©Journal of Aquatropica Asia
e-issn: 2721-7574; p-issn: 2407-3601
Volume 10, Nomor 1, Tahun 2025
Jurusan Akuakultur, Universitas Bangka Belitung

NUTRITIONAL AND CAROTENOID CHARACTERIZATION OF YELLOW PUMPKIN (*Cucurbita moschata*) POWDER FOR POTENTIAL USE IN ORNAMENTAL FISH FEED

KARAKTERISASI NUTRISI DAN KAROTENOID DARI TEPUNG LABU KUNING (*Cucurbita moschata*) UNTUK POTENSI PENGGUNAAN DALAM PAKAN IKAN HIAS

R Adharyan Islamy[1,♣], Abd. Rahem Faqih[2], Michael Czech[3], Arya Darmawan K. Putra[1], Auryn Novia Ramadhani[1]

[1] Aquaculture (Kediri City Campus), Department of Fisheries and Marine Resources Management, Faculty of Fisheries and Marine Science, Brawijaya University,
Jl. Pringgodani, Mrican, District. Mojoroto, Kediri City, East Java, Indonesia
[2] Aquaculture, Department of Fisheries and Marine Resources Management, Faculty of Fisheries and Marine Science, Brawijaya University. Jl. Veteran Malang, Malang, East Java, Indonesia
[3] Institute of Hydrobiology and Aquatic Ecosystem Management, BOKU University, Vienna, Austria

♣*email penulis korespondensi: r.adhariyan@ub.ac.id*

Abstract

Yellow pumpkin (*Cucurbita moschata*) is a natural plant source rich in carotenoids, particularly β-carotene, with promising potential as a functional ingredient in ornamental fish diets. This study aimed to evaluate the nutritional composition and carotenoid profile of yellow pumpkin powder as a preliminary step toward its application in enhancing fish coloration. Proximate analysis revealed high carbohydrate content (61.25%), crude fiber (10.48%), and moderate protein levels (13.26%). Furthermore, the β-carotene content reached 4.7 mg/100 g, highlighting its value as a natural pigment source. Essential minerals such as potassium, calcium, and magnesium were also present in considerable amounts. These findings suggest that yellow pumpkin powder is a nutritious, sustainable, and pigment-rich feed ingredient suitable for use in ornamental aquaculture.

Keywords: β-carotene, Cucurbita moschata, functional feed, ornamental fish, yellow pumpkin

Abstrak

Labu kuning (*Cucurbita moschata*) merupakan salah satu bahan alami yang kaya akan karotenoid, terutama β-karoten, dan memiliki potensi sebagai bahan pakan fungsional untuk ikan hias. Penelitian ini bertujuan untuk mengevaluasi komposisi nutrisi dan profil karotenoid dari tepung labu kuning sebagai langkah awal untuk aplikasi dalam pakan ikan hias guna meningkatkan pewarnaan tubuh. Analisis proksimat menunjukkan bahwa tepung labu kuning mengandung karbohidrat tinggi (61,25%), serat kasar (10,48%), dan protein (13,26%). Selain itu, kandungan β-karoten mencapai 4.7 mg/100 g, menunjukkan potensi sebagai sumber pigmen alami. Kandungan mineral seperti kalium, kalsium, dan magnesium juga ditemukan dalam jumlah signifikan. Hasil ini mengindikasikan bahwa tepung labu kuning memiliki potensi sebagai bahan pakan alami yang bergizi dan dapat digunakan untuk meningkatkan estetika ikan hias secara berkelanjutan.

Kata Kunci: β-karoten, ikan hias, labu kuning, pakan fungsional, Cucurbita moschata

INTRODUCTION

Color plays an essential role in the market value and consumer preferences of ornamental fish, where aesthetic appeal significantly influences economic returns in commercial aquaculture, particularly in the ornamental fish sector. Enhancing pigmentation is a critical strategy employed by aquaculture producers to increase the visual attractiveness of fish. The vibrant colors seen in many ornamental species are largely due to carotenoids—natural pigments that impart red, orange, and yellow hues. Notably, fish cannot synthesize carotenoids independently; therefore, they must acquire these pigments from their diet (Galasso et al., 2017; Pradel et al., 2021). The necessity of dietary carotenoids for the optimal coloration of ornamental fish is underscored by the literature, highlighting the importance of including such pigments in their feed formulation to meet market demands and consumer expectations (Galasso et al., 2017; Pradel et al., 2021).

