PRODUCT INNOVATIONS FROM TUNA AND MILKFISH PROCESSING BY-PRODUCTS FOR HUMAN FOOD CONSUMPTION

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ABSTRACT

Tuna and milkfish are the most internationally traded fishes in the Philippines. Both species are processed as canned/bottled; and frozen i.e. prime cuts. Practically, all stages involved in these processes can generate large volume of by-products. Meanwhile, backbones, frames and its adhering meat are regarded as milkfish by-products (11.3%). Out of about 50 % tuna by-products recorded, only about 35% are processed, of which 22% are black meat and 3.5% are brown meat. In Japan, tuna steaks and fillets without connective tissues (so-called sinew) command a much higher price, thus, contributing an additional 10–15 % of sinew to the total weight of the by-products. More than 12 processors are actively engaged in sashimi and sushi processing and 9 tuna canners based in General Santos City although, one of the latter had expanded to milkfish canning. Milkfish processing is more concentrated in Northern Luzon and Western Visayas with more than 10 companies engaged, predominantly in milkfish deboning (brined, marinated or smoked). The global demand for frozen and canned tuna and milkfish products is increasingly growing. This trend implies a more significant increase in the bulk of by-products that may be generated in the years to come. These by-products contain nutritionally important bioactive components in quantities that are comparable or even better than those found in the prime meats (Panggat, 1998). Transforming them into an innovative and market-competitive products will not only reduce disposal and environmental problems but will provide increased revenues.

Value-added tuna and milkfish products commonly produced in the Philippines include sausages (longanisa and hot dogs); fish balls, embutido, tocino, nuggets, burgers, spring rolls, quikiam and skin crispies among others. Tuna black meat that normally exhibits a strong flavor may however, be used as raw material for making high-jellied products e.g. chorizo and ham. Collaborative effort between the government and the entrepreneurs is deemed necessary in order to increase efficiency and productivity. New scientifically-derived formula e.g. restructured milkfish fillets, terrine, ham, fish rolls, and other ready-to-eat and ready-to-cook foods must be well disseminated and employed. Appropriate post-harvest technologies including packaging and marketing as well as quality and safety management are important concerns that must also be addressed.

Key words: By-products, innovation, tuna black meat, sinews, and seafood terrines

INTRODUCTION

Tuna and milkfish are the most internationally traded fishes in the Philippines. Both species are processed as canned or bottled, chilled and frozen, although the former is primarily utilized for sashimi and sushi productions. Practically, all stages involved in the manufacturing processes can provide huge volumes of by-products, accounting to more than 50% of the fish body weight. These by-products contain nutritionally important substances e.g. proteins, omega-3 fatty acids, vitamins, minerals and other bioactive substances in quantities that are comparable or even better than those found in the prime meats (Panggat, 1998, Hearn et.al 1987; Saito et.al 1996; Panggat and Shindo 2003). These materials
generally offer the sensorial attributes, specifically desired for highly innovative value-added seafood products. Transforming them into novel seafood products will not only reduce disposal and environmental problems but will also provide increased revenues and food security.

Despite dwindling supply of raw materials for processing, especially on sashimi tuna, the conservation and management of the available fish stocks remain a top priority for the stakeholders. In anticipation of an increasing gap between supply and demand in fisheries, there is a strong imperative to optimize the use of available resources in the country. Milkfish aquaculture, however, ascertains the availability of raw materials for the production of chilled/frozen milkfish products e.g. boneless milkfish fillets, thus generating increased volumes of by-products. Strong collaboration though, between the government and the private sector is highly recommended to support the industry’s needs for better sustainability and productivity.

The expansion and diversification of product forms become an important concern in order to meet the export demand, particularly, on the quality and safety issues, including packaging and eco-labeling. Value-added products that are popularly sold at the retail stalls i.e. along the busy street corners, schools, malls and supermarkets include the fish balls, quikiam, spring rolls, sausages, burgers, nuggets amongst others. This paper presents status and trends; product innovations; opportunities and challenges for improved utilization of by-products generated from the processing of tuna and milkfish. The tuna referred to is mainly the yellow fin tuna.

