International Journal of Food Science and Nutrition
www.foodsciencejournal.com
ISSN: 2455-4898
Received: 08-02-2025, Accepted: 09-03-2025, Published: 24-03-2025
Volume 10, Issue 2, 2025, Page No. 41-45

Sensory characteristics, nutrient content, and microbial load of Tocino-flavored rice eel (*Monopterus albus*) flavored with different fruit extracts

Halem Karenez Y Ladipe[1*], Isagani P Angeles Jr[1], Arjay B Pataueg[2], Marites R Castro[1], Mary Joy L Asprec[1]
[1] Provincial Institute of Fisheries, Isabela State University, Matusalem, Roxas, Isabela, Philippines
[2] Department of Agriculture-Bureau of Fisheries and Aquatic Resources, Tuguegarao City, Cagayan, Philippines
[3] Department of Fisheries and Aquatic Sciences, Cavite State University, Naic, Cavite, Philippines

Abstract
This study aimed to develop and assess the acceptability, nutrient content, and microbial load levels of tocinoflavored fish enhanced with different fruit extracts. Four experimental tocino-flavored fish were formulated to contain *O. niloticus* + 0%fruit extract (C_0), *M. albus* + 2.34% Philippine lime (T_1), *M. albus* + 2.34% Lemon (T_2), and *M. albus* + 2.34% Orange (T_3). Sensory attributes such as appearance, texture, color, aroma, taste, and acceptability of the formulated product were evaluated using the acceptability composite index (ACI) and a 9-point hedonic scale. Proximate composition, nutrient content, and microbial load were also analyzed. For sensory attributes, results show that all treatments were perceived as "liked very much". Nutrient analysis revealed that T_3 contained the highest amount of protein (30%) and energy (160kcal), followed by T_2 (29% protein, 130kcal), T_1 (28% protein, 106kcal), and C_0 (26% protein, 152kcal), respectively. All treatment groups showed acceptable limits of microbial levels ($<10^6$ cfu/g) until 32 days of storage. Generally, this study underscores the potential of tocinoflavored *M. albus* enhanced with different fruit extracts as an adequate and nutritious source of protein-rich food.

Keywords: Rice eel, *Monopterus albus*, nutrient analysis, value-added products, Philippines

Introduction

Rice eel (*M. albus*), or the rice field eel or swamp eel, are small freshwater fish found in ponds, lakes, rice fields, ditches, and other shallow bodies of water [42]. *M. albus* is a commercially significant air-breathing fish from the Synbranchidae family. Its natural habitat encompasses tropical, subtropical, and temperate climates, but it is frequently found in East and Southeast Asia, where people widely trade it [28, 12]. There is a large market for *M. albus* in some countries, such as China, Hong Kong, Japan, and the United States, where it is utilized as food and for medicinal purposes [21].

M. albus was brought to the Philippines in 1905 for aquaculture. However, the negative impact of this invasive species on the agriculture and aquaculture sector has not been considered [24]. This species destroys fish and rice farms by boring holes into the rice paddies and pond dikes, causing significant water loss and damage [20]. Some interventions have been made to control the proliferation of *M. albus* in ponds and rice paddies. During the peak infestation of the *M. albus*, the fisherfolk caught this species and turned them into an export-quality commodity. The Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR) has aimed at increasing the utilization of *M. albus* as an alternative nutritious food by turning the fish flesh into a favorable value-added products [26] such as sausages, burger patties, crispy chicharron spring rolls, nuggets, and smoked eels [30, 36]. Several post-harvest studies are continuously being conducted to develop valueadded products from *M. albus* and therefore increase its utilization.

Fruits and their juices are among the most essential foods for humans since they promote excellent health and replenish nutrient losses in the body. Several food industries use fruits to enhance food products' nutritional quality and acceptability [8]. Philippine lime (*Citrofortunella macrocarpa*), orange (*Citrus sinensis*), and lemon (*Citrus Limon*) are some of the popularly known nutrient-dense foods because these are rich in vitamins, minerals, and phytochemicals that are helpful to health [39]. Due to their scent, sugar, acidity, antioxidant, and antimicrobial properties, these fruits are utilized in dishes as natural flavoring agents or as a food additive in various food formulations and confectionaries [27], as a seasoning in food [31], or as a condiment in food to accentuate flavors on fish dishes [37].