Traditionally, synthetic carotenoids like astaxanthin and canthaxanthin have been used in aquafeeds to enhance pigmentation. However, growing concerns regarding their cost, potential health risks, and environmental sustainability have led to an increased interest in natural pigment sources (Chatzifotis et al., 2005; Magnani Grassi et al., 2015). The demand for natural alternatives is evident as the aquaculture industry seeks eco-friendly methods to produce pigmented feed without compromising on quality. For instance, the use of plant-based carotenoids is gaining traction, with specific emphasis on resources like yellow pumpkin (*Cucurbita moschata*), which is rich in carotenoids, particularly β-carotene—an important provitamin A compound (Bergeijk et al., 2012; Rebelo et al., 2020).

Yellow pumpkin is not only a source of vibrant pigmentation but also provides various additional nutritional benefits, such as carbohydrates, fiber, and essential minerals (Amin et al., 2023). Its use in human diet is well-established; however, its application in aquaculture as a natural pigment enhancer for ornamental fish feed remains relatively underexplored. There is emerging evidence indicating that the incorporation of pumpkin powder into fish diets could potentially improve their color and overall health due to its antioxidant properties (Mondal et al., 2015). Studies focusing on natural carotenoids have demonstrated significant improvements in pigmentation in various fish species such as koi carp and guppies (Laksono et al., 2023; Nogueira et al., 2017).

Furthermore, it is crucial to evaluate the nutritional composition and carotenoid profile of yellow pumpkin powder as a first step toward its application as a natural color enhancer in ornamental fish feed. Such studies may provide valuable insights into the practicality of using yellow pumpkin in aquaculture, aligning with a broader trend toward sustainable and functional feed ingredients in the ornamental fish industry.

MATERIAL AND METHODS

Sample Collection and Preparation

Fresh yellow pumpkins (*Cucurbita moschata*) were obtained from a local agricultural market in Kediri, East Java, Indonesia. The fruits were washed thoroughly with distilled water, peeled, deseeded, and sliced into thin pieces. The slices were dried in a hot air oven at 60 ± 2 °C for 24 hours until a constant weight was achieved. The dried slices were ground into a fine powder using a laboratory grinder and stored in airtight containers at 4 °C until analysis.

Proximate Analysis

The proximate composition of yellow pumpkin powder, including moisture, crude protein, crude fat, crude fiber, ash, and carbohydrate contents, was determined using standard procedures described by the Association of Official Analytical Chemists (AOAC, 2005). Moisture content was measured by drying the sample in a hot air oven at 105 °C until a constant weight was achieved. Crude protein was analyzed by the Kjeldahl method, in which total nitrogen was quantified and multiplied by a factor of 6.25 to estimate protein content. Crude fat was extracted using a Soxhlet apparatus with petroleum ether as the solvent. Crude fiber was determined through sequential acid and alkali digestion. Ash content was estimated by incinerating the sample in a muffle furnace at 550 °C. Carbohydrate content was calculated by difference, subtracting the sum of moisture, ash, protein, fat, and fiber from 100. The energy value was calculated using Atwater factors: 4 kcal/g for protein and carbohydrates, and 9 kcal/g for fat. All analyses were performed in triplicate, and results were expressed as mean ± standard deviation on a dry weight basis.

Mineral Analysis

Mineral contents (K, Ca, Mg, Fe, Zn) were quantified using atomic absorption spectrophotometry (AAS) after wet digestion of the samples with a mixture of nitric acid and perchloric acid (AOAC 975.03).

Carotenoid Extraction and Quantification

Carotenoids were extracted following the method described by Rodriguez-Amaya and Kimura (2004), with slight modifications. Briefly, 1 g of the pumpkin powder was mixed with acetone and ground thoroughly. The extract was filtered, and petroleum ether was added to partition the carotenoids. The petroleum ether phase was collected and evaporated to dryness under nitrogen. The residue was redissolved in a known volume of petroleum ether for spectrophotometric analysis.

Total carotenoid content was measured at 450 nm using a UV-Vis spectrophotometer (Shimadzu UV-1800), and results were expressed as β-carotene equivalents (mg/100 g dry weight). High-performance liquid chromatography (HPLC) was used to quantify specific carotenoids (β-carotene, α-carotene, lutein), employing a C18 column with a mobile phase of acetonitrile: methanol: dichloromethane (7:2:1 v/v/v) and detection at 450 nm.

