Consumer Awareness and Perception of Food Safety Regarding Nitrate Content in Sugbusog Leafy Vegetables

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DOI: https://doi.org/10.68050/JAMS.2026.938

Received: 28 October 2026; Accepted: 02 November 2026; Published: 10 November 2026

ABSTRACT

This study assessed consumer awareness and perception of food safety related to nitrate content in Sugbusog leafy vegetables and served as the basis for a Food Safety Education Program. The study involved 80 respondents and examined their demographic profile, level of awareness regarding nitrate sources, health hazards, and safe handling and preparation methods, as well as their perception of vegetable safety, nitrate-related health risks, and institutional monitoring. The study also determined the relationships between demographic characteristics, consumer awareness, and consumer perception. Findings showed that the respondents were predominantly young adults, female, Junior High School graduates under the K–12 curriculum, and students. The respondents demonstrated an overall favorable level of awareness, with weighted means of 3.550 for nitrate source knowledge, 3.530 for knowledge of health hazards, and 3.581 for safe handling and preparation, all interpreted as Aware. Their perception was likewise positive, with weighted means of 3.8286 for vegetable safety, 3.8325 for perceived health risks, and 3.8153 for confidence in monitoring and institutional oversight. Gender and employment status were significantly related to selected dimensions and overall awareness, whereas age and educational attainment were not. No demographic characteristic was significantly related to overall perception. Moreover, all dimensions of awareness had significant positive relationships with all dimensions of perception. Overall awareness was significantly associated with overall perception ($r = .623$, $p = .000$), while safe handling and preparation knowledge showed the strongest relationship with overall perception ($r = .632$, $p = .000$). Based on these findings, a four-month Food Safety Education Program was proposed to strengthen consumer knowledge, safe practices, reliable information access, stakeholder collaboration, and nitrate monitoring.

Keywords: Consumer Awareness, Consumer Perception, Food Safety, Nitrate Content, Sugbusog Leafy Vegetables, Safe Handling, Nitrate Monitoring, Food Safety Education Program

1. INTRODUCTION

Leafy vegetables are widely consumed across international, national, and local contexts as staple components of daily diets, valued for their nutritional benefits yet scrutinized for potential nitrate and nitrite accumulation that can pose food safety concerns (Iammarino et al., 2022). Globally, evidence indicates that leafy greens tend to accumulate higher nitrate levels due to physiological and agronomic factors such as cultivar differences, nitrogen fertilization practices, and environmental conditions, which can influence consumer exposure through regular intake (Banach et al. 2019). In the Philippines, Mindanao's agricultural prominence and its role in supplying diverse vegetables to regional markets underscore the importance of monitoring such contaminants within local supply chains and school-based food programs. Within this regional frame, local schools and communities are increasingly attentive to how food safety information shapes consumer perceptions and behaviors, particularly regarding nitrate-related hazards associated with leafy vegetables commonly consumed at home and in school settings (Dodocioiu et al., 2025). These regional dynamics align with international and national literature that frames nitrate and nitrite presence in leafy vegetables as a critical public health concern due to potential adverse

health effects, especially among vulnerable groups, and the need for ongoing risk assessment and consumer education (Iammarino et al., 2022).

The current literature demonstrates a persistent gap in understanding consumer awareness and perception of nitrate content in leafy greens within specific local contexts, including school environments in the Philippines. Much of the existing work emphasizes analytical measurements of nitrate/nitrite in vegetables and risk assessment at broad scales, while comparatively fewer studies examine how consumers interpret nitrate-related information, trust food safety communications, or translate scientific findings into everyday dietary choices in school settings (Gräf et al. 2020). This study identifies a timeliness gap: as nitrate regulations and educational initiatives evolve, there is a pressing need to explore how students, parents, and educators perceive nitrate content in commonly consumed leafy vegetables, such as those offered in school meals or local markets, and how these perceptions shape consumption patterns and risk mitigation behaviors (Banach et al. 2019). At the same time, observed variability in nitrate accumulation across leafy vegetables, along with the influence of cultivation and preparation practices on nitrate levels, suggests an opportunity to pair consumer education with practical food safety education to support safer choices (Gräf et al. 2020).

The researcher of this study notes a specific research gap in the intersection of consumer awareness, perception, and local food safety considerations relating to nitrate content in leafy vegetables in a Philippine context. The topic is timely given ongoing global and national discourse on nitrate exposure from vegetables and the rising emphasis on Food Safety Education Programs in school settings to empower informed dietary decisions (Banach et al. 2019). The potential or actual problems addressed include the need to understand how knowledge about nitrate/nitrite risks translates into perceptions of leaf vegetable safety among students and guardians, and how this understanding can inform targeted information campaigns and curriculum design. By examining awareness and perception in the specific local environment of Cagayan National High School, this study seeks to generate evidence that can guide the development of culturally appropriate, age-relevant food safety messaging and actionable recommendations for school-based nutrition programs, ultimately contributing to safer consumption practices without compromising nutritional benefits (Iammarino et al., 2022).

Thus, Food Safety Education Program is proposed to address the identified gaps by integrating findings from nitrate-related literature with locally tailored consumer education strategies. The place of study is Cagayan National High School, where the implementation of a targeted education initiative can be piloted, evaluated, and refined to promote safer leafy vegetable consumption and to enhance awareness of nitrate and nitrite risks among students and their communities (Banach et al. 2019). The researcher of this study emphasizes that such a program would be grounded in established scientific evidence on nitrate occurrence in leafy vegetables, the health implications of nitrate and nitrite exposure, and best practices for effective risk communication within school populations (Dodocioiu et al. 2025). This integrated approach aims to bridge analytical toxicology and consumer education to support evidence-based decisions at the local level while contributing to broader understandings of how nitrate safety information is received and acted upon in school communities.