Hence, this study aimed at developing a nutrientdense fishery product using *M. albus* enhanced with different fruit extracts. *M. albus* has long been considered a pest and is caught abundantly by the local farmers. Transforming Rice eel into a valueadded product is a natural way of controlling the fish population. This approach might provide an additional and readily available protein source and improve the local farmers' productivity.

Materials and methods

A total of 21 kilograms live *M. albus* was bought directly from the traders of Nueva Vizcaya, Philippines. The additives included were 35g whole garlic, 15g powdered black pepper, 30 ml Philippine lime juice, 30 ml lemon juice, 30 ml orange juice, 115g brown sugar, 120 ml soy sauce, and cooking oil for frying. These were all purchased from the local market.

Fruit extraction

The researcher extracted fruit juices following the procedure of Zalameda *et al*., (2013) [43]. Briefly, the fruits were rinsed in clean water to remove dirt and prevent the growth of harmful microbial organisms. The fruits were then cut into halves and extracted using a household juice extractor. A strainer was used to remove pulp and impurities.

Experimental treatments

Four groups of Tocino-flavored fish, in triplicates, were formulated to contain *O. niloticus* + 0%fruit extract (C_0), *M. albus* + 2.34% Philippine lime (T_1), *M. albus* + 2.34% Lemon (T_2), and *M. albus* + 2.34% Orange (T_3).

Table 1: Formulation of Tocino-flavored Rice eel with various fruit extracts

Ingredients	C_0	T_1	T_2	T_3
O. niloticus (g)	1000	0	0	0
M. albus (g) Marinating Solution	0	1000	1000	1000
Brown Sugar (g)	115	115	115	115
Black Pepper Powder (g)	15	15	15	15
Garlic (g)	35	35	35	35
Soy Sauce (ml)	120	120	120	120
Philippine lime Juice (ml)	0	30	0	0
Lemon Juice (ml)	0	0	30	0
Orange Juice (ml)	0	0	0	30
Water (ml)	0	15	15	15

Initially, the head and viscera of the fish were removed. Salt was applied to scrub the whole surface of the fish, thereby removing the slime. The fish were filleted using a sharp knife and cut into small pieces. To thoroughly remove the remaining blood, the fillets were washed and drained to remove excess water. The tocino-flavored Rice eel was formulated following the methods of the Bureau of Fisheries and Aquatic Resources 02 with slight modifications. All ingredients such as Garlic, brown sugar, soy sauce, and black pepper were measured and combined in a bowl. The fish fillets were then marinated for six hours. After which, the fillets were drained, packed in a polyethylene bag, sealed, and kept at a freezing temperature of -18ºC for 24 hours. After the curing period, the tocino-flavored fish was fried in mediumheated cooking oil.

Sensory evaluation

The sensory evaluation examines a product using the senses of sight, touch, smell, and taste to assess quality characteristics like appearance, flavor, aroma, and texture [38]. Part of food product development is determining whether the products are liked by consumers [41]. The 9-point hedonic scale is the commonly used scale for consumers [2], and it is numbered from 1 to 9, with 1 being the least liked and 9 being the most liked [22]. This study used the hedonic test to assess the quality and acceptability of the formulated tocino-flavored fish in terms of its appearance, aroma, color, taste, and texture. A total of 50 respondents, composed of 25 males and 25 females aged 15-50 years old, were randomly selected to evaluate the product.

Acceptability Composite Index (ACI)

The Acceptability Composite Index (ACI) was applied to assess the overall acceptability of the formulated tocino-flavored fish. The ACI was used in accordance with Reyes (2019) [35], with slight modifications. Briefly, the participants' recommended acceptable percentage for each sensory criterion per treatment was recorded. The product's acceptability was then determined and ranked using the hedonic ACI scale values.

