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Proximate composition of surimi-based value-added products from Milkfish (*Chanos chanos*)

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Abstract

Surimi, a versatile seafood ingredient, serves as the foundation for various processed products. The purpose of this study was to utilize and formulate surimi-based products such as fish balls, fish nuggets, and shrimp analogue using milkfish surimi to boost fish consumption and contribute to the production of nutritious food items to address the increasing demand for more variety of healthy products. Results on the proximate composition analysis of each product showed that moisture content was the predominant component in all products, followed by crude protein, with low levels of crude fat, crude fiber, and ash content. However, the amount of crude fat, crude fiber, and ash content varied among the products. This variability is attributed to the added ingredients or seasonings, which contributed to the differences in proximate composition values. Therefore, the study suggests that using surimi to develop ready-to-cook (RTC) and Ready-to-Eat (RTE) products from fish, with the right ingredients and formulation process, could lead to the creation of new nutritious products.

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Introduction

Milkfish, locally known as "Bangus" (*Chanos chanos* Forsskal, 1775), which is endemic in the Indo-Pacific Region predominantly along the Coral Reef Triangle holds a prominent position as the primary fish commodity in the Philippines, standing out as the leading commodity both in terms of production and consumption. As reported by BFAR, the production of milkfish in 2020 was 416,315 metric tons (MT), representing 17.9% of the entire production from fisheries and adding roughly Php 43.5 billion to the GDP of the nation. This sum amounts to around 2 to 3 percent of the Gross Value Added (GVA) productivity for the Agriculture, Fishery, and Forestry (AFF) industries. Over the past two decades, the volume of harvested milkfish has risen significantly, escalating from 225,337 MT in 2001 to 416,315 MT in 2020, reflecting an impressive production growth of about 84.5%. On average, its production performance displayed a 3.37% annual growth rate increment (PSA, 2020). Notably, milkfish constitutes approximately 10% of the average Filipino household's annual fish consumption, which is 36.8 kg, as per the BFAR Philippine Fisheries Profile in 2018. Moreover, in the Philippines, the production of milkfish (*Chanos chanos*) is notably high since it is cultured in a wide range of water systems which includes freshwater, brackishwater, and marine environments. Also, Milkfish stands out as a sought-after species for aquaculture due to various factors. The hardiness and ease of handling of milkfish fry are notable, attributed to its remarkable tolerance and adaptability to changes in salinity. Moreover, it exhibits a superior growth rate in comparison to other herbivorous fish, making it conducive for polyculture alongside other finfish and crustaceans. The species' robust resistance to diseases further enhances its suitability for success in aquaculture ventures and this elevated production not only meets demand but also opens avenues for creating value-added goods, particularly those centered on surimi-based products. Indeed, one of the priorities under the Philippine Milkfish Industry Roadmap 2021-2040 is to develop and make available more value-added milkfish products in the market, which significantly contributes to increased income for milkfish farmers through diversified value-added products (BFAR, 2022).

However, regarding market and trade dynamics, milkfish represent a substantial portion of the fish volume traded daily in nearly all public markets across the Philippines. The majority of locally traded milkfish is offered in a fresh chilled state, available either as whole fish or deboned. In contemporary times, an increasing proportion of the milkfish harvest undergoes processing to yield value-added products, including smoked, dried, marinated, fermented, canned, or bottled variations. Certain enterprises have adopted the manufacturing of milkfish products packaged using vacuum-sealing techniques, facilitating their entry into global markets. Notably, surimi-based products using milkfish is not yet widely practiced, but there have been several studies on surimi production utilizing different species of fish such as mackerel (Panpipat, 2023), lizardfish (Jaziri *et al.*, 2021), and Bigtooth pompret (Endoma *et al.*, 2022). Milkfish is a fish variety suitable as a raw ingredient for surimi production (Yuliana *et al.*, 2020). As per the USDA National Nutrient Database for Standard Reference (2013), milkfish is identified as a high-protein and medium-fat fish, with protein content at 20.53% and fat content at 6.73%. The fresh milkfish has the following special nutritional value: it contains 19.56% omega-3, 7.47% omega-6, and 19.24% omega-9. In a study conducted by Yuliana *et al.* (2018), they reported that the yield of milkfish surimi was 58.72% which makes it a potential raw material for surimi making. The term "Surimi" originates from Japan and refers to a partially processed frozen fish protein, where the minced fish meat has undergone leaching by water and adding cryoprotectants and is then subjected to freezing. Additionally, incorporating surimi into food items is a method for developing new value-added products. Furthermore, there is a keen interest in broadening the utilization of surimi in food processing to develop various surimi-based products that can be Ready-to-Eat (RTE) and Ready-to-Cook (RTC). Consequently, the development of surimi-based products holds the potential to boost fish consumption and contribute to the production of nutritious food items to address the increasing demand for more variety of healthy products.