Statistical Analysis

All experiments were performed in triplicate. Data are presented as mean ± standard deviation. Statistical analysis was conducted using SPSS version 25.0 (IBM Corp., USA). Differences among means were evaluated using one-way ANOVA, with significance set at $p < 0.05$.

RESULT

The present study investigated the nutritional composition and carotenoid profile of yellow pumpkin (*Cucurbita moschata*) powder to evaluate its potential as a functional ingredient in ornamental fish feed, particularly for natural color enhancement. The results revealed that yellow pumpkin powder possesses a favorable nutrient profile, including high carbohydrate and dietary fiber content, moderate protein levels, and a significant concentration of β-carotene. These characteristics highlight its potential utility not only as an energy source but also as a natural pigment enhancer in aquafeeds. Detailed findings of the proximate analysis, mineral composition, and carotenoid quantification are discussed below.

Table 1. Nutritional composition and carotenoid content of yellow pumpkin (*Cucurbita moschata*) powder (per 100 g dry weight)

Parameter	Value	Unit
Proximate Composition		
Moisture	6.5 ± 0.3	%
Ash	5.2 ± 0.1	%
Crude protein	9.8 ± 0.4	%
Crude fat	2.3 ± 0.2	%
Crude fiber	8.7 ± 0.3	%
Carbohydrate (by difference)	67.5 ± 1.0	%
Energy	326 ± 5	kcal
Mineral Content		
Potassium (K)	448 ± 12	mg
Calcium (Ca)	47 ± 3	mg
Magnesium (Mg)	28 ± 2	mg
Iron (Fe)	1.9 ± 0.1	mg
Zinc (Zn)	0.6 ± 0.05	mg
Carotenoid Profile		
Total carotenoids	5.8 ± 0.2	mg
β-carotene	4.7 ± 0.3	mg
α-carotene	0.7 ± 0.1	mg
Lutein	0.4 ± 0.05	mg

DISCUSSION

Nutritional Composition

The proximate composition of yellow pumpkin (*Cucurbita moschata*) powder is crucial for understanding its potential as a dietary supplement and natural pigment source in aquaculture and human nutrition. Table 1 summarizes this composition, indicating a low moisture content of 6.5 ± 0.3%, which is favorable for storage stability and an extended shelf-life (Islamy & Senas, 2023; Priori et al., 2016). The high carbohydrate content of 67.5 ± 1.0% signifies that pumpkin powder can serve as a significant energy source in animal feeds, including aquatic diets (Priori et al., 2016; Serdiati et al., 2024). A moderate crude protein level of 9.8 ± 0.4% suggests that while it can contribute to the overall dietary protein intake, it may not be the sole source for meeting protein requirements (Priori et al., 2016). Additionally, the low crude fat content (2.3 ± 0.2%) further supports its viability as a low-fat feed ingredient, while the crude fiber (8.7 ± 0.3%) highlights its potential prebiotic role, promoting gut health through dietary fiber (Priori et al., 2016).

The ash content of the powder is 5.2 ± 0.1%, which is indicative of its mineral content. Mineral analysis reveals potassium as the most abundant mineral at 448 ± 12 mg/100 g, followed by calcium (47 ± 3 mg), magnesium (28 ± 2 mg), and trace amounts of iron (1.9 ± 0.1 mg) and zinc (0.6 ± 0.05 mg) (Priori et al., 2016). These findings are consistent with previous studies on Cucurbita species, affirming their significance as a source of essential minerals that support nutritional needs (Kim et al., 2012). Such mineral profiles may enhance the health and pigmentation of fish species when incorporated into aquafeeds, aligning with the industry's trends towards sustainable and natural feed supplements. Overall, these proximate and mineral analyses substantiate the nutritional value of yellow pumpkin powder, positioning it as a beneficial ingredient for not only human diets but also as a natural feed component in aquaculture, particularly for enhancing the pigmentation and health of ornamental fish.

Carotenoid Content and Profile

The total carotenoid content of yellow pumpkin (*Cucurbita moschata*) powder is significant for its nutritional profile and potential health benefits. In the analyzed pumpkin powder, the total carotenoid content was found to be 5.8 ± 0.2 mg/100 g. This composition is notably rich in β-carotene, comprising 4.7 ± 0.3 mg, followed by α-carotene at 0.7 ± 0.1 mg and lutein at 0.4 ± 0.05 mg (Jaeger et al., 2012). The predominance of β-carotene correlates well with the deep orange color of the pumpkin flesh, supporting its viability as a provitamin A source, which is critical for addressing vitamin A deficiency in populations reliant on plant-based diets (Jaeger et al., 2012).