Proximate Analysis

All treatments were analyzed for nutrient content [19, 25]. A total of 250g per treatment was sent to the Department of Agriculture Region 2- Regional Feed Chemical Analysis Laboratory (DA R02- RFCAL) for proximate composition (moisture, ash, protein, and fat) and nutrition facts (kcal, total fat, total carbohydrates, crude fiber, and total protein) analysis of tocino-flavored fish. The analysis was performed using the methods of the Association of Official Analytical Chemists (AOAC). Gravimetric analysis was employed for moisture and ash content analysis. The ANKOM filter bag technique was used for crude fiber and fat analysis. While Kjeldahl method was used to analyze the crude protein of the samples.

Microbial Analysis

A total of 10 grams per treatment was used for the microbial analysis. Samples were packed into a sterile polyethylene bag and were stored in a 4ºC refrigerator for 8, 16, 24, and 32 days, respectively. The samples were then sent to DA-BFAR R02 for microbial analysis. The laboratory follows the guidelines of [4] standards for the Total Plate Count (TPC) analysis. The total plate count was used for the estimation of the total count of microorganisms, which includes mold, yeast, and bacteria [5, 32].

Statistical Analyses

Analysis of Variance (ANOVA) using SPSS software. A Tukey's Post Hoc test was used to determine any significant differences. Acceptability Composite Index and Hedonic scale were also used for the descriptive analysis of treatments.

Results

Acceptability Composite Index (ACI)

Based on the ACI, T_1 ranked as the most preferred formulated tocino-flavored rice eel product with a mean score of 7.73, followed by C_0 (7.66), T_2 (7.51), and T_3 (7), respectively. The ACI reveals the grand mean rating of five criteria and determines the most preferred treatment.

Table 2: Acceptability Composite Index (ACI) of Tocino-flav

Treatment	Appearance	Aroma	Colour	Taste	Texture	Total ACI	Rank
	15.1%	17.65%	18.32%	30.54%	18%		
C_0	1.06	1.33	1.39	2.54	1.43	7.66 (LVM)	2
T_1	1.13	1.37	1.40	2.43	1.41	7.73 (LVM)	1
T_2	1.09	1.32	1.39	2.32	1.40	7.51 (LVM)	3
T_3	1.04	1.31	1.36	2.31	1.37	7.38 (LVM)	4

**LVM – Liked It Very Much

Table 3: Sensorial attributes of Tocino-Flavored Rice eel (mean ± SD) enhanced with different fruit extracts

Sensorial attribute	C_0	T_1	T_2	T_3
Appearance	7.04 ± 1.13^a	7.46 ± 1.09^a	7.22 ± 1.23^a	6.9 ± 1.14^a
Aroma	$7.56 \pm .89^a$	7.76 ± 1.14^a	7.46 ± 1.33^a	7.40 ± 1.26^a
Color	7.54 ± 1.42^a	$7.58 \pm .99^a$	7.54 ± 1.17^a	7.36 ± 1.30^a
Taste	$8.02 \pm .89^a$	7.96 ± 1.14^a	7.60 ± 1.33^a	7.56 ± 1.26^a
Texture	7.82 ± 1.09^a	7.72 ± 1.10^a	7.66 ± 1.23^a	7.52 ± 1.34^a

For the hedonic sensory attributes (table 3), no significant differences have been observed among treatment groups - indicating that *M. albus* could be a potential substitute for *O. niloticus* and possibly for other meat-based products.

Proximate Analysis

For proximate protein content, T3 contained the highest crude protein (21.37%), followed by T2 (20.48%), T1 (19.94%), and C0 (18.69%). The crude fiber content was higher in the control group (0.22%) followed by T2 (0.18%), T3 (0.18%), and T1 (0.07%). Crude fat was higher in T3 (2.38%) followed by the C0 group (2.17%), T2 (0.73%), and T1 (0.36%). The moisture content of the products ranges from 60.40% to 72.50%. For the ash content, T3 has the highest ash content with 2.62%, followed by C0 (1.90%), T1 (1, 56%), and T2 (1.40%).

