ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2024; 24(11): 24968-24981 https://doi.org/10.18697/ajfand.136.24825

Date	Submitted	Accepted	Published
	29th April 2024	21st August 2024	18th November 2024

DEVELOPMENT AND SENSORY PROFILING OF FLAVORED TILANGGIT (DRIED, SPLIT, AND SALTED JUVENILE TILAPIA)

Magoncia SJV[1]*, Bucay DM[1], Castillo RF[1], Estolloso LL[1], Oco DMC[1], Palmes KA[1], Suazo MLE[1] and WA Coronado[2]

Stephen Jhon Magoncia

*Corresponding author email: stephenjhon.magoncia@msunaawan.edu.ph

[1]Faculty, College of Business Administration and Accountancy, Mindanao State University at Naawan, Pedro Pagalan St., Poblacion, Naawan, Misamis Oriental, Mindanao, Philippines, 9023

[2]Faculty, College of Education and Social Sciences, Mindanao State University at Naawan Pedro Pagalan St., Poblacion, Naawan, Misamis Oriental, Mindanao, Philippines, 9023

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

ABSTRACT

With the increase in tilapia farming there are opportunities to explore value-added tilapia products. This study aimed to develop flavored varieties of dried, split, and salted juvenile tilapia, commonly known as "tilanggit," given the staple consumption of dried fish in places like Africa and Asia. Freshly harvested juvenile Nile tilapia fish were gutted, cleaned, deboned, brined, marinated, and dried. Four flavor formulations were developed: no flavor (NF), honey-calamansi (HC), garlic (G), and hot and spicy (HS). Each flavor formulation's sensory attributes, including appearance, aroma, taste, and texture, were assessed using a 5-point Likert scale, where 1 represented "disliked a lot" and 5 represented "liked a lot", with samples being deep-fried in an individual vat of vegetable oil for ~5-10 sec at 150°C. A total of 40 consenting female participants from 19 to 63 years old, from low and middle-income homes who purchase and consume dried fish, were medically screened and used to evaluate the sensory attributes of the flavored dried tilanggit products. The results showed that the G formulation was rated as having the best appearance, aroma, and taste, followed by the NF sample which suggested that the addition of garlic to dried tilanggit significantly enhanced several important sensory attributes. In terms of texture, the NF sample was rated the highest, followed by the G sample. The results indicate statistically significant differences among these four treatments in terms of appearance, taste and texture, ($p<0.05$) using the Kruskal-Wallis H test. Therefore, it is recommended that garlic be used as a flavor for dried tilanggit products however, honey-calamansi and hot and spicy be improved so they, too, can be used to flavor dried tilanggit to better suit the preferences of different consumers and offer additional choices in the marketplace. Moreover, a sensory evaluation with region-wide and more diversified participants is recommended to assess broader market viability. These results provide insights for tilapia farmers and processors seeking to diversify their product offerings to cater to consumer preferences for flavored dried fish products.

Key words: Flavored tilanggit, tilapia, *Oreochromis niloticus*, fish drying, dried salted fish, *tuyông isda*

ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

INTRODUCTION

Over one billion people depend on fish for both sustenance and livelihood [1]. Fish are an important source of fatty acids, protein, and micronutrients such as iron, zinc and calcium, vitamin A [2, 3]. However, the growing need for seafood in conjunction with advancements in fishing technology and globalization has resulted in the depletion of fish stocks in many regions worldwide. This has impacted fishermen's livelihoods and the food security of communities dependent on seafood.

As an archipelagic country, the Philippines have a multitude of fish and fishing resources that Filipinos can use for food and to earn a living [4]. Since fish are highly perishable [5], fish processing can help meet consumer demand for seafood by extending its shelf life, and giving consumers access to alternative seafood sources that are more readily available, more reasonably priced, and/or easier to transport and store [4]. Locally known as *tuyông isda*, dried salted fish, are a traditional product of the Philippines. These fish are consumed for their flavor, nutritional content, and low cost. They have always been a staple food among Filipinos, particularly for the population's underprivileged groups [6]. However, some users, especially those unaccustomed to its flavor, may find the strong fishy smell and taste of dried fish unpleasant [7, 8]. Adding flavors to the dried fish could be a potential way to enhance its sensory properties and increase consumer acceptability.

