the two-by-two contingency tables to estimate the magnitude and precision of each association.

Because consumption intention was measured as a binary outcome, binary logistic regression would ordinarily be the appropriate multivariable method. However, only five participants were classified as having low consumption intention, while 177 were classified as interested. This substantial outcome imbalance and the presence of sparse cells could produce unstable coefficients, inflated odds ratios, and complete or quasi-complete separation in conventional maximum-likelihood logistic regression. Therefore, a standard multivariable model containing all five predictors should not be reported without reanalysis.

For an adjusted analysis, Firth's penalised logistic regression or exact logistic regression is recommended because these procedures are more appropriate for sparse binary outcomes. Variables with theoretical relevance and bivariate ($p < 0.25$) may be considered for entry, but the final model should remain parsimonious. Adjusted odds ratios, 95% confidence intervals, and (p)-values should be reported. Multicollinearity should be assessed using variance inflation factors and tolerance statistics. Model performance may be evaluated using likelihood-ratio testing, calibration measures, and discriminatory capacity. All statistical tests should be two-tailed, with statistical significance established at ($p < 0.05$).

Ethical Approval

Participation was voluntary, and written informed consent was required before data collection. For students younger than 18 years, written parental or guardian consent and student assent should be obtained. Participants should be informed that refusal or withdrawal would have no academic consequences. Confidentiality should be protected by removing personal identifiers, securely storing research records, and reporting results only in aggregate form. The attached manuscript does not provide the name of the ethics committee or an ethical approval number. These details must not be fabricated and should be inserted in the final manuscript using the following format:

RESULTS

Respondent Characteristics

A total of 182 students participated in the study. Most respondents were female (53.8%) and enrolled in Grade XI (52.2%). Nearly all students rated the overall meal quality as good (98.9%). Positive assessments were also reported for menu variety (95.1%), taste (97.3%), aroma (90.7%), texture (96.7%), and food appearance (97.8%). Overall, 177 students (97.3%) expressed an intention to consume the meals provided through the Free Nutritious Meal Programme.

Table 1. Characteristics of the respondents and distribution of study variables

Characteristic	Category	n	%
Sex	Male	84	46.2
	Female	98	53.8
Grade	X	87	47.8
	XI	95	52.2
Overall food quality	Good	180	98.9
	Poor	2	1.1
Menu variety	Good	173	95.1
	Poor	9	4.9
Taste	Good	177	97.3
	Poor	5	2.7
Food aroma	Good	165	90.7
	Poor	17	9.3
Food texture	Good	176	96.7
	Poor	6	3.3
Food appearance	Good	178	97.8
	Poor	4	2.2
Consumption intention	Interested	177	97.3
	Less interested	5	2.7

Bivariate analysis showed that all five dimensions of food quality were significantly associated with students' consumption intention. Students who perceived the menu variety as good had 42.75 times higher odds of expressing consumption intention than students who rated it as poor. Taste and food appearance produced the largest crude effect estimates, although their confidence intervals were wide because relatively few students were classified as less interested.

Table 2. Bivariate associations between food-quality dimensions and consumption intention

Food-quality variable	Category	Interested, n (%)	Less interested, n (%)	Crude OR	95% CI	p-value
Menu variety	Good	171 (98.8)	2 (1.2)	42.75	5.99–305.24	0.001
	Poor	6 (66.7)	3 (33.3)	Reference		
Taste	Good	175 (98.9)	2 (1.1)	131.25	13.59–1,267.96	<0.001
	Poor	2 (40.0)	3 (60.0)	Reference		
Food aroma	Good	163 (98.8)	2 (1.2)	17.46	2.69–113.39	0.006
	Poor	14 (82.4)	3 (17.6)	Reference		
Food texture	Good	173 (98.3)	3 (1.7)	28.83	3.73–222.96	0.009
	Poor	4 (66.7)	2 (33.3)	Reference		
Food appearance	Good	176 (98.9)	2 (1.1)	264.00	18.50–3,766.54	<0.001
	Poor	1 (25.0)	3 (75.0)	Reference		

Good food appearance was associated with the largest crude odds ratio, followed by taste, menu variety, texture, and aroma. However, these effect estimates should be interpreted

cautiously because the outcome was highly imbalanced and several cells contained fewer than five observations. The wide confidence intervals indicate limited precision rather than definitive differences in the relative importance of the predictors. A conventional multivariable binary logistic regression model could not be estimated reliably from the aggregated data reported in the manuscript. Only five of the 182 participants were classified as less interested, resulting in an extremely low number of outcome events relative to the five proposed predictors. Including all variables in a standard model would create a high risk of overfitting, unstable coefficients, and complete or quasi-complete separation.