Table 4: Proximate analysis of Flavored-Tocino Rice eel enhanced with fruit extracts

Treatment	CP	CF	C*fat*	M	A
C0	18.69	0.22	2.17	62.80	1.90
T1	19.94	0.07	0.36	72.50	1.56
T2	20.48	0.18	0.73	66.90	1.40
T3	21.37	0.18	2.38	60.40	2.62

**CP – Crude protein, CF – Crude fiber, Cfat – Crude fat, M – Moisture content, A – Ash content

Nutrient Analysis

The nutritional content of Tocino-flavored Rice eel enhanced with different fruit extracts includes information on energy, energy from fat, total fat, total carbs, and total protein per serving. Percent RENI values reflect how much each serving contributes to the recommended energy and nutrient intake for a reference male adult aged 19 to 29 years old. Most packaged foods under the regulation of the United States Food and Drug Administration (US FDA) contain Nutrition Facts labels, which give information on serving size and amounts of nutrients such as calcium, cholesterol, fiber, and total fat [33]. The nutritional facts of the formulated Tocinoflavored rice eel enhanced with fruit extracts as shown in table 5.

Table 5: Nutrition facts of formulated tocino-flavored Rice eel with different fruit extracts

		C_0		T_1		T_2		T_3
No of servings per container	2.5		2.5		2.5		2.5	
Serving size (g)	100		100		100		100	
Amount per serving		%RENI		%RENI		%RENI		%RENI
Energy (kcal)	152	6%	106	4%	130	5%	160	6%
Energy from fat (kcal)	20		3		7		21	
Total fat (g)	2		0		1		2	
Total carbohydrates (g)	14		6		10		13	
Crude fiber**	0		0		0		0	
Total protein	19	26%	20	28%	20	29%	21	30%

*Percent RENI values are based on the 2018 RENI PDRI reference male adult requirement of 19-29 years old.

Microbial Analysis

Table 6: Microbial analysis of rice eel tocino flavored with different fruit extracts

Treat ment	Day 8	Day 16	Day 24	Day 32
C_0	$4.2x10^5$	$5.25x10^5$	$5.6x10^5$	$5.15x10^5$
T_1	$6.3x10^5$	$7.8x10^5$	$7.8x10^5$	$8.35x10^5$
T_2	$6.45x10^5$	$7.05x10^5$	$6.8x10^5$	$9.05x10^5$
T_3	$7.75x10^5$	$8.0x10^5$	$8.55x10^5$	$6.2x10^5$

The Total Plate Count (TPC) was recorded to be $<10^6$ cfu/g in all treatments, which falls under the acceptable limit of the microbial level of processed fish food products based on the International Commission on Microbiological Specifications for Foods (ICMSF) [9]. The analysis results for Tocinoflavored Rice eel enhanced with different fruit extracts were recorded on days 8, 16, 24, and 32.

Discussion

In this study, T_1 gained the highest acceptability among all treatment groups. According to Muniz (2023) [29], a product's color plays an important factor on the impression of its taste since people prefer to associate colors with certain products and tastes. T_1 also has the highest preference for aroma. Food additives like garlic, black pepper, and soy sauce enhance food's aroma [14]. The C_0 group showed the highest acceptability for texture and taste among all treatment groups. Food texture is an essential aspect in food products because it increases consumer food preferences [3]. The ingredients used in marinade are crucial for achieving the intended sensory qualities of the finished product [1]. In the Philippines, the as a flavoring likely contributed to the product's high rating. Its appealing flavor aligns well with the participants' preferences and may have enhanced the overall sensory experience of the dish, leading to a favorable response from the participants.

The proximate analysis revealed that the crude protein of the product ranges from 18.69% to 21.37%, which is within the range of high-quality protein content of fish (16-22%) [17]. Protein is a crucial component of fish that significantly influences its nutritional value [6]. T_3 has the highest protein content among treatments due to its lower moisture content. According to Islam (2020) [23], fish is regarded as a high protein source when their protein level is more than 15%, hence, rice eel is classified as a highprotein fish. Furthermore, several studies have shown that the total protein content of various fish also correlates with different factors such as seasons, processing methods, sex differences, size, and age variations [7]. The highest value of crude fat was observed in T_3 with 2.23%. The increase in fat content in fried fillets is primarily attributed to the absorption of oil and the leaching out of water during the

deep-frying process [16]. When fish fillets are submerged in hot oil for frying, they absorb some of the oil, contributing to the increase in fat content. The moisture content of the formulated fish products ranges from 60.40%-72.50%. The moisture content of fish fillets fell steadily as the frying time increased, and the higher the frying temperature, the faster the moisture content was reduced [10]. The ash content of the four treatments ranges from 1.40% to 2.62 %, which falls within the range of ash content for fish. The high ash level in the fried samples could be due to reduced moisture content, which raised all other nutrients and ash content [40]. Ash is a constituent in the food product, equating to its mineral content [18]. Microorganisms within food can be classified into several types, including bacteria, fungi, and viruses, each of which affects the quality and safety of the foods. Microbial decomposition degrades food and poses a health risk [13]. The TPC analysis of C_0, T_1, T_2, and T_3 showed an increasing microbial load from day 8 to day 32. This could be due to the high moisture content in the formulated product that could support the growth of bacteria [18]. However, the formulated product has a microbiological level that is acceptable within the limit, $<10^6$ cfu/g, outlined by the International Commission on Microbiological Specifications for Foods (ICMSF) [9] even after storage for 32 days. Furthermore, marinades improve color, flavor, and tenderness while extending shelf life by inhibiting the growth of harmful microbes and lipid oxidation [15]. Therefore, this marinated tocinoflavored fish could be stored in the freezer for prolonged shelf life and usability.

Conclusion

The sensory attributes of the formulated tocinoflavored fish product have been perceived as "liked very much," suggesting that the tocino-flavored Rice eel can be an alternative to other meat-based tocino products while benefitting local farmers, who regard rice eel as a pest.

The present study provides practical and helpful information on the nutritional composition of food processed *M. albus*. In addition, dishes are constantly evolving and often experiment with new ingredients and flavors. The tocino-flavored Rice eel could gain popularity, especially if there is interest in incorporating an alternative protein source into food. Promoting value addition can enhance the utilization and acceptability of rice eel as food, which could benefit the farmers and their local economy.

Acknowledgments

The authors are grateful for the technical assistance provided by the Provincial Institute of Fisheries at Isabela State University-Roxas Campus and of the Bureau of Fisheries and Aquatic Resources Region 02- Provincial Fishery Office of Nueva Vizcaya, Philippines.

Conflict of interest

The authors declare no conflict of interest in any way.

Ethics statement

This research adheres to the highest standards of ethical conduct and integrity. The Rice eel (*M. albus*) used in the study was sourced from registered traders certified by the Bureau of Fisheries and Aquatic Resources Region 02. All efforts were made to ensure the ethical handling and processing of the eels.

References

1. Aberoumand A. Preliminary studies on nutritive and organoleptic properties in processed fish fillets obtained from Iran. Food Sci Technol,2014:34:287-291.
2. Addo-Preko E, Amissah JGN, Adjei MYB. The relevance of the number of categories in the hedonic scale to the Ghanaian consumer in acceptance testing. Front Food Sci Technol,2023:3:1071216.
3. Alemu T. Texture profile and design of food product. J Agric Horti Res,2023:6:272-281.
4. Andrews W. Manual of food quality control. 4th ed. Rev, 1. Microbiological analysis. Food and Drug Administration. FAO Food and Nutrition Paper,1992:14(4 Rev 1):1-338.
5. Arifan F, Winarni S, Wahyuningsih W, Pudjihastuti I, Broto RW. Total plate count (TPC) analysis of processed ginger on Tlogowungu village. In: International Conference on Maritime and Archipelago (ICoMA 2018): Atlantis Press, 2019, 377-9.
6. Balachandran KK. Post-harvest technology of fish and fish products. Daya Books, 2001.
7. Bezbaruah G, Deka DD. Variation of moisture and protein content in the muscle of three catfishes: A comparative study. Int J Fish Aquat Stud,2021:9(1):223-226.
8. Bursac Kovacevic D, Barba FJ, Lorenzo JM, Rocchetti G, Lucini L, Putnik P. Innovative technologies for fruit extracts: Value-added opportunities in the meat industry. In: IOP Conference Series: Earth and Environmental Science: IOP Publishing, 2019, 012017.
9. Centre for Food Safety. Microbiological Guidelines for Food (For ready-to-eat food in general and specific food items). Hong Kong: Food and Environmental Hygiene Department, 2014.
10. Chang L, Lin S, Zou B, Zheng X, Zhang S, Tang Y. Effect of frying conditions on self-heating fried Spanish mackerel quality attributes and flavor characteristics. Foods,2021:10(1):98.
11. Cheong MW, Zhu D, Sng J, Liu SQ, Zhou W, Curran P, Yu B. Characterisation of calamansi (Citrus microcarpa). Part II: Volatiles, physicochemical properties and nonvolatiles in the juice. Food Chem,2012:134(2):696-703.
12. Chen H, Liu H, Li R, Lin X, Luo H, Ji H, Hu W, Luo D. Blood cell identification and hematological analysis during natural sex reversal in rice field eel (*Monopterus albus*). Aquaculture,2021:538:736543.
13. Dash KK, Fayaz U, Dar AH, Shams R, Manzoor S, Sundarsingh A, *et al*. A comprehensive review on heat treatments and related impact on the quality and microbial safety of milk and milk-based products. Food Chem Adv,2022:1:100041.
14. Dini I, Laneri S. Spices, condiments, extra virgin olive oil and aromas as not only flavorings, but precious allies for our wellbeing. Antioxidants,2021:10(6):868.
15. Ehsanur Rahman SM, Islam S, Pan J, Kong D, Xi Q, Du Q, *et al*. Marination ingredients on meat quality and safety—A review. Food Qual Saf,2023:7:fyad027.
16. Erkan N, Ozden O, Selcuk A. Effect of frying, grilling, and steaming on amino acid composition of marine fishes. J Med Food,2010:13(6):1524-1531. PMid: 20874243. Available from: http://dx.doi.org/10.1089/jmf.2009.0203

17. Espejo-Hermes J. Fish processing technology in the tropics,2nd ed. TAWID Publications, 2004.
18. Fadhlullah M, Prasetyati SB, Marleni NR. The application of different heat processing technique on eel (*Monopterus albus*) galantine. In: IOP Conference Series: Earth and Environmental Science: IOP Publishing, 2021, 012003.
19. Ganogpichayagrai A, Suksaard C. Proximate composition, vitamin and mineral composition, antioxidant capacity, and anticancer activity of Acanthopanax trifoliatus. J Adv Pharm Technol Res,2020:11(4):179-183.
20. Guerrero III RD. Impacts of introduced freshwater fishes in the Philippines (1905-2013): A review and recommendations. Philipp J Sci,2014:143(1):49-59.
21. Guan RZ, Zhou LH, Cui GH, Feng XJ. Studies on the artificial propagation of *Monopterus albus* (Zuiew). Aquaculture Res, 1996, 587-96.
22. Heymann H, Lawless HT. Sensory evaluation of food: principles and practices. Springer Science & Business Media, 2013.
23. Islam MA, Mohibbullah M, Suraiya S, Sarower-E-Mahfuj M, Ahmed S, Haq M. Nutritional characterization of freshwater mud eel (Monopterus cuchia) muscle cooked by different thermal processes. Food Sci Nutr,2020:8(11):6247-6258.
24. Juliano RO, Guerrero III R, Ronquillo I. The introduction of exotic aquatic species in the Philippines. In: De Silva SS, editor. Exotic aquatic organisms in Asia: Proceedings of the Workshop on Introduction of Exotic Aquatic Organisms in Asia: 1981 Jun 19-21: Asian Fish Soc Spec Publ,1989:3:83-90.
25. Kari NM, Ahmad F, Ayub MNA. Proximate composition, amino acid composition and food product application of anchovy: a review. Food Res,2022:6(4):16-29.
26. Lubis NDA, Ichwan M, Nasution IK. Introducing Eel Nugget as a Potential Alternative of High-protein Processed Food. [place of publication unknown], 2020.
27. Manner IH, Buker RS, Smith VE, Ward D, Elevitch RC. Species profiles for Pacific Island Agroforestry. Available from: www.traditionaltree.org, 2006.
28. Matsumoto S, Kon T, Yamaguchi M, Takeshima H, Yamazaki Y, Mukai T, *et al*. Cryptic diversification of the swamp eel *Monopterus albus* in East and Southeast Asia, with special reference to the Ryukyuan populations. Ichthyol Res,2010:57(1):71-77.
29. Muniz VRGDF, Ribeiro IS, Beckman KRL, Godoy RCBDF. The impact of color on food choice. Braz J Food Technol,2023:26:e2022088.
30. Nitura KPMD. A market acceptability study of rice eel longaniza from asian swamp eel (*Monopterus albus*) in Aurora, Cauayan City, and San Mateo, Isabela. [place of publication unknown], 2016.
31. Ostonal JM, Arugay MB, Bassig BT, Iñigo HBR, Mahmudah NA, Dichoson HKE, *et al*. Effects of Pretreatment and Addition of Calamansi Juice Extract on Oyster Mushroom Kropek Sensory and Physicochemical Properties. [Place of publication unknown]: [date unknown].
32. Padeniya U, Larson ET, Septriani S, Pataueg A, Kafui AR, Hasan E, *et al*. Probiotic treatment enhances pre-feeding larval development and early survival in zebrafish Danio rerio. J Aquatic Anim Health,2022:34(1):3-11.
33. Pfledderer CD, Ranjit N, Pérez A, Malkani RI, Ferreira De Moraes AC, Hunt ET, *et al*. Using the Nutrition Facts Label to Make Food Choices Is Associated with Healthier Eating among 8th and 11th-Grade Students: An Analysis of Statewide Representative Data from the 2019–2020 Texas School Physical Activity and Nutrition Survey. Nutrients,2024:16(2):311.
34. Refai MK. Manuals of food quality control. 4th ed. Microbiological analysis, 1979.
35. Reyes DA. Product development and acceptability of bottled Big-eyed Scad Selar crumenophthalmus in Spanish-oil style with organic flavoring. Int J Food Sci Nutr,2019:4(3):19-24.
36. Revilloza HC, Libatique-Asprec MJ, Jr IPA, Ame EC, Ballad EL. Acceptability of Mexican-style chorizo sausage using rice eel (*Monopterus albus*) meat. Int J Food Sci Nutr,2024:9(3):26-30.
37. Romero J. Investigating the flavor of fresh calamondin peel and juice using instrumental and descriptive sensory analysis. Master's thesis, Texas Woman's University, 2020.
38. Sharif MK, Butt MS, Sharif HR, Nasir M. Sensory evaluation and consumer acceptability. In: Handbook of food science and technology,10th ed, 2017, 362-86.
39. Tiencheu B, Nji DN, Achidi AU, Egbe AC, Tenyang N, Ngongang EFT, *et al*. Nutritional, sensory, physico-chemical, phytochemical, microbiological and shelf-life studies of natural fruit juice formulated from orange (*Citrus sinensis*), lemon (*Citrus limon*), honey and ginger (*Zingiber officinale*). Heliyon, 2021, 7(6).
40. Ünlüsayın M, Kaleli S, Gulyavuz H. The determination of flesh productivity and protein components of some fish species after hot smoking. J Sci Food Agric,2001:81(7):661-664.
41. Wichchukit S, O'Mahony M. The 9-point hedonic scale and hedonic ranking in food science: some reappraisals and alternatives. J Sci Food Agric,2015:95(11):2167-2178.
42. Yang D, Chen F, Ruan G. Aquaculture of the paddy eel, *Monopterus albus*. In: Aquaculture in China: Success stories and modern trends, 2018, 283-96.
43. Zalameda EC, Falco MEM, Conoza VB, Esteban LR, Florendo NEC. Preparation & preservation of fruit juices. 3rd ed. ISSN 1656-6831. Livelihood Technology Series 3. Industrial Technology Development Institute-DOST, 2013.