Although there is significant tilapia farming in the country, the exploration of value-adding options for tilapia as human food has not received much attention [2]. With the traditional consumption of dried fish, one value-added product that has become popular domestically is *tilapiang dinanggit*, or *tilanggit,* a dried, split, salted juvenile tilapia. These products can receive higher prices, offer convenience to consumers, and provide a different way to consume tilapia.

Flavoring dried fish may have potential benefits, but further research is needed to determine the optimal combination of flavors that can enhance its sensory qualities and appeal to a broader consumer base. This study aimed to develop a flavored dried tilanggit product, assess its consumer sensory characteristics, and compare different flavor options. The research specifically seeks to create dried tilanggit with various flavorings, and to evaluate them sensorily to assess appearance, aroma, taste and mouthfeel.

MATERIALS AND METHODS

Experimental design

A 4-factor factorial design was used to evaluate the consumer acceptability of flavored marinades for dried tilanggit. The marinades tested were honey-calamansi (a citrus hybrid predominantly cultivated in the Philippines), garlic, and hot and spicy.

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Consumer panelists were used for the sensory analysis of appearance, aroma, taste, and mouthfeel to assess how these marinades were received. This enabled identifying optimal flavor enhancement strategies to improve the product's sensory appeal [9]. The factorial design efficiently evaluated the main effects of each marinade as well as interactions between flavors on consumer acceptability metrics.

Processing Method

Thirty (30) kg of fresh 90-day old Nile tilapia (*Oreochromis niloticus)* weighing 25-30 g [10] each were harvested from the fish tanks of MSUN-CARES (Mindanao State University Naawan - Center for Aquaculture Research, Enterprise, and Services, Philippines). The fish were acquired fresh and transported to the laboratory, washed, gutted, deboned and fileted manually with skin on using a sharp stainless-steel knife and washed using running water and drained in a sterile colander [11].

Samples were brined in a mixture of 4% salt, 0.05% minced garlic and 0.03% in water at freezing temperatures (<32°F/0°C – 25°F/-4°C) for two hours to accelerate salt uptake by the fish muscle tissue through slower diffusion rates which with the longer time allows deeper salt penetration, optimized protein denaturation, and improved water holding capacity [12, 13]. To ensure even distribution of the brine throughout each sample, the fillets were gently stirred after one hour during the brining period. The filets were thoroughly rinsed under cool running water to remove any residual surface particles or undissolved brine ingredients from the fish. After rinsing, the fillets were allowed to completely drain excess liquid in a sterile colander for 3-5 min.

The sample was divided into four portions. One portion remained unflavored and was chilled at 4°C after it completely drained. The other three portions were marinated using three marinade formulations originally developed by researchers: (a) honey-calamansi marinade with 89% pure, organic bee honey, 10% fresh, concentrated calamansi juice purchased from the local market of Naawan, Misamis Oriental, Philippines, and 1% freshly ground black pepper; (b) garlic marinade with 87% minced garlic, 10% garlic powder, and 3% freshly ground black pepper; and (c) hot and spicy marinade with 80% chili peppers, 3% cayenne pepper, 9% paprika, and 8% freshly ground black pepper. Each formulation was mixed for every 1 kg of filleted tilanggit. The samples were stored in a freezer that ranged from -4°C (25°F) to 0°C (32°F) for 1.5 hours. To ensure a uniform distribution of the marinade ingredients, each sample formulation was stirred at 45-min [14]. After marination, the samples were transferred to a sun dryer for drying for 8 to 10 hours [10]. The fish were arranged in a single layer on the drying racks, positioned in the area that received direct sunlight and regularly monitored and turned to ensure even drying [15].

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Research participants

Using purposive sampling, forty female participants, residents of Poblacion, Naawan, Misamis Oriental, from 19 to 63 years old, from low and middle-income homes who consume fish and who are in-charge of household grocery shopping were used for the sensory evaluation.

The study adhered to the ethical requirements established by the Mindanao State University Naawan Research Ethics Committee. Prior to the sensory evaluations, an orientation was done to explain the research's purpose, procedures, potential risks, and ethical guidelines.