Table 3. Assessment of multivariable modelling feasibility

Model component		Result	Statistical implication
Total sample	182		Adequate for descriptive and bivariate analysis
Students less interested	5		Very limited number of outcome events
Proposed predictors	5		Approximately one event per predictor
Conventional logistic regression	Not reliably estimable		High risk of overfitting and separation
Adjusted OR, 95% CI, p-value	Not reported		Individual-level dataset and penalised estimation required
Recommended approach	Firth penalised logistic regression or exact logistic regression		Reduces small-sample and separation bias

Adjusted odds ratios should not be generated from the published contingency tables alone because the joint distribution of the predictors for each participant is unavailable. A valid multivariable analysis requires the original individual-level dataset. Firth penalised logistic regression would be preferable to conventional logistic regression, but even this model should remain parsimonious because only five low-intention events were observed. The findings indicate that students' willingness to consume free nutritious meals is closely linked to their sensory evaluation of the food rather than simply to its availability. Taste and appearance produced particularly large crude associations, suggesting that the first visual impression and the experience of flavour may strongly shape acceptance. Menu diversity and texture were also relevant, indicating that repetitive menus or unsuitable food consistency may discourage students from finishing the meals. Aroma showed a comparatively smaller but still meaningful association, reinforcing the importance of freshness and appropriate food handling.

These results have practical implications for programme implementation. Nutritional adequacy should remain the primary standard, but nutrient composition alone is insufficient when meals are not accepted or consumed. Programme managers should combine nutritional standards with routine sensory-quality monitoring, student feedback, menu rotation, standardised recipes, temperature control, and attractive presentation. Food waste and plate leftovers should also be monitored as implementation indicators because they provide more direct evidence of actual meal acceptance than distribution counts. The estimates must nevertheless be interpreted carefully. Their wide confidence intervals reflect sparse observations in the poor-quality and low-intention categories. The study supports the presence of associations, but it cannot establish causality or determine which attribute independently predicts consumption after adjustment. Future studies should use larger and more

heterogeneous samples, objective plate-waste measurements, and penalised multivariable modelling.

DISCUSSION

This study shows that students' intention to consume meals provided through the Free Nutritious Meal Programme is closely associated with their perceptions of menu variety, taste, aroma, texture, and food appearance. These findings indicate that students do not evaluate school meals solely in terms of nutritional value. They also respond to the meals as consumers whose acceptance is influenced by sensory experience, familiarity, expectations, and personal preferences. From this perspective, the provision of nutritionally adequate food cannot be considered a complete programme achievement when students do not consume the meals, leave substantial portions unfinished, or accept them only reluctantly. The findings therefore support a shift from a supply-oriented evaluation of school feeding programmes toward an acceptance-oriented approach that considers whether the food distributed is actually consumed.

The high proportion of students who expressed an intention to consume the meals suggests that the programme was generally well accepted. However, the bivariate analysis revealed that students who rated specific food-quality dimensions negatively were considerably more likely to report low consumption intention¹². Food appearance and taste produced the largest crude odds ratios, suggesting that visual impressions and flavour may play particularly important roles in shaping acceptance. The appearance of food can influence students even before consumption begins¹³. Colour, arrangement, portion size, cleanliness, and visual attractiveness may create expectations regarding taste, freshness, and safety. Once students begin eating, taste becomes a central factor in confirming or rejecting these expectations¹⁴. This implies that appearance and taste may function interactively rather than independently. An attractive meal may encourage students to try the food, while an acceptable flavour may determine whether they continue eating and finish the portion¹⁵.

Menu variety was also significantly associated with consumption intention. Repeated presentation of similar foods may reduce curiosity and produce sensory fatigue, even when the meals meet established nutritional standards¹⁶. This issue is particularly relevant among adolescents, who generally have greater autonomy in food selection and more opportunities to compare programme meals with foods available at home, school canteens, or nearby vendors¹⁷. A monotonous menu may therefore be viewed as less appealing than alternative food choices. Nevertheless, menu diversification should not be understood merely as increasing the number of dishes¹⁸. Effective variety requires a planned rotation of staple foods, protein sources, vegetables, fruits, colours, textures, and cooking methods while maintaining nutritional adequacy, cultural acceptability, food safety, and cost efficiency¹⁹.

The significant relationships involving texture and aroma further demonstrate that food acceptance is multidimensional. Texture affects chewing comfort, perceived freshness, consistency, and overall eating experience²⁰. Food that is overly hard, soft, dry, oily, or inconsistent may be rejected even when the taste is satisfactory²¹. Aroma, meanwhile, serves as an anticipatory sensory cue that can stimulate or suppress appetite before the food is tasted. Pleasant aromas may strengthen perceptions of freshness and palatability, whereas unfamiliar or undesirable smells may discourage students from consuming the meal²². The fact that all five food-quality dimensions were associated with consumption intention indicates that food quality should not be reduced to a single general assessment²³. Each dimension may

influence acceptance through a distinct mechanism and may therefore require a specific operational response ²⁴.