2. RESEARCH METHODOLOGY

2.1. Research Design

To comprehensively assess consumer awareness and perception of food safety related to nitrate content in Sugbusog leafy vegetables during the School Year 2026–2027, the researcher employed a descriptive-correlational research design. The descriptive component was used to determine the demographic profile of the respondents and their levels of awareness and perception regarding nitrate content, while the correlational component was used to determine the significant relationships between the respondents' demographic profile, awareness, and perception.

A carefully designed survey questionnaire featuring a 5-point Likert scale was administered to the consumer-respondents. The instrument gathered information on the respondents' demographic characteristics in terms of age, gender, educational level, and employment status. It also measured their level of awareness regarding nitrate content in Sugbusog leafy vegetables in terms of nitrate source knowledge, knowledge of health hazards related to nitrate intake, and knowledge of safe handling and preparation methods.

Furthermore, the questionnaire assessed the respondents' perception regarding nitrate content in Sugbusog leafy vegetables in terms of perception of vegetable safety, perceived health risks of nitrate exposure, and confidence in monitoring production and institutional oversight. The quantitative data obtained from the survey were analyzed statistically to determine whether significant relationships existed between the respondents' demographic profile and their levels of awareness and perception, as well as between awareness and perception regarding nitrate concentration.

The study also included items that identified the challenges encountered by consumers in understanding and managing food safety risks associated with nitrates. The findings from the descriptive and correlational analyses, together with the identified challenges, served as the basis for the development of a proposed Food Safety Education Program designed to enhance consumer understanding and management of nitrate-related food safety risks in Sugbusog leafy vegetables.

2.2. Environment

The study was conducted at Cagay National High School, a DepEd public secondary school in Barili, Cebu, Philippines. An active participant in the Sugbusog Program, the school utilizes a 20×30-meter agricultural plot to cultivate leafy vegetables for school feeding and community projects in partnership with DepEd and the Department of Agriculture.

Located in a rural farming community, the site offers direct access to students, teachers, parents, and residents who regularly grow, purchase, and consume green vegetables. This makes it an ideal setting to evaluate local awareness of nitrate levels in produce and to develop a targeted Food Safety Education Program.

2.3. Respondents

The respondents of this study consisted of 80 selected individuals from the community of Cagay National High School who were involved in or exposed to the consumption of Sugbusog leafy vegetables. They were categorized into three groups: employees, learners, and parents. Purposive sampling was employed to select respondents who were considered relevant to the study based on their familiarity with or experience in consuming leafy vegetables. Specifically, the respondents included 10 employees, 30 learners, and 40 parents, for a total of 80 respondents.

Table 1. Distribution of Respondents of the Study

Respondents	Frequency	Percentage
Employees	10	12.50
Learners	30	37.50
Parents	40	50.00
Total	80	100.00

Table 1 presents the distribution of the respondents according to their respective groups. Parents comprised the largest group, with 40 respondents or 50.00%, followed by learners, with 30 or 37.50%, and employees, with 10 or 12.50%. These respondents provided information relevant to assessing consumer awareness and perceptions regarding food safety related to nitrate content in Sugbusog leafy vegetables.

2.4. Instruments

The study utilized a researcher-developed survey questionnaire to evaluate consumer awareness and perceptions of food safety regarding nitrate levels in Sugbusog leafy vegetables. To ensure instrument quality, it underwent expert content and language validation, pilot testing for clarity, and reliability testing using Cronbach's alpha.

Structured into four sections, the questionnaire collected respondents' demographic profiles in Part I, assessed awareness of nitrate sources, health hazards, and safe preparation in Part II, evaluated perceptions of vegetable safety and institutional oversight in Part III, and identified key challenges consumers face in understanding and managing nitrate-related food safety risks in Part IV.

2.5. Data Gathering Procedure

To obtain permission to conduct the study, the researcher sent a formal transmittal letter to the School Head of Cagay National High School. Upon approval, the researcher administered the researcher-developed survey questionnaire to the identified consumer-respondents. The respondents were provided with appropriate instructions regarding the purpose of the study and the manner of answering the questionnaire. The data-gathering process was conducted during the School Year 2026–2027. After the completed questionnaires were retrieved, the researcher checked, tallied, coded, and tabulated the responses. The collected data were then encoded and processed using the Statistical Package for the Social Sciences (SPSS) for statistical analysis and interpretation.

2.6. Statistical Treatment

To analyze the gathered data, frequencies and percentages were first used to describe the respondents' demographic profile across age, gender, educational level, and employment status. The overall level and variability of consumer awareness and perception regarding nitrate content in Sugbusog leafy vegetables were measured using the weighted mean and standard deviation. For relational and comparative analyses where, parametric assumptions were not met, non-parametric tests were applied: The Spearman rank-order correlation coefficient assessed the relationship between awareness, perception, and ordinal demographics, while the Mann-Whitney U and Kruskal-Wallis H tests evaluated significant differences in awareness and perception across two-category and multi-category demographic groups, respectively.