Therefore, this study was conducted to develop and evaluate the proximate composition of value-added products derived from milkfish surimi such as fish nuggets, fish balls, and shrimp analogue.

Materials and methods

Processing of surimi from milkfish

Surimi was prepared following the method of Espejo-Hermes (2004) with some modifications, particularly on the cryoprotectant used which is egg white powder. Frozen surimi were thawed and subsequent blending was carried out using an electric mixer.

Preparation of surimi-based products

Fish nuggets

The formulation of fish nuggets has the following basic processing steps which include a Pre-cool stand mixer with ice and cut tempered surimi into cubes. Add salt and continue grinding until the mixture becomes sticky. Add onions and garlic and mix thoroughly, continue mixing for 2 minutes. Add Class A flour, oil, breadcrumbs, sugar, and shrimp powder, and mix for 5 minutes. Spread the mixture in an aluminum pan and cut them into desired sizes (2x3 cm) using a spatula then freeze for 4 hours. Dip nuggets in a cool batter mix then coat them with breadcrumbs, vacuum packed, and stored in a freezer.

Fish ball

Fish ball formulation followed these basic processing steps which comprised of thawing the frozen surimi (controlled thawing at -90C) and passing through a stand mixer. Add water equal to 30% of the weight of the frozen surimi. Mix minced fish with salt to make a paste, then add other ingredients. Form into balls manually using a spoon. Set the balls by placing them in water (40-450C) for 20-30 minutes. After setting, cook the product in boiling water on steam. Cooled after cooking then vacuum packed and stored in a freezer.

Shrimp analogue

Shrimp Analogue preparation followed these basic processing steps which comprised of Pre-cooling the stand mixer with ice and cutting tempered surimi into cubes. Add salt and continue mixing until the mixture becomes sticky. Add egg white powder, potato starch, and chilled water and mix well. The flavor enhancer (shrimp powder) is added then shrimp powder. Mix well. Spread the mixture in an aluminum pan. Cut them into desired sizes (4 cm long). Roll them into a cylindrical shape using aluminum foil until 1 cm in diameter. Steam for 30 minutes and cool. Vacuum-packed and stored in a freezer.

Proximate analysis

Proximate composition of fish nuggets, fish balls, and shrimp analogue, encompassing crude protein, crude fiber, crude fat, moisture, and ash content, adhered to the AOAC official method and was conducted by the laboratory technician at DA-CVIAL Region 2. The crude protein was determined through the Kjeldahl method, while the crude fiber and crude fat were determined using the ANKOM Filter bag Method. Additionally, the moisture and ash content were measured through the gravimetric method.

Results and discussion

Proximate composition of surimi-based products

Table 1 shows the proximate composition of surimi-based products (fish balls, fish nuggets, and shrimp analogue) using milkfish. It could be gleaned from the table that moisture was among the components with the highest values which is indicative of the amount of water present in all products. This can affect the texture and juiciness of the products, the higher the moisture content the more succulent and tender the products would be; followed by protein wherein milkfish is known as a high protein fish while the crude fat, crude fiber, and ash content values varied in each product which could be due to the added ingredients or seasonings that contributed to these proximate compositions value. It was noted also that the product with the highest moisture content was also found to have the highest protein content, whereas the product with the lowest moisture content had the lowest protein content which indicates that the high moisture content in each product was a consequence of a protein content wherein this parameter correlates directly with the product's water retention (Silva *et al.*, 2011).

Fish balls showed a notable moisture content of 72.44% which is within the range of Malaysian fish balls ranging from 72.5 to 89.9% (Huda *et al.,* 2010) and lower than the moisture content of fish balls produced from Indian mackerel which is 73.84 for 100g (Alkuraieef *et al.*, 2020). This indicates that the moisture content of products varies depending on the products and different factors which include raw materials, process, and composition of ingredients. However, if a product has lower moisture content it often means that the product will have a longer shelf life and be crunchier in terms of their texture. The crude protein content, recorded at 14.69%, the significant source of protein is the milkfish surimi which is 94% of the food composition. Huda *et al.*, 2010 emphasized that the protein content of fish ball products is attributed to the amount of fish meat added to the formulation. Moreover, Huda *et al.* (2010) also reported that the manufacturers of fish balls in Malaysia reduced their production costs by decreasing the amount of fish meat and substituting it with other extenders like starch which resulted in the low amount of protein in the products. The percentage of protein in the fish ball formulated using surimi of milkfish is higher compared to the recorded protein content of commercial Malaysian fish balls which ranged from 7.54 to 9.89% (Huda *et al.*, 2010). The ash content of 2.60% denotes a discernible presence of inorganic minerals, while the least component is the crude fat content at 1.76% which is higher compared to the fat content of commercial Malaysian fish balls ranging from 0.13 to 1.75% in the study of Huda *et al.*, 2010 and fish balls made from Indian mackerel with a fat content of 0.43%. The fat content of fish balls using milkfish surimi was under the proposed limit of fat intake which stipulates below 30% (WHO). There are various types of fat present in food such as trans fatty acids, saturated fatty acids, and unsaturated fatty acids (Mumena *et al.*, 2023). However, milkfish is a type of fatty fish, and the fat content is primarily composed of saturated and polyunsaturated fats including omega-3 fatty acids. Moreover, the fatty acid composition of fish is influenced by various environmental factors such as salinity and temperature. The crude fiber content of 2.01% indicates the presence of indigestible plant material.