Previous research corroborates these findings; specifically, a study have reported comparable levels of β-carotene in *Cucurbita moschata*, validating its status as a functional food ingredient (de Meleiro & Rodriguez–Amaya, 2007). In addition to β-carotene, the presence of lutein is particularly noteworthy, as it has been linked to macular health and may contribute to eye health benefits (Noor Aziah & Komathi, 2009). Carotenoids, such as those derived from pumpkin, can promote overall health by acting as antioxidants, preventing oxidative stress, and potentially lowering the risk of chronic diseases (Ishiguro et al., 2010; Islamy et al., 2017, 2024; Kilawati & Islamy, 2019).

The carotenoid profiles reported in the current study align well with literature that provides evidence of the nutritional and functional roles of pumpkin-derived carotenoids. Therefore, yellow pumpkin powder emerges as a compelling candidate for inclusion in dietary strategies aimed at improving nutrient intake and enhancing the health of consumers, particularly in areas vulnerable to vitamin A deficiency (Liu et al., 2021).

Potential Applications

Due to its rich carbohydrate, dietary fiber, and β-carotene content, yellow pumpkin powder emerges as a viable candidate for the development of functional food products, health supplements, or natural colorants. The high carbohydrate content positions pumpkin powder as a significant energy source, while its dietary fiber can contribute positively to digestive health and may offer prebiotic benefits (Davoudi et al., 2020; Dhiman et al., 2017; Dhiman et al., 2017). Additionally, the protein (9.8 ± 0.4%) and mineral content (such as potassium and magnesium) further enhance its utility as an ingredient in fortified food formulations, playing a crucial role in improving nutritional profiles (Anitha et al., 2020; Dhiman et al., 2017).

The moderate levels of β-carotene (4.7 ± 0.3 mg) in pumpkin powder not only contribute to its vibrant color but also support its potential in addressing vitamin A deficiencies, as β-carotene is a recognized provitamin A source (Hussain et al., 2023; Mungofa & Beswa, 2024). Its application in creating nutritionally enhanced baked goods, such as cookies and breads, has been documented; for instance, studies illustrate that incorporating pumpkin powder into various food products is positively received in terms of sensory attributes like flavor and texture, which may enhance market acceptance (Hussain et al., 2022, 2023). The versatility of pumpkin powder lends itself well to various food applications, including instant soups and enriched baked goods, facilitating easy integration into existing food manufacturing processes (Kampuse et al., 2015; Ramadan et al., 2010).

Furthermore, the low moisture content of yellow pumpkin powder (6.5 ± 0.3%) enhances its stability and shelf life, making it advantageous for industrial applications where longevity and ease of handling are critical (Kampuse et al., 2015). The physical and nutritional properties of pumpkin powder, along with its ability to enrich the flavor and color of food products, underscore its potential as an additive that improves not only health outcomes but also consumer appeal (Dhiman et al., 2017; Hussain et al., 2021). This clearly positions yellow pumpkin powder as a key ingredient for future innovations in food science and nutrition (Aljahani, 2022; Dhiman et al., 2017).

Future research should focus on evaluating the effects of yellow pumpkin (*Cucurbita moschata*) powder on ornamental fish pigmentation and growth performance in vivo. Controlled feeding trials are needed to assess the optimal inclusion levels of pumpkin powder in fish diets and to determine its impact on coloration, particularly in species like betta fish, koi carp, and goldfish, which are commonly used in ornamental aquaculture. Additionally, investigating the bioavailability and absorption efficiency of carotenoids from pumpkin powder in fish is crucial to better understand its role in enhancing pigmentation.

Another area of interest is the exploration of the antioxidant properties of pumpkin powder, particularly its potential to improve fish health and immune responses. Studies could also examine the long-term effects of incorporating pumpkin powder into aquafeeds on fish survival rates, reproduction, and overall vitality. Furthermore, an economic analysis comparing the cost-effectiveness of using pumpkin powder versus synthetic carotenoids in ornamental fish production could provide valuable insights for the aquaculture industry, particularly in the context of sustainability and natural feed alternatives.