2.7. Scoring Procedure

A five-point Likert scale was used to interpret the weighted mean of the responses concerning the consumers' level of awareness and perception regarding nitrate content in Sugbusog leafy vegetables. The following mean ranges were used for interpretation:

Table 2. Scoring Procedure for Consumer Awareness and Perception Level

Mean Range	Consumer Awareness Level	Consumer Perception Level
4.21–5.00	Very High Awareness	Very Positive Perception
3.41–4.20	High Awareness	Positive Perception
2.61–3.40	Moderate Awareness	Moderately Positive Perception
1.81–2.60	Low Awareness	Negative Perception
1.00–1.80	Very Low Awareness	Very Negative Perception

The scoring procedure provided a consistent basis for interpreting the respondents' levels of awareness and perception regarding nitrate content and food safety risks associated with Sugbusog leafy vegetables. The resulting interpretations, together with the identified consumer challenges, were used as the basis for developing the proposed Food Safety Education Program.

3. RESULTS AND DISCUSSION

3.1. Demographic Profile of the Respondents

This section presents the demographic profile of the 80 respondents in terms of age, gender, educational level, and employment status. These variables were examined to describe the respondents' backgrounds and provide a clearer understanding of the characteristics of the individuals who participated in the study. The distribution of respondents across these categories provides context for interpreting their awareness and perceptions regarding food safety related to nitrate content in Sugbusog leafy vegetables.

3.1.1. Age of the Respondents

Table 3. Age of the Respondents.

Age	Frequency	Percentage
18–27 years old	40	50.00
28–37 years old	12	15.00
38–47 years old	14	17.50
48–57 years old	10	12.50
58 years old and above	4	5.00
Total	80	100.00

Table 3 shows that among the 80 respondents, 40 or 50.0% were 18–27 years old, representing the largest group. This was followed by those aged 38–47 years old with 14 or 17.5%, 28–37 years old with 12 or 15.0%, and 48–57 years old with 10 or 12.5%. The smallest group consisted of respondents aged 58 years old and above, with 4 or 5.0%.

It implies that the respondents were predominantly young adults aged 18–27 years old, while respondents aged 58 years old and above comprised the smallest proportion. This age distribution provided varied perspectives across different age groups while indicating stronger representation from younger respondents.

This aligns with the study of Nurhidayati et al., whose food safety survey of 551 Indonesian adults also drew its largest age group from young adults aged 18–25 years (41.2%). The strong representation of young adults here (50.00% aged 18–27) is consistent with such consumer surveys. It also matters because that study noted younger consumers tend to have less food safety knowledge and information than older adults.

3.1.2. Gender Profile of the Respondents

Table 4. Gender Profile of the Respondents

Gender	Frequency	Percentage
Male	18	22.50
Female	60	75.00
Prefer not to say	1	1.30

Others	1	1.30
Total	80	100.00

Table 4 shows that the majority of the respondents were female, with 60 respondents or 75.0% of the total sample. This was followed by male respondents, with 18 or 22.5%. Meanwhile, one respondent or 1.3% preferred not to disclose their gender, and another one or 1.3% identified under other gender categories.

It implies that the respondents were predominantly female, indicating that their responses constituted the largest representation in the study. The inclusion of male, prefer-not-to-say, and other respondents also reflected diversity in the gender composition of the participants.

This aligns with the study of Putri et al. (2024), who reported that women dominated their sample of vegetable consumers and attributed this to women's larger role in household purchasing decisions for staples, including vegetables. The 75.0% female share in this study likely reflects the same pattern, since women are often the main buyers of fresh vegetables and so are well placed to speak on their safety.

3.1.2. Educational Level of the Respondents

Table 5. Educational Level of the Respondents

Educational Level	Frequency	Percentage
College Graduate	8	10.00
Postgraduate Studies	4	5.00
Elementary Level	4	5.00
Elementary Graduate	6	7.50
High School Level (Old Curriculum)	8	10.00
High School Graduate (Old Curriculum)	12	15.00
Junior High School Graduate (K-12)	20	25.00
Senior High School Graduate (K-12)	13	16.30
Technical/Vocational Course	2	2.50
College Level/Undergraduate	3	3.80
Total	80	100.00

Table 5 shows that the largest proportion of respondents were Junior High School Graduates (K-12), with 20 or 25.0% of the total respondents. This was followed by Senior High School Graduates (K-12) with 13 or 16.3%, and High School Graduates under the Old Curriculum with 12 or 15.0%. College Graduates accounted for 8 or 10.0%, while respondents with a High School Level under the Old Curriculum comprised 8 or 10.0%. The smallest proportion consisted of respondents who completed a Technical/Vocational Course, with 2 or 2.5%.

It implies that most respondents had attained secondary-level education, particularly Junior High School or Senior High School, indicating that the respondents generally had basic to intermediate educational backgrounds that could influence their understanding, participation, and responses concerning the subject of the study.

This aligns with the study of Swinehart and Feng, who found that consumers with an associate degree or lower had lower food safety knowledge and risk perception than those with higher education. Because most respondents here finished only junior or senior high school, their understanding of nitrate-related food safety may likewise be basic to intermediate. This is why awareness-building and information campaigns suit this group.