Fish nuggets are widely regarded as a favorite convenient food choice globally, owing to their superior nutritional value, attractive sensory characteristics, safety for consumption, low price, and the convenience of being ready-to-eat fish products (Barbut, 2012). Notably, fish nuggets exhibit a moisture content of 56.95%, signifying considerable juiciness and tenderness. The crude fat content, measured at 3.13%, significantly contributes to the richness and flavor profile, wherein this crude fat content is lower compared to the fat content of chicken nuggets which ranged from 18.14-25% (Lukman *et al.*, 2009) which indicates that the fish nuggets formulated using milkfish surimi is healthier than chicken nuggets. According to the World Health Organization (WHO), dietary fat is crucial for good health, with both quantity and quality playing significant roles. WHO advises also that adults should restrict total fat intake to 30% or less of total energy intake. Additionally, fat consumed by individuals aged 2 years and older should consist mainly of unsaturated fatty acids, with saturated fatty acids contributing no more than 10% of total energy intake and trans-fatty acids no more than 1% of total energy intake, sourced from both industrially produced and ruminant animal sources. While the crude protein content of 12.94% establishes a noteworthy source of essential nutrients. The ash content is 2.32%, indicating a lower yet substantial presence of inorganic minerals. Lastly, the crude fiber content is minimal at 0.01%, underscoring a negligible contribution of indigestible plant material (e.g. onions and garlic) to the overall composition.

Table 1. Proximate Composition of surimi-based products

Lab No.	Sample description	Crude Protein %	Crude Fiber %	Crude Fat %	Moisture %	Ash %
FT-2022-0231	Fish Balls	14.69	2.01	1.76	72.44	2.60
FT-2022-0232	Fish Nuggets	12.94	0.01	3.13	56.95	2.32
FT-2022-0233	Shrimp Analogue	13.52	1.04	2.11	70.15	2.41

The proximate composition of the shrimp analog using milkfish surimi was 70.15% moisture content, 13.52% crude protein, 2.41% ash content, 2.11 crude fat, and 1.04% crude fiber as shown in Table 1. The study of Karuppasamy *et al.* (2019) on the proximate composition of the ready-to-eat shrimp analogue using surimi of lizard fish had 87% moisture content which is higher compared to shrimp analogue formulated using milkfish surimi. However, the concentration of other proximate compositions of the products in this study such as protein, ash content, and crude fat is relatively higher than on shrimp analogue using surimi of lizard fish. In the results of the study of Arpi *et al.* (2020), the value of protein content in shrimp with different treatments ranged from 7.88 to 16.34% with an average of 12. 26% which is lower compared to this present study. This indicates that the ingredients (e.g. egg white) in the formulation contributed to the level of protein content which is similar to the results of the study of Arpi *et al.* (2020) that incorporating additives like egg whites in the formulation of shrimp analog, the protein content of the product will increase. Furthermore, the fat content of shrimp analogue from milkfish surimi is higher compared to that of triggerfish, sardine, tilapia, and snakehead fish with a fat content ranging from 0.44% to 0.48% with an average of 0.46 but lower to the fat content of analogue shrimp made from African catfish surimi (Sahubawa *et al.*, 2023). In terms of crude fiber, majority of the innovative products of shrimp analogue using surimi were not evaluated.

Conclusion

In summary, this study aimed to formulate surimi-based products such as fish balls, fish nuggets, and shrimp analogs using milkfish surimi. The proximate composition analysis of each product showed that moisture content was the predominant component, followed by crude protein, with low levels of crude fat, crude fiber, and ash content. These compositions are considered beneficial for human health. Therefore, the study suggests that using surimi to develop ready-to-cook (RTC) and Ready-to-Eat (RTE) products from fish, with the right ingredients and formulation process, could lead to the creation of new nutritious products.

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