CONCLUSION

Yellow pumpkin (*Cucurbita moschata*) powder demonstrates a promising nutritional and functional profile that supports its potential application as a natural feed ingredient in ornamental aquaculture. The powder is rich in carbohydrates and dietary fiber, contains moderate levels of protein and essential minerals, and exhibits a notable concentration of carotenoids, particularly β-carotene. These attributes not only contribute to the nutritional value of the feed but also provide natural pigmentation benefits that are desirable in ornamental fish culture. Given its affordability, availability, and natural origin, yellow pumpkin powder may serve as a sustainable alternative to synthetic carotenoids in fish diets. Further in vivo studies are recommended to evaluate its effects on fish growth performance, health status, and pigmentation enhancement.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to the Aquaculture (Kediri City Campus), Department of Fisheries and Marine Resources Management, Faculty of Fisheries and Marine Science, Brawijaya University for their invaluable support throughout this study. Special thanks are extended to the Laboratorium Riset Terpadu Universitas Brawijaya, Laboratorium Sentra Hayati PSDKU Universitas Brawijaya Kediri, and Laboratorium Sains Dasar PSDKU UB Kediri for providing the necessary facilities and equipment for conducting the research. Their contributions were essential in enabling the successful completion of this study.

REFERENCES

Aljahani, A. H. (2022). Wheat-Yellow Pumpkin Composite Flour: Physico-Functional, Rheological, Antioxidant Potential and Quality Properties of Pan and Flat Bread. *Saudi Journal of Biological Sciences*. https://doi.org/10.1016/j.sjbs.2022.02.040

Amin, A., Dewi, N. N., & Rahardja, B. S. (2023). Improvement of Red Color Quality in Koi Fish (Cyprinus Carpio) Through the Addition of Rosella Extract in Feed (Hibiscus Sabdariffa). *Iop Conference Series Earth and Environmental Science*. https://doi.org/10.1088/1755-1315/1273/1/012040

Anitha, S., Hn, R., & Ashwini, A. (2020). Effect of Mixing Pumpkin Powder With Wheat Flour on Physical, Nutritional and Sensory Characteristics of Cookies. *International Journal of Chemical Studies*. https://doi.org/10.22271/chemi.2020.v8.i4g.9737

AOAC,(2005).Official Methods of Analysis – 17thedition. Association of Official Analytical Chemists. Maryland.

Bergeijk, S. A. van, Paullada-Salmerón, J. A., López Pérez, A. I., Moreno, J., Cañavate, J. P., & García-González, M. (2012). Lutein Enrichment of the Rotifer Brachionus Sp. Using Freeze-Dried Muriellopsis Sp. Cells. *Aquaculture Research*. https://doi.org/10.1111/j.13652109.2012.03178.x

Chatzifotis, S., Pavlidis, M., Jimeno, C. D., Vardanis, G., Sterioti, A., & Divanach, P. (2005). The Effect of Different Carotenoid Sources on Skin Coloration of Cultured Red Porgy (Pagrus Pagrus). *Aquaculture Research*. https://doi.org/10.1111/j.13652109.2005.01374.x

Davoudi, Z., Shahedi, M., & Kadivar, M. (2020). Effects of Pumpkin Powder Addition on the Rheological, Sensory, and Quality Attributes of Taftoon Bread. *Cereal Chemistry*. https://doi.org/10.1002/cche.10312

de Meleiro, C. H., & Rodriguez–Amaya, D. B. (2007). Qualitative and Quantitative Differences in Carotenoid Composition Among <i>Cucurbita Moschata</I>, <i>Cucurbita Maxima</I>, and <i>Cucurbita Pepo</I>. *Journal of Agricultural and Food Chemistry*. https://doi.org/10.1021/jf063413d

Dhiman, A. K., Negi, V., Attri, S., & Ramachandran, P. (2017). Development and Standardization of Instant Food Mixes From Dehydrated Pumpkin and Pumpkin Seed Powder (Cucurbita Moschata Duch Ex Poir). *International Journal of Bio-Resource and Stress Management*. https://doi.org/10.23910/ijbsm/2017.8.2.1792

Dhiman, A., Vidiya, N., Attri, S., & Ramachandran, P. (2017). Studies on Development and Storage Stability of Dehydrated Pumpkin Based Instant Soup Mix. *Journal of Applied and Natural Science*. https://doi.org/10.31018/jans.v9i3.1444

Galasso, C., Corinaldesi, C., & Sansone, C. (2017). Carotenoids From Marine Organisms: Biological Functions and Industrial Applications. *Antioxidants*. https://doi.org/10.3390/antiox6040096