3.1.3. Employment Status of the Respondents

Table 6. Employment Status of the Respondents

Employment Status	Frequency	Percentage
Student	36	45.00
Government Employee	11	13.80
Private Sector Employee	2	2.50
Self-Employed	1	1.30
Farmer/Agricultural Worker/Fisherfolk	2	2.50
Homemaker/Stay-at-Home Parent	21	26.30
Unemployed	7	8.80
Total	80	100.00

Table 6 shows that among the 80 respondents, the largest group consisted of students, with 36 respondents or 45.0%. This was followed by homemakers or stay-at-home parents, with 21 respondents or 26.3%, and government employees, with 11 respondents or 13.8%. Meanwhile, 7 respondents or 8.8% were unemployed. Private sector employees and farmer/agricultural workers/fisherfolk each accounted for 2 respondents or 2.5%, while only 1 respondent or 1.3% was self-employed.

It implies that the respondents were predominantly students and homemakers/stay-at-home parents, indicating that these groups constituted the major employment-status categories represented in the study.

This aligns with the study of Gkana and Nychas (2017), who surveyed Greek consumers across employment categories (students, public servants, private employees, homemakers, the unemployed and the self-employed). They found that homemakers had deficiencies in food safety knowledge and that students reported a higher incidence of foodborne illness. The predominance of students and homemakers among the respondents is therefore relevant, because these groups are the ones most likely to need food safety awareness efforts.

3.2. Level of Consumer Awareness Regarding Nitrate Content In Sugbusog Leafy Vegetables

This section presents the level of consumer awareness regarding nitrate content in Sugbusog leafy vegetables. It covers the respondents' knowledge of nitrate sources, knowledge of health hazards related to nitrate intake, and knowledge of safe handling and preparation methods. The findings describe the extent to which consumers recognized the sources, potential health risks, and appropriate food-safety practices associated with nitrate-containing leafy vegetables.

Table 7. Nitrate Source Knowledge

Statements	Weighted Mean	Standard Deviation	Verbal Interpretation
Leafy vegetables naturally contain nitrates.	3.575	1.134	Moderately Aware
Agricultural fertilizers contribute nitrates to leafy vegetables.	3.613	0.961	Moderately Aware
Excessive fertilizer application increases nitrate levels in vegetables.	3.55	1.09	Moderately Aware
Soil conditions affect the nitrate absorption of leafy vegetables.	3.55	1.124	Moderately Aware
Irrigation practices influence nitrate levels in leafy vegetables.	3.575	1.156	Moderately Aware
Sunlight exposure influences nitrate accumulation in plants.	3.488	1.191	Moderately Aware
Harvesting time (morning vs. afternoon) affects crop nitrate concentration.	3.5	1.191	Moderately Aware
Overall Weighted Mean	3.55		Moderately Aware

Table 7 shows that the respondents were generally Moderately Aware of the sources and environmental factors associated with nitrate content in Sugbusog leafy vegetables, as indicated by the overall weighted mean of 3.550. The highest weighted mean was obtained for the statement that agricultural fertilizers contribute nitrates to leafy vegetables (WM = 3.613, SD = 0.961), followed by the statements that leafy vegetables naturally contain nitrates and that irrigation practices influence nitrate levels in leafy vegetables (both WM = 3.575). The lowest weighted mean was recorded for the statement that sunlight exposure influences nitrate accumulation in plants (WM = 3.488, SD = 1.191). Despite having the lowest mean, the item remained within the Moderately Aware category.

It implies that the respondents demonstrated substantial knowledge of the natural occurrence of nitrates and the agricultural and environmental factors that may influence nitrate accumulation in leafy vegetables. However, their awareness had not yet reached the Extremely Aware level, indicating the need to further strengthen consumer education regarding fertilizer application, soil conditions, irrigation practices, sunlight exposure, and harvesting time as factors affecting nitrate concentration.

This aligns with the study of Bian et al. (2020), who reported that nitrate accumulation in leafy vegetables is regulated by fertilizer or nutrient management and by environmental factors such as light. They also noted that harvesting at the end of the light period is recommended to produce vegetables with lower nitrate concentration. The fertilizer, sunlight, and harvest-time factors in Table 7 are therefore scientifically sound, so the respondents' only moderate awareness of them supports the need for stronger consumer education.

Table 8. Knowledge of Health Hazards Related to Nitrate Intake

Statements	Weighted Mean	Standard Deviation	Verbal Interpretation
Excessive dietary nitrate intake poses human health risks.	3.45	1.179	Moderately Aware

Infants are particularly vulnerable to high nitrate exposure.	3.35	1.104	Somewhat Aware
Prolonged exposure to high nitrate levels causes long-term adverse health effects.	3.61	1.119	Moderately Aware
Crop nitrate concentration represents a significant food safety concern.	3.56	1.157	Moderately Aware
Routine monitoring of crop nitrate levels protects consumers from health risks.	3.66	1.124	Moderately Aware
Overall Weighted Mean	3.53		Moderately Aware

Table 8 shows that the respondents were generally Moderately Aware of the health hazards and food-safety concerns associated with nitrate intake, as reflected by the overall weighted mean of 3.530. The highest weighted mean was recorded for the statement that routine monitoring of crop nitrate levels protects consumers from health risks (WM = 3.660, SD = 1.124), followed by the statement that prolonged exposure to high nitrate levels causes long-term adverse health effects (WM = 3.610, SD = 1.119). The lowest weighted mean was obtained for the statement that infants are particularly vulnerable to high nitrate exposure (WM = 3.350, SD = 1.104), which fell under the Somewhat Aware category.