To ensure safety, participants underwent an actual medical examination at the university infirmary to identify pre-existing food allergies, sensitivities, or other conditions to ensure that the sensory testing would not put them at risk. Only the participants who received medical clearance were allowed to proceed.

Sensory evaluation

Sensory evaluation was done in batches of 10 participants. Preparations of samples were done by batch. Each sample of the different formulation was deep-fried for 5 to 10 sec in an individual vat of commercial vegetable oil [16] heated to 150°C/302°F. The frying time was adjusted based on the maximum thickness as measured through the average length, width and weight of the dried tilanggit fillets to ensure proper cooking. Dried tilanggit samples with an average length of 8.35 cm, average width of 7.85 cm and an average weight of 1 g was cooked for 5 sec while samples above the average for all of these parameters were cooked for 10 sec. Samples were individually placed in a plain white disposable cup on a white tray with an assigned 3-digit random code, and were distributed to participants within 2 min after preparation.

During the evaluation, each participant sat at an individual table designed for independent work, with no contact with others. The room's fluorescent lighting and temperature were constant. White bread and water were available as taste neutralizer [17].

Each sample product was scored for appearance, aroma, taste, and texture using a 5-point hedonic Likert scale ranging from 5 ("like a lot") down to 1 ("dislike a lot").

Statistical analysis

Data analyses were done using the Statistical Package for the Social Sciences (SPSS) version 29.0 software (SPSS, Armonk, NY, USA). Comparative analysis of the four formulations were examined using the Kruskal-Wallis H test to determine any significant differences on the sensory evaluations of the participants. A post-hoc analysis using Dunn's post-hoc pairwise comparison was done to determine which

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

formulations were different. Results were considered statistically significant if $p<0.05$.

RESULTS AND DISCUSSION

Flavor is considered more important as it impacts both perceived food quality and overall consumer acceptance [18]. The result of the different flavor formulations on the sensory attributes of dried tilanggit are shown in Table 1. The garlic sample was rated as having the best appearance, aroma, and taste, followed by the unflavored sample. In terms of texture, the no flavor sample was rated the highest, followed by the garlic flavored sample. The results indicate significant variations among these four treatments in terms of appearance, aroma and texture (Table 2).

Appearance

The visual appearance of food products has an important role in shaping consumer perceptions and evaluations even before other sensory inputs are experienced. The appearance mean scores shown in Table 1 indicated that the garlic flavored dried tilanggit had the highest mean score, indicating that participants liked it a lot. Meanwhile, the honey-calamansi flavored tilanggit scored the lowest having a neutral rating. The lowest rating for the honey-calamansi flavor's appearance may be linked to participants' visual preference for the traditional lighter color of dried fish.

The Kruskal-Wallis H test results shown in Table 2 indicated that the appearance of the different tilanggit flavors were statistically significantly different. The post-hoc analysis shown in Table 3 shows the pairs having a statistical difference ($p<0.05$).

The differences were likely due to the distinct burnt or darkened appearance [18] of the dried tilanggit flavored with honey-calamansi as honey, being a natural source of various sugars, may potentially act as a catalyst for browning reactions leading to a greater color change.

Aroma

The sensation of aroma is a complex and nuanced attribute that impacts food perception. When people smell foods, scent compounds bind to olfactory receptors, triggering neural signals that create an impression in the brain [20].

The garlic flavored dried tilanggit has the highest mean score, indicating that participants liked it a little (Table 1). This can be attributed to the ability of garlic to impart desirable aroma notes in preserved fish products due to its rich profile of volatile compounds which is consistent with the results of El-Sohaimy *et al.* [21], which showed that adding garlic extract positively impacted the sensory quality and taste of herring fish fillets. Similar results were also reported by Ahmed *et al.* [22], where catfish preserved using a garlic-ginger homogenate was rated as having the best aroma among the tested formulations.

ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

However, the Kruskal-Wallis H test results (Table 2) showed that the aroma of the different flavor formulations were not significantly different.