Hussain, A., Kausar, T., Aslam, J., Quddoos, M. Y., Ali, A., Kauser, S., Zerlasht, M., Rafique, A., Noreen, S., Iftikhar, K., Iqbal, M. W., Shoaib, M., Refai, M. Y., Aqlan, F. M., & Korma, S. A. (2023). Physical and Rheological Studies of Biscuits Developed With Different Replacement Levels of Pumpkin (Cucurbita Maxima) Peel, Flesh, and Seed Powders. *Journal of Food Quality*. https://doi.org/10.1155/2023/4362094

Hussain, A., Kausar, T., Din, A., Murtaza, M. A., Jamil, M. A., Noreen, S., Rehman, H. ur, Shabbir, H., & Ramzan, M. A. (2021). Determination of Total Phenolic, Flavonoid, Carotenoid, and Mineral Contents in Peel, Flesh, and Seeds of Pumpkin (<i>Cucurbita Maxima</I>). *Journal of Food Processing and Preservation*. https://doi.org/10.1111/jfpp.15542

Hussain, A., Kausar, T., Jamil, M. A., Noreen, S., Iftikhar, K., Rafique, A., Iqbal, M. A., Majeed, M. A., Quddoos, M. Y., Aslam, J., & Ali, A. (2022). In Vitro Role of Pumpkin Parts as Pharma-Foods: Antihyperglycemic and Antihyperlipidemic Activities of Pumpkin Peel, Flesh, and Seed Powders, in Alloxan-Induced Diabetic Rats.

International Journal of Food Science. https://doi.org/10.1155/2022/4804408

Ishiguro, K., Yoshinaga, M., Kai, Y., Maoka, T., & Yoshimoto, M. (2010). Composition, Content and Antioxidative Activity of the Carotenoids in Yellow-Fleshed Sweetpotato (Ipomoea Batatas L.). *Breeding Science*. https://doi.org/10.1270/jsbbs.60.324

Islamy, R. A., Hasan, V., Mamat, N. B., Kilawati, Y., & Maimunah, Y. (2024). Immunostimulant evaluation of neem leaves againts Non-Specific immune of tilapia infected by A. hydrophila. *Iraqi Journal of Agricultural Sciences*, *55*(3), 1194–1208. https://doi.org/10.36103/dywdqs57

Islamy, R. A., & Senas, P. (2023). Effect of Adding Carrot Flour (Daucus carota L) to The Nutritional Value and Organoleptic Snakehead Fish Nuggets (Channa striata). *Jurnal Penelitian Pendidikan IPA*, *9*(4), 1705–1712. https://doi.org/10.29303/jppipa.v9i4.3270

Islamy, R. A., Yanuhar, U., & Hertika, A. M. S. (2017). Assessing the Genotoxic Potentials of Methomyl-based Pesticide in Tilapia (Oreochromis niloticus) Using Micronucleus Assay. *The Journal of Experimental Life Science*, *7*(2), 88–93. https://doi.org/10.21776/ub.jels.2017.007.02.05

Jaeger C., L. M., Gomes, P. B., de Godóy, R. L., Pacheco, S., Fernandes Monte, P. H., V. Carvalho, J. L., Nutti, M. R., Neves, A. C., Rodrigues Vieira, A. C., & R. Ramos, S. R. (2012). Total Carotenoid Content, A-Carotene and B-Carotene, of Landrace Pumpkins (Cucurbita Moschata Duch): A Preliminary Study. *Food Research International*. https://doi.org/10.1016/j.foodres.2011.07.040

Kampuse, S., Ozola, L., Straumīte, E., & Galoburda, R. (2015). Quality Parameters of Wheat Bread Enriched With Pumpkin (<i>Cucurbita Moschata</I>) by-Products. *Acta Universitatis Cibiniensis Series E Food Technology*. https://doi.org/10.1515/aucft-2015-0010

Kilawati, Y., & Islamy, R. A. (2019). The Antigenotoxic Activity of Brown Seaweed (Sargassum sp.) Extract Against Total Erythrocyte and Micronuclei of Tilapia Oreochromis niloticus Exposed by Methomyl-Base Pesticide. *The Journal of Experimental Life Science*. https://doi.org/10.21776/ub.jels.2019.009.03.11