It implies that the respondents possessed substantial knowledge regarding the potential health risks associated with excessive and prolonged nitrate exposure, particularly the importance of monitoring nitrate levels in crops. However, the Somewhat Aware rating concerning the vulnerability of infants suggests a specific knowledge gap that should be addressed through targeted food-safety education. Strengthening awareness of vulnerable population groups may help consumers make more informed decisions regarding the preparation and consumption of nitrate-containing leafy vegetables.

This aligns with the study of Shaban et al. (2023), who reported that infants are more vulnerable to nitrate because of their lower methemoglobin reductase levels, and that nitrate-rich vegetables and drinking water raised methemoglobin levels in infants. This supports the respondents' recognition of long-term nitrate risks, and it shows why their lower "Somewhat Aware" rating on infant vulnerability is a knowledge gap that targeted food-safety education should address.

Table 9. Knowledge of Safe Handling and Preparation Methods

Statements	Weighted Mean	Standard Deviation	Verbal Interpretation
Thorough washing reduces surface residues on leafy vegetables.	3.663	1.078	Moderately Aware
Cooking or blanching leafy vegetables reduces their nitrate concentration.	3.55	1.101	Moderately Aware
Trimming stems and outer leaves lowers total nitrate content in vegetables.	3.475	1.079	Moderately Aware
Purchasing produce from certified food-safe vendors reduces health risks.	3.613	1.037	Moderately Aware

Proper refrigeration prevents nitrate accumulation in cooked or stored leafy vegetables.	3.513	1.031	Moderately Aware
Proper storage techniques maintain the fresh quality of leafy vegetables.	3.613	1	Moderately Aware
Reliable information sources specify safe daily consumption limits for leafy vegetables.	3.575	1.111	Moderately Aware
Official government sources provide guidelines regarding the safe handling of leafy vegetables.	3.65	0.956	Moderately Aware
Overall Weighted Mean	3.581		Moderately Aware

Table 9 shows that the respondents were generally Moderately Aware of safe handling and preparation practices related to nitrate-containing leafy vegetables, as indicated by the overall weighted mean of 3.581. The highest weighted mean was obtained for the statement that thorough washing reduces surface residues on leafy vegetables (WM = 3.663, SD = 1.078), followed by the statement that official government sources provide guidelines regarding the safe handling of leafy vegetables (WM = 3.650, SD = 0.956). The lowest weighted mean was recorded for trimming stems and outer leaves to lower total nitrate content in vegetables (WM = 3.475, SD = 1.079). Nevertheless, all the statements were within the Moderately Aware category.

It implies that the respondents demonstrated substantial knowledge of appropriate handling, preparation, storage, and information-seeking practices related to nitrate-containing leafy vegetables. Their awareness of these practices provides a foundation for safer food preparation and consumption. However, since the overall awareness remained at the Moderately Aware level rather than Extremely Aware, continuous food-safety education is necessary to further enhance consumers' knowledge and encourage the consistent application of appropriate practices in washing, preparing, storing, and selecting leafy vegetables.

This aligns with the study of Luetic et al. (2023), who reported that washing and soaking leafy vegetables lowers nitrate levels by about 10–15% and that cooking lowers them by about 30–40%. The respondents' moderate awareness of washing and cooking therefore matches scientifically supported practices, which supports the need for continued food-safety education so that consumers apply these methods consistently.

3.3. Level of Consumer Perception Regarding Nitrate Content in Sugbusog Leafy Vegetables

This section presents the level of consumer perception regarding nitrate content in Sugbusog leafy vegetables. It covers the respondents' perceptions of vegetable safety, perceived health risks of nitrate exposure, and confidence in monitoring production and institutional oversight. The results provide an overall assessment of how consumers view the safety of Sugbusog leafy vegetables and the measures implemented to manage potential nitrate-related food safety risks.

Table 10. Perception of Vegetable Safety

Statements	Weighted Mean	Standard Deviation	Verbal Interpretation
Sugbusog leafy vegetables are safe for daily consumption.	4.0125	0.9345	Agree

Leafy vegetables produced by local farmers meet consumer safety standards.	3.925	0.9517	Agree
Leafy vegetables sold in local public markets are safe to consume.	3.55	0.9264	Agree
Sugbusog leafy vegetables maintain safe chemical residue levels.	3.75	0.9744	Agree
Sugbusog leafy vegetables maintain acceptable physical quality.	3.8375	0.9993	Agree
Sugbusog leafy vegetables maintain acceptable freshness.	3.875	0.9596	Agree
The nutritional benefits of eating leafy vegetables outweigh potential risks associated with nitrate content.	3.85	0.9154	Agree
Overall Weighted Mean	3.8286		Agree

Table 10 shows that all seven statements obtained a verbal interpretation of Agree, with weighted means ranging from 3.5500 to 4.0125. The highest weighted mean was recorded for the statement that *Sugbusog leafy vegetables are safe for daily consumption* (WM = 4.0125, SD = 0.9345), while the lowest was obtained for the statement that *leafy vegetables sold in local public markets are safe to consume* (WM = 3.5500, SD = 0.9264). The overall weighted mean of 3.8286 indicates that the respondents generally agreed that Sugbusog leafy vegetables possess acceptable food safety and quality characteristics despite potential concerns related to nitrate content.

It implies that the respondents generally perceived Sugbusog leafy vegetables as safe and acceptable for consumption, particularly in terms of daily consumption, physical quality, freshness, chemical residue levels, and nutritional benefits. This positive perception indicates the need to sustain proper food safety practices while strengthening consumer education on nitrate-related risks and safe handling and production practices.