GENERATION OF BY-PRODUCTS FROM TUNA AND MILKFISH PROCESSING

The importance of tuna and milkfish as raw materials for processing differs due to its variability in chemical and sensorial properties (e.g. muscle pigmentation, fat and moisture contents, etc.). Tuna is a migratory marine fish that can grow up to about 100 kg per piece while milkfish is a brackish water aquaculture fish which becomes ready for harvest as it reaches an average weight of around 500g. Both differ in their food habit. The former, being a carnivorous and the latter, an herbivorous, which make them invariably different in processing yields and functionality.

Tuna By-products

Production of tuna sashimi and sushi demands a prime quality raw material. Any deviations from specified quality standards would result to detention or rejection and subsequent increased volume of wastes. Out of the more than 50% by-products recorded, only about 35% are processed (Fig. 1). The rests are generally sold as residues at the local markets at a much cheaper price and currently used as raw materials for value-addition.
Percentage distribution of tuna by-products is presented in Fig. 2, in the decreasing order of proportion. The heads, gills and entrails; and black meat provide the highest share at the respective levels of 28.4% and 22%. The skin (5.8%) is used for making chicharon or cracklings while brown meat (3.5%) is predominantly used for making value-added tuna products such as longanisa (Philippine sausage), burgers, nuggets, fish balls and spring rolls.

Fig. 2. Percentage distribution of tuna by-products (Solidarios, pers. com. 2010).

Fig. 1. Percentage recovery of tuna by-products (Panggat and Shindo, 2003)
Black meat is very fatty, slimy and has a strong fishy odor and tastes (Fig. 3); while ribs have hard bones that limit its edibility (Fig. 4). Black meat is presently not used for any value adding purposes. However, with the advent of surimi and other advanced technologies, these materials may be transformed into high-end value-added products (e.g. high-jellied sausages, ham, etc.).

Removal of connective tissues (i.e. sinew) from tuna ground meat increases its yield and market price (Fig. 5, Fig. 6, and Fig. 7). Sinews can be used as binder and main ingredient in value adding seafood products. It renders a gelatinous and chewy texture to fish balls, tempura, sausages etc.

**Milkfish By-products**

The growing milkfish industry in the Philippines, specifically, production of boneless milkfish has largely contributed to increased volumes of wastes. The Aklan’s Boneless Bangus for instance, has the capacity to produce 8 tones per day of frozen boneless milkfish. There are around 10 milkfish processors registered in the country and each producing almost similar forms of products but invariably different in quality and price. Filleting of fish provides separation of wastes from the major edible portion i.e. meat. Percentage distribution of wastes generated from milkfish deboning is shown in Fig. 8. A total yield of edible meat (77.2 %) presents the largest portion. The entrails and bones with adhering meat accounted for 9.9% and 11.3 %, of the total body weight of fish, respectively, with fins the smallest (1.6%). Milkfish backbones with adhering meats are shown in Fig. 9.
SUSTAINABILITY AND ACCEPTABILITY OF BY-PRODUCTS INTENDED FOR VALUE-ADDITION

Supply and Demand

Sashimi processing has a tremendous impact in the international fish trade (11th National Tuna Congress, 2009). More than 12 processors in General Santos City are engaged in sashimi and sushi processing (Department of Trade and Industry, 2010). Demand for fresh/chilled and frozen yellow fin tuna is yet increasingly growing. This trend implies a more significant increase in the bulk of wastes that may be generated in the years to come.

Meanwhile, an increasing number of milkfish processors have already developed their own brands primarily intended for the international markets. These are dominated by processors engaged in freezing boneless milkfish and prime cut bellies. Majority of them are classified under the small and medium enterprises (SMEs) and are particularly situated in Northern and Central Luzon and Western Visayas, where milkfish aquaculture is evident. More than 50% of the total number of milkfish processors is already U.S.A and the EU accredited to export frozen deboned milkfish (seasoned or unseasoned fillets), prime cut bellies and stuffed or relleno. These products can yield equally vast amounts of by-products.

Forty per cent of the meat recovered from the backbones and further removal of pin bones during milkfish deboning are good materials for the development of embutido, sisig, and spring rolls, etc. (Sazon, pers.com.2010). A great portion of the produce is sold in high - rated Manila hotels, food chains and major beach resorts e.g. Boracay Beach Resort. Very limited amounts are exported to the U.S.A., mostly catering to the Filipino communities. But
with the growing interest of consumers to ethnic food innovations, traditional culinary arts are now becoming an integral part of new product development. Ethnic flavors continue to inspire food innovators to explore flavors from the many parts of Asia. It may be noted though, that processes