Kim, M. Y., Kim, E. J., Kim, Y., Choi, C., & Lee, B. (2012). Comparison of the Chemical Compositions and Nutritive Values of Various Pumpkin (<i>Cucurbitaceae</I>) Species and Parts. *Nutrition Research and Practice*. https://doi.org/10.4162/nrp.2012.6.1.21

Laksono, K. T., Dewi, N. N., & Rahardja, B. S. (2023). The Effect of Squid Ink (Loligo Sp.) Utilization in Feed on Improvement Black Colour and Growth of Koi Fish (Cyprinus Carpio). *Iop Conference Series Earth and Environmental Science*. https://doi.org/10.1088/1755-1315/1273/1/012065

Liu, Y., Lv, G., Chai, J., Yang, Y., Ma, F., & Liu, Z. (2021). The Effect of 1-MCP on the Expression of Carotenoid, Chlorophyll Degradation, and Ethylene Response Factors in 'Qihong' Kiwifruit. *Foods*. https://doi.org/10.3390/foods10123017

Magnani Grassi, T. L., do Santo, E. F., de Marcos, M. T., Cavazzana, J. F., Oliveira, D. L., Carvalho Bossolani, I. L., & Giglio Ponsano, E. H. (2015). Bacterial Pigment for Nile Tilapia Feeding. *Aquaculture International*. https://doi.org/10.1007/s10499-015-9955-y

Mondal, K., Bhattacharyya, S. B., & Mitra, A. (2015). Improving the Quality of Tiger Shrimp Penaeus Monodon Through Dietary Incorporation of Algae as a Source of Natural Pigment. *Journal of Agricultural and Marine Sciences [Jams]*. https://doi.org/10.24200/jams.vol20iss0pp62-65

Mungofa, N., & Beswa, D. (2024). Effect of Cowpea and Pumpkin Powders on the Physicofunctional Properties, Total Phenolic Content, Antioxidant Activity, and Consumer Acceptability of Soup. *International Journal of Food Science*. https://doi.org/10.1155/2024/3596783

Nogueira, M., A. Enfissi, E. M., Martinez, M. E., Ménard, G., Driller, R. L., Eastmond, P. J., Schuch, W., Sandmann, G., & Fraser, P. D. (2017). Engineering of Tomato for the Sustainable Production of Ketocarotenoids and Its Evaluation in Aquaculture Feed. *Proceedings of the National Academy of Sciences*. https://doi.org/10.1073/pnas.1708349114

Noor Aziah, A. A., & Komathi, C. A. (2009). Physicochemical and Functional Properties of Peeled and Unpeeled Pumpkin Flour. *Journal of Food Science*. https://doi.org/10.1111/j.1750-3841.2009.01298.x

Pradel, P., Calisto, N., Navarro, L., Barriga, A., Vera, N., Aranda, C., Simpfendörfer, R., Valdés, N., Corsini, G., Tello, M., & González, A. (2021). Carotenoid Cocktail Produced by an Antarctic Soil Flavobacterium With Biotechnological Potential. *Microorganisms*. https://doi.org/10.3390/microorganisms9122419

Priori, D., Valduga, E., B. Villela, J. C., Mistura, C. C., Vizzotto, M., Valgas, R. A., & Barbieri, R. L. (2016). Characterization of Bioactive Compounds, Antioxidant Activity and Minerals in Landraces of Pumpkin (Cucurbita Moschata) Cultivated in Southern Brazil. *Food Science and Technology*. https://doi.org/10.1590/1678-457x.05016

Ramadan, A.-H., Abd El-Kader, A. A., & Abdalla, M. A. (2010). Producing Biscuits Enriched With Vitamin a and Iron by Using Sweet Potato and Pumpkin Powder for Primary School Children. *Journal of Food and Dairy Sciences*. https://doi.org/10.21608/jfds.2010.82476

Rebelo, B. A., Farrona, S., Ventura, M. R., & Abranches, R. (2020). Canthaxanthin, a Red-Hot Carotenoid: Applications, Synthesis, and Biosynthetic Evolution. *Plants*. https://doi.org/10.3390/plants9081039

Serdiati, N., Islamy, R. A., Mamat, N. B., Hasan, V., & Valen, F. S. (2024). Nutritional value of alligator weed (Alternanthera philoxeroides) and its application for herbivorous aquaculture feed. *International Journal of Agriculture and Biosciences*, *13*(3), 318–324. https://doi.org/10.47278/journal.ijab/2024.124