This aligns with the study of Simoglou and Roditakis (2022), who found that consumers recognize the benefits of pesticide use for food production yet still express concern about residues in food. They concluded that risk communication is needed to address food safety issues, which parallels this study's call to strengthen consumer education on nitrate-related risks.

Table 11. Perceived Health Risks of Nitrate Exposure.

Statements	Weighted Mean	Standard Deviation	Verbal Interpretation
The presence of high nitrate levels in leafy vegetables presents a significant health hazard.	3.8	0.9332	Agree
Excessive intake of dietary nitrates results in adverse human health effects.	3.8375	0.9473	Agree

Nitrate content is a primary food safety indicator when selecting leafy vegetables.	3.8	0.9332	Agree
Public disclosure of health risks related to nitrate exposure is necessary for consumer safety.	3.75	0.9613	Agree
Consumer access to nitrate risk information leads to safer food purchasing decisions.	3.975	0.9675	Agree
Overall Weighted Mean	3.8325		Agree

Table 11 shows that the respondents generally agreed with the statements concerning the health risks and food-safety implications associated with nitrate content in leafy vegetables, as indicated by the overall weighted mean of 3.8325. Among the indicators, the statement that consumer access to nitrate risk information leads to safer food purchasing decisions obtained the highest weighted mean of 3.9750, while the statement regarding the necessity of publicly disclosing health risks related to nitrate exposure obtained the lowest weighted mean of 3.7500. The standard deviations, ranging from 0.9332 to 0.9675, indicate relatively moderate variation in the respondents' perceptions.

It implies that the respondents generally recognized the potential health concerns associated with nitrate exposure and acknowledged the importance of providing consumers with accessible and understandable nitrate-related food-safety information to support safer purchasing decisions.

This aligns with the study of Ssemugabo et al.(2023), who found that consumers were aware of pesticide residues in fruits and vegetables and believed these residues put their health at risk. This is consistent with the respondents' agreement that high nitrate levels are a health hazard. Likewise, Suk and Nam found that consumers' perception of food labeling was linked to buying safety-labeled food, which supports the respondents' view that access to risk information leads to safer purchasing decisions.

Table 12. Confidence in Monitoring Production and Institutional Oversight

Statements	Weighted Mean	Standard Deviation	Verbal Interpretation
I trust government and food safety agencies to monitor the safety of vegetables.	3.8875	0.9139	Agree
Public health agencies adequately enforce food safety standards in vegetable retail markets.	3.75	0.893	Agree
Government agricultural agencies effectively monitor nitrate levels during crop production.	3.625	0.9596	Agree
Local farmers effectively regulate crop nitrate levels through good agricultural practices.	3.7375	0.9513	Agree
Commercial vegetable production undergoes sufficient institutional oversight for food safety.	3.725	0.9933	Agree
Laboratory testing provides accurate data regarding vegetable nitrate concentration.	3.7625	1.0094	Agree

Cooperation between local farmers and government agencies enhances vegetable safety.	3.9125	0.9961	Agree
Direct collaboration between local farmers and consumers improves vegetable safety.	3.9625	0.9736	Agree
Active communication between government food safety agencies and consumers strengthens vegetable safety.	3.975	1.0789	Agree
Overall Weighted Mean	3.8153		Agree

Table 12 shows that the respondents generally agreed that institutional oversight, government monitoring, laboratory testing, farmer practices, and collaboration among farmers, government agencies, and consumers contributed to vegetable food safety, as indicated by the overall weighted mean of 3.8153. The highest-rated statement was that active communication between government food safety agencies and consumers strengthened vegetable safety (WM = 3.9750), followed by the statement that direct collaboration between local farmers and consumers improved vegetable safety (WM = 3.9625). The lowest-rated statement was that government agricultural agencies effectively monitored nitrate levels during crop production (WM = 3.6250), although it still received an interpretation of Agree.

It implies that respondents recognized the importance of coordinated institutional oversight and communication in maintaining vegetable food safety, particularly through active interaction among government agencies, farmers, and consumers. It further suggests that strengthening government monitoring of nitrate levels during crop production could enhance public confidence and improve the overall management of food-safety risks related to nitrate content.

This aligns with the study of Wang et al. (2021), who found that consumers' trust in government, certification organizations, producers, and retailers was positively related to their perception of food safety for fresh food. The respondents' agreement that government monitoring, farmer practices, and collaboration among farmers, agencies, and consumers make vegetables safer fits this finding.

3.4. Relationship Between Respondents' Demographic Profile and their Awareness and Perception of Nitrate Content

This section presents the significant relationships between the respondents' demographic profile and their level of awareness and perception regarding nitrate content in Sugbusog leafy vegetables. It examines whether age, gender, highest educational attainment, and employment status were significantly associated with the respondents' knowledge of nitrate sources, health hazards, safe handling and preparation methods, perception of vegetable safety, perceived health risks, confidence in monitoring production and institutional oversight, and overall awareness and perception. The results provide a basis for determining whether demographic characteristics should be considered in developing food safety education and information initiatives.

Table 13. Significant Relationship Between the Demographic Profile of the Respondents and their Level of Awareness.