Taste

Taste probably has the major role in determining consumer acceptance of new products. Therefore, it requires optimization to enhance palatability [23]. In this study the highest taste liking score was for the garlic flavored dried tilanggit, indicating that participants liked it a little (Table 1). This is consistent with Bi *et al.*'s [24] results, where garlic was widely preferred by consumers and can enhance the scent and richness of dried fish. As a versatile ingredient, garlic adds complexity to diverse dishes without overpowering them. In its dried form, garlic lends subtle and harmonious notes that likely complemented the dried tilanggit well.

Furthermore, the Kruskal-Wallis H test results (Table 2) showed that the taste of the different dried tilanggit flavors were significantly different. Dunn's post-hoc pairwise comparisons results in Table 3 shows the statistically significantly different pairs ($p<0.05$). The no-flavor sample showed a distinct taste profile compared to the hot and spicy which can be attributed to the effective uptake of spicy flavors which enabled the release of enough compounds to activate taste sensations on the palate. The honey-calamansi's flavor can be attributed to a sweet and tangy flavor. Skillful incorporation of flavor compounds can result in distinctive and noticeable tastes, that if done right can improve consumer attractiveness and selection [25].

Texture

The texture of dried fish is an important quality attribute that influences consumer acceptability and preference [26]. Specifically, mouthfeel - the tactile sensation during eating - strongly influences the overall sensory experience [27]. The no-flavor samples received the highest mean score (Table 1) indicating that participants liked it a lot. This suggests that the participants' liking for dried tilanggit's texture can be optimized without needing any further added ingredients.

Results (Table 2) showed significant texture differences among flavor formulations. Dunn's post-hoc pairwise comparisons showed that the no-flavor treatment was significantly different from two of the three flavored samples ($p<0.05$). This shows that flavorings can affect texture perception. As posited by Lawless and Heymann [28], visual and tactile cues create preconceived expectations about food mouthfeel. When perceived and actual texture diverge, acceptance decreases. Here, the spices likely elicited negative tactile sensations that disagreed with the visual clues for dried fish.

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The study determined that *Oreochromis niloticus* has a better flavor with garlic as the participants preferred the appearance, aroma and taste of those samples of dried tilanggit. The addition of garlic also had a better texture than the other flavors although not as good as that without flavor added. It is thus recommended that garlic be used as the initial flavor for the development of a flavored dried tilanggit product. It is also recommended that the other two flavors be further optimized either by formula changes or the addition of additional flavor ingredients to meet the palatability desires of consumers. Also, a sensory evaluation with a more region-wide and diversified panel is recommended. These tests might also add some demographic questions to potentially identify market sub-segments that might particularly favor a particular tilanggit flavor. The development of new forms will lead to improvement of the value chain of tilanggit products, and provide commercialization potential.

ACKNOWLEDGEMENTS

The authors hereby express their profound gratitude to Mindanao State University at Naawan, under the leadership of Chancellor Dr. Elnor C. Roa, for the generous support provided through an in-house research grant administered by the Research Division. Sincere appreciation is also extended to the School of Marine Fisheries and Technology, headed by Dr. Dan M. Arriesgado, and to MSUN-CARES (Mindanao State University Naawan - Center for Aquaculture Research, Enterprise, and Services), under the direction of Associate Professor Victor R. Navarro, for their invaluable contributions to this research endeavor. We would also like to express our appreciation to the research participants for their cooperation and hospitality. Additionally, we thank our research assistants for their diligent efforts during the data collection phase.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this manuscript.

ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 1: Mean scores of sensory attributes

Sensory Attributes	Flavor Formulation			
	NF	HC	G	HS
Appearance	4.2±1.3	3.1±1.4	4.3±1.0	4.0±1.1
Aroma	4.0±1.3	3.7±1.2	4.2±1.2	3.9±1.0
Taste	4.1±1.3	3.9±1.2	4.2±1.1	3.4±1.3
Mouthfeel	4.3±1.1	3.8±1.3	4.2±1.1	3.7±1.3

Note: *NF (No flavor), HC (Honey-Calamansi), G (Garlic), HS (Hot and Spicy); Mean±SD; Interpretation: 1.00-1.80 – Dislike a Lot; 1.81-2.60 – Dislike a Little; 2.61-3.40 – Neutral; 3.41-4.20 – Like a Little; 4.21-5.00 – Like a Lot*

ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 2: **Kruskal-Wallis H test results of the sensory attributes**

Sensory Attributes	Flavor Formulation	Kruskal-Wallis H	df	p-value
Appearance	No Flavor	22.996	3	<0.001*
	Honey-Calamansi			
	Garlic			
	Hot and Spicy			
Aroma	No Flavor	6.86	3	0.077
	Honey-Calamansi			
	Garlic			
	Hot and Spicy			
Taste	No Flavor	10.511	3	0.015*
	Honey-Calamansi			
	Garlic			
	Hot and Spicy			
Texture	No Flavor	8.766	3	0.033*
	Honey-Calamansi			
	Garlic			
	Hot and Spicy			

Note: ** - Significant at $\alpha = 0.05$*

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 24 No. 11
November 2024
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 3: Dunn's post-hoc pairwise comparisons of different formulations

Sensory Attribute	Formulations	Test Statistic	Std. Error	Sig.
Appearance	Honey-Calamansi -- Hot and Spicy	-27.950	9.767	0.004
	Honey-Calamansi -- Garlic	-40.337	9.767	0.000
	Honey-Calamansi -- No Flavor	-27.950	9.767	0.000
Taste	Hot and Spicy -- No Flavor	-24.387	9.798	0.013
	Hot and Spicy -- Garlic	29.813	9.798	0.002
Texture	Hot and Spicy -- No Flavor	-24.375	9.728	0.012
	Honey-Calamansi -- No Flavor	-21.150	9.728	0.030

Note: *Significant at* $\alpha = 0.05$

REFERENCES

1. **Warren C and DJ Steenbergen** Fisheries decline, local livelihoods and conflicted governance: An Indonesian case. *Ocean & Coastal Management*. 2021; **202**: 105498.

2. **Peñarubia O, Toppe J, Ahern M, Ward A and M Griffin** How value addition by utilization of tilapia processing by-products can improve human nutrition and livelihood. *Reviews in Aquac*ulture. 2023; **15**: 32-40.

3. **Ojutiku RO, Kolo RJ and ML Mhammed** Comparative study of sun drying and solar tent drying of *Hyperopisus bebeoccidentalis*. *Pakistan Journal of Nutrition*. 2009; **8(7)**: 955-957.

4. **Tahiluddin A and AE Kadak** Traditional fish processing techniques applied in the Philippines and Turkey. *Menba Kastamonu Üniversitesi Su Ürünleri Fakültesi Dergisi*. 2022; **8(1)**: 50-58.

5. **Fitri N, Chan SXY, Che Lah NH, Jam FA, Misnan NM, Kamal M and F Abas** A Comprehensive review on the processing of dried fish and the associated chemical and nutritional changes. *Foods.* 2022; **11(19**): 2938.

6. **Gabriel AA and AS Alano-Budiao** Microbial, physicochemical, and sensory quality evaluations of salted herring (*Sardinella fimbriata*) subjected to different drying processes. *Food Science and Technology Research.* 2015; **21(2)**: 213–221.

7. **Li L, Tu C, Zhang L, Sha XM, Wang H, Pang JJ and PP Tang** The effect of ginger and garlic addition during cooking on the volatile profile of grass carp (*Ctenopharyngodon idella*) soup. *Journal of Food Science and Technology*. 2016; **53(8)**: 3253–3270.

8. **Zakipour RE, Bakar J, Che Man YB, Abdul HN and A Arshadi** The impact of lipid content, cooking and reheating on volatile compounds found in narrow–barred Spanish mackerel (*Scomberomorous commerson*). *Iranian Journal of Fisheries Sciences*. 2011; **10(2)**: 336-345.

9. **Næs T, Brockhoff B and O Tomić** Important data collection techniques for sensory and consumer studies. **In:** Statistics for Sensory and Consumer Science. United Kingdom: John Wiley & Sons Ltd, 2010: 5-10.

10. **Arriesgado DM** Tilapia farming for tilanggit production. Naawan, Misamis Oriental. MSU. Philippines, n.d.

11. **Youssef AM, El-Sayed HS, Islam EN and SM El-Sayed** Preparation and characterization of novel bionanocomposites based on garlic extract for preserving fresh Nile tilapia fish fillets. *RSC Advances*. 2021; **11(37):** 22571-22584.

12. **Jittinandana S, Kenney PB, Slider SD and RA Kiser** Effect of brine concentration and brining time on quality of smoked rainbow trout fillets. *Journal of Food Science*. 2002; **67(6)**: 2095-2099.

13. **Birkeland S, Sivertsvik M, Nielsen HH and T Skåra** Effects of brining conditions on weight gain in herring (*Clupea harengus*) fillets. *Journal of Food Science*, 2005; **70(7)**: e418-e424.

14. **Monteiro MLG, Máralém ET, Lázaro CA, da Silva Canto ACVC, da Lima BRC, da Cruz AG and CA Conte-Júnior** Effect of transglutaminase on quality characteristics of a value-added product tilapia wastes. *Journal of Food Science and Technology.* 2014; **52(5):** 2598–2609.

15. **Sormin RBD and IKE Savitri** Drying process characteristics of dried anchovy (*Stolephorus sp.*) by using the cabinet and tunnel of the sun dryer. In *IOP Conference Series: Earth and Environmental Science*. 2020; **530(1)**: 012016. IOP Publishing.

16. **Tkáčová J, Pavelková A, Sajdová A and M Angelovičová** Sensory evaluation of fishery product - Cod in mayonnaise. *Journal of Microbiology, Biotechnology and Food Sciences.* 2019; **8(4):** 1084–1088.

17. **Wu T, Wang M, Wang P, Tian H and P Zhan** Advances in the formation and control methods of undesirable flavors in fish. *Foods.* (2022); **11:** 2504.

18. **ALaerjani WMA, Abu-Melha S, Alshareef RMH, Al–Farhan BS, Ghramh HA, Al-Shehri BM, Bajaber MA, Khan KA, Alrooqi MM, Modawe GA and MEA Mohammed** Biochemical reactions and their biological contributions in honey. *Molecules, 2022;* **27(15):** 4719.

19. **Shepherd G** Outline of a theory of olfactory processing and its relevance to humans. *Chemical Senses*. 2005; **30(Supplement 1):** i3–i5.

20. **El-Sohaimy SA, Shehata MG, Abd-Rabou HS and H El-Menshawy** Extend shelf-life of vacuum-packaged herring fish fillets using garlic and ginger extracts. *Journal of Pure and Applied Microbiology*. 2019; **13(3):** 1571–1581.

21. **Ahmed AA** Sensory quality of smoked *Clarias gariepinus* (Burchell, 1822) as affected by spices packaging methods. *International Journal of Food Properties*. 2019; **22(1):** 704–713.

22. **O'Mahony M** Taste perception, food quality and consumer acceptance.*Journal of Food Quality*. 1991; **14(1):** 9–31.

23. **Bi J, Yang Z, Li Y, Bian L, Gao Y, Ping C, Liu S and C Li** Effects of different cooking methods on volatile flavor compounds in garlic. *International Journal of Gastronomy and Food Science*. 2023; **31:** 100642.

24. **Buettner A, and J Beauchamp** Chemical input–sensory output: Diverse modes of physiology–flavour interaction. *Food Quality and Preference*, 2010; **21(8)**: 915-924.

25. **Fitri N, Chan SXY, Che Lah NH, Jam FA, Misnan NM, Kamal N, Sarian MN, Mohd Lazaldin MA, Low CF, Hamezah HS, Rohani ER, Mediani A and FA Abas** Comprehensive review on the processing of dried fish and the associated chemical and nutritional changes. *Foods*. 2022; **11(19):** 2938.

26. **X L, Tu Z, Sha X, Li Z, Li J and M Huang** Effect of coating on flavor metabolism of fish under different storage temperatures. *Food Chemistry*. 2023; **13:** 100256.

27. **Lawless HT and H Heymann** Texture evaluation. **In**: Sensory Evaluation of Food: Principles and Practices. Food Science Text Series. New York, NY, Springer, 2016; **11:** 259-281.