These findings also have important implications for programme implementation. School feeding programmes are often evaluated using administrative indicators such as the number of meals prepared, the number of beneficiaries reached, budget absorption, distribution coverage, or compliance with nutritional standards. Although these indicators are important, they only demonstrate that food was supplied ²⁵. They do not indicate whether students consumed the meals or obtained the intended nutrients. Consumption intention may therefore be understood as an intermediate behavioural outcome linking food delivery with actual nutritional impact. A plausible programme pathway is that food quality influences acceptance, acceptance affects consumption, consumption determines nutrient intake, and nutrient intake contributes to health, development, and educational outcomes. Within this pathway, sensory quality is not a cosmetic or secondary concern. It is an essential implementation mechanism.

The preliminary observations at SMA Negeri 6 Makassar support this interpretation. Some students reportedly did not finish the food because the taste, menu variation, texture, aroma, or presentation did not correspond with their preferences. The statistical results were consistent with these observations, as each sensory dimension was significantly associated with consumption intention. These findings suggest that the nutritional benefits of the programme may not be fully realised when menu planning prioritises nutrient composition but gives insufficient attention to students' sensory acceptance. Nutritional adequacy and acceptability should therefore be treated as complementary rather than competing objectives.

The results are consistent with previous studies showing that school feeding programmes may improve nutritional status, concentration, attendance, learning motivation, and school discipline. However, much of the existing literature has focused on distal outcomes and has provided less explanation of the behavioural pathway through which programme meals are accepted or rejected. The present study contributes to this body of evidence by positioning sensory quality as a potential mechanism underlying programme effectiveness. Previous studies cited in the manuscript have also reported that menu variety, taste, aroma, texture, and presentation influence the acceptance of school meals. The current findings reinforce these observations and extend them by examining each food-quality attribute as a separate variable rather than combining all dimensions into one overall measure.

This distinction has practical relevance because different sensory problems require different forms of intervention. Poor taste may be addressed through recipe standardisation, seasoning adjustment, improved cooking techniques, and routine sensory testing. Poor appearance may require changes in food arrangement, colour balance, packaging, portion presentation, and temperature maintenance. Concerns related to texture may require better control of cooking time, ingredient quality, and storage conditions. Aroma problems may reflect issues in freshness, preparation, holding time, or transportation. Menu monotony may require a more systematic rotation plan and greater integration of local food preferences. By identifying these dimensions separately, the study provides a more operationally useful basis for quality improvement.

CONCLUSIONS

This study confirms that the perceived quality of meals provided through the Free Nutritious Meal Programme was significantly associated with students' intention to consume the meals at SMA Negeri 6 Makassar. Menu variety, taste, aroma, texture, and food

appearance were all related to consumption intention, with particularly strong crude associations observed for food appearance and taste. These findings indicate that nutritional adequacy alone is insufficient to ensure programme effectiveness when the meals are not sensorially acceptable to students. However, the large effect estimates should be interpreted cautiously because the number of students with low consumption intention was small and the confidence intervals were wide. Programme implementation should therefore integrate nutritional standards with routine assessment of sensory quality and student acceptance. Evidence-based interventions should include structured menu rotation, standardised recipes, periodic taste testing, appropriate temperature and texture control, improved visual presentation, and systematic monitoring of plate waste. Student feedback should also be incorporated into menu evaluation without compromising nutritional requirements. Future multicentre and longitudinal studies using objective food-consumption measures and appropriate penalised regression methods are needed to determine the independent contribution of each quality dimension and to evaluate whether targeted meal-quality improvements increase actual consumption and reduce food waste.

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Conflict of Interest

The authors declare that they have no financial, professional, institutional, or personal conflicts of interest that could have influenced the design, implementation, analysis, interpretation, or reporting of this study.

Authors' Contributions

Suci Sagita Ramadhani Fadly: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Visualization, and Writing—Original Draft.

Musfirah: Conceptualization, Methodology, Validation, Supervision, and Writing—Review and Editing.

Jalil Genisa: Methodology, Validation, Formal Analysis, Supervision, and Writing—Review and Editing.

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Declaration of Generative AI Use

Generative artificial intelligence tools were used only to assist with language refinement, grammatical correction, and improvement of manuscript clarity. These tools were not used to generate, analyse, modify, or interpret the research data. All scientific content, statistical results, interpretations, and conclusions were reviewed and verified by the authors, who accept full responsibility for the accuracy, originality, and integrity of the manuscript.

Data Availability Statement

The datasets generated and analysed during this study are not publicly available because they contain information obtained from school students and are subject to ethical and confidentiality restrictions. De-identified data may be made available by the corresponding author upon reasonable request, subject to approval from the relevant institution and compliance with applicable ethical and data-protection requirements.

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