Variables	Nitrate Source Knowledge	Knowledge of Health Hazards Related to Nitrate Intake	Knowledge of Safe Handling and Preparation Methods	Level of Awareness
Age	-0.203	-0.136	-0.126	-0.176
	0.072	0.23	0.266	0.118

Gender	-.297**	-.299**	-0.195	-.288**
	0.007	0.007	0.083	0.009
Highest Educational Attainment	0.088	0.101	0.05	0.101
	0.439	0.371	0.657	0.374
Employment Status	-.242*	-0.161	-0.191	-.221*
	0.03	0.153	0.09	0.048

Table 13 shows the significant relationship between the demographic profile of the respondents and their level of awareness regarding nitrate content in Sugbusog leafy vegetables. The results indicate that age had no significant relationship with nitrate source knowledge (r = -0.203, p = 0.072), knowledge of health hazards related to nitrate intake (r = -0.136, p = 0.230), knowledge of safe handling and preparation methods (r = -0.126, p = 0.266), and overall level of awareness (r = -0.176, p = 0.118), since all p-values were greater than 0.05. Gender had significant negative relationships with nitrate source knowledge (r = -0.297, p = 0.007), knowledge of health hazards (r = -0.299, p = 0.007), and overall level of awareness (r = -0.288, p = 0.009), but had no significant relationship with knowledge of safe handling and preparation methods (r = -0.195, p = 0.083). Highest educational attainment showed no significant relationship with any dimension of awareness, as all p-values exceeded 0.05. Meanwhile, employment status had a significant negative relationship with nitrate source knowledge (r = -0.242, p = 0.030) and overall level of awareness (r = -0.221, p = 0.048), but had no significant relationship with knowledge of health hazards or safe handling and preparation methods.

It implies that respondents' gender and employment status were associated with their overall level of awareness regarding nitrate-related food safety, while age and highest educational attainment were not significant factors. The findings suggest that awareness may vary according to gender and employment-related circumstances, particularly in understanding nitrate sources and general food-safety concerns. Therefore, food safety education initiatives should give particular attention to groups that demonstrate lower awareness and should provide accessible information on nitrate sources, health hazards, and safe handling and preparation practices.

This aligns with the study of Choudhury et al. (2026), whose scoping review of urban consumers in low- and lower-middle-income countries found that gender and employment status were significantly associated with food safety knowledge, while several studies found no link between food safety outcomes and age or education. These mixed findings match the present results, where gender and employment status were related to awareness of nitrate-related food safety but age and highest educational attainment were not.

Table 14. Significant Relationship Between the Demographic Profile of The Respondents and their Level of Perception Regarding Nitrate Content

Variables	Perception of Vegetable Safety	Perceived Health Risks of Nitrate Exposure	Confidence in Monitoring Production and Institutional Oversight	Level of Perception Regarding Nitrate Content
Age	.030	.026	.045	.033
	.795	.822	.691	.771
Gender	-.059	-.120	-.042	-.094
	.601	.289	.710	.409

Highest Educational Attainment	.123	-.039	.140	.074
	.278	.729	.216	.514
Employment Status	.005	.010	-.052	-.022
	.965	.928	.648	.844

Table 14 shows that there was no significant relationship between the respondents' demographic profile and their level of perception regarding nitrate content. Age had no significant relationship with perception of vegetable safety (r = .030, p = .795), perceived health risks of nitrate exposure (r = .026, p = .822), confidence in monitoring production and institutional oversight (r = .045, p = .691), and the overall level of perception regarding nitrate content (r = .033, p = .771). Similarly, gender was not significantly related to perception of vegetable safety (r = -.059, p = .601), perceived health risks (r = -.120, p = .289), confidence in monitoring production and institutional oversight (r = -.042, p = .710), or overall perception (r = -.094, p = .409). Highest educational attainment also showed no significant relationship with any perception dimension, with p-values ranging from .216 to .729. Employment status likewise had no significant relationship with perception of vegetable safety, perceived health risks, confidence in monitoring production and institutional oversight, or the overall level of perception, as indicated by p-values of .965, .928, .648, and .844, respectively. Since all p-values were greater than the .05 level of significance, the null hypothesis was accepted.

It implies that the respondents' perceptions regarding nitrate content in Sugbusog leafy vegetables were not significantly influenced by their age, gender, highest educational attainment, or employment status. This suggests that perceptions of vegetable safety, health risks associated with nitrate exposure, confidence in monitoring production and institutional oversight, and overall nitrate-related perception were generally consistent across different demographic groups. Therefore, food safety education and information campaigns may be designed to address the respondents as a general group rather than relying heavily on demographic characteristics as bases for differentiating perception-related interventions.

This aligns with the study of Sekabojja et al. (2021), who found that education level, gender, and age group were not associated with consumers' risk perception of pesticide-stained tomatoes in Uganda. That result matches the finding here that age, gender, educational attainment, and employment status did not significantly relate to perception of nitrate content in Sugbusog leafy vegetables.

3.5. Significant Relationship Between the Consumers' Level of Awareness and their Level of Perception Regarding Nitrate Concentration in Sugbusog Leafy Vegetables

This section presents the significant relationship between the consumers' level of awareness and their level of perception regarding nitrate concentration in Sugbusog leafy vegetables. It examines the associations between knowledge of nitrate sources, knowledge of health hazards related to nitrate intake, knowledge of safe handling and preparation methods, and the overall level of awareness with perceptions of vegetable safety, perceived health risks of nitrate exposure, confidence in monitoring production and institutional oversight, and the overall level of perception regarding nitrate content.

Table 15. Significant Relationship Between the Consumers' Level of Awareness and their Level of Perception Regarding Nitrate Concentration in Sugbusog Leafy Vegetables

Variables	Perception of Vegetable Safety	Perceived Health Risks of Nitrate Exposure	Confidence in Monitoring Production and Institutional Oversight	Level of Perception Regarding Nitrate Content
nitrate source knowledge	.486**	.559**	.457**	.556**

	.000	.000	.000	.000
knowledge of health hazards related to nitrate intake	.446**	.513**	.510**	.542**
	.000	.000	.000	.000
knowledge of safe handling and preparation methods	.517**	.556**	.621**	.632**
	.000	.000	.000	.000
level of awareness	.522**	.592**	.569**	.623**
	.000	.000	.000	.000

Table 15 shows that there was a significant positive relationship between all dimensions of the consumers' level of awareness and all dimensions of their level of perception regarding nitrate concentration in Sugbusog leafy vegetables. Nitrate source knowledge had significant positive relationships with perception of vegetable safety ($r = .486$, $p = .000$), perceived health risks of nitrate exposure ($r = .559$, $p = .000$), confidence in monitoring production and institutional oversight ($r = .457$, $p = .000$), and overall perception regarding nitrate content ($r = .556$, $p = .000$). Knowledge of health hazards related to nitrate intake also had significant positive relationships with perception of vegetable safety ($r = .446$, $p = .000$), perceived health risks ($r = .513$, $p = .000$), confidence in monitoring production and institutional oversight ($r = .510$, $p = .000$), and overall perception ($r = .542$, $p = .000$). Similarly, knowledge of safe handling and preparation methods was significantly and positively related to perception of vegetable safety ($r = .517$, $p = .000$), perceived health risks ($r = .556$, $p = .000$), confidence in monitoring production and institutional oversight ($r = .621$, $p = .000$), and overall perception ($r = .632$, $p = .000$). Overall level of awareness showed significant positive relationships with perception of vegetable safety ($r = .522$, $p = .000$), perceived health risks ($r = .592$, $p = .000$), confidence in monitoring production and institutional oversight ($r = .569$, $p = .000$), and overall level of perception ($r = .623$, $p = .000$). Since all p-values were less than .05, the null hypothesis was rejected.

It implies that higher levels of awareness regarding nitrate sources, health hazards, and safe handling and preparation methods were associated with more favorable and informed perceptions regarding nitrate concentration in Sugbusog leafy vegetables. The strongest relationship was between safe handling and preparation knowledge and overall perception regarding nitrate content ($r = .632$), indicating that practical food-safety knowledge was particularly associated with consumers' perceptions. The findings emphasize the importance of strengthening consumers' knowledge because improved awareness may be accompanied by more informed perceptions of vegetable safety, health risks, and production and institutional monitoring.

This aligns with the study of Ishra et al., who found that consumers' food safety knowledge was significantly and positively correlated with their perception of food safety risk ($r = .302$, $p < .01$). This supports the present finding that greater awareness of nitrate sources, health hazards, and safe handling and preparation goes with more informed perceptions of vegetable safety. The correlations here ($r = .446$ to $.632$) are stronger than the one Ishra et al. reported.

4. CONCLUSION

The respondents were predominantly young adult females with secondary-level education, primarily comprising students and stay-at-home parents. Overall, they demonstrated a favorable level of awareness regarding nitrate sources, health hazards, and safe preparation practices, alongside positive perceptions regarding the safety and institutional oversight of Sugbusog leafy vegetables. While gender and employment status were significantly associated with awareness levels—unlike age and educational background—no demographic factor significantly affected overall safety perceptions. Crucially, a significant positive correlation was established between awareness and perception, indicating that higher consumer knowledge directly leads to stronger, more informed food safety perceptions.

ACKNOWLEDGEMENT

The authors extend their sincere gratitude to the Public Schools District I Supervisor (PSDS) of Barili Cebu and the School Principal of Cagay National School for granting administrative approval and facilitating the research process. The authors also acknowledge the institutional support provided by the Department of Education - Division of Cebu Province and Cebu Technological University – Barili Campus. This research received no specific grant or external financial funding from public, commercial, or non-profit agencies, and no study sponsors were involved in the study design, data collection, statistical analysis, interpretation, or manuscript preparation.

Competing interests

Authors have declared that no competing interests exist.

Authors' Contributions

Norinyl A. Malazarte conceptualized the study, performed the statistical analysis, formulated the research protocol, and wrote the initial draft of the manuscript. Author Janeth L. Lacostales provided methodological oversight and guided the conceptual framework of the learning retention enhancement program. Authors Ruth Nemeño Cedeño, Katrin Mae I. Dantes, Vicar R. Antiquina, Earl M. Alterado, and Danilo L. Libradilla managed the literature review, instrument validation, and data collection procedures. All authors read and approved the final manuscript.

Ethical Approval

The study adhered to strict ethical principles to protect participant welfare, rights, and anonymity. Prior to data collection, authorization was obtained from school administration. Informed consent was secured for adult respondents, while parental consent and minor assent were obtained for participants under 18, with participation remaining entirely voluntary and free of penalty for withdrawal. Confidentiality was strictly maintained by anonymizing responses and using data exclusively for academic purposes. Furthermore, the researchers ensured scientific integrity, objectivity, and respect throughout the research process, utilizing the findings fairly to inform a proposed Food Safety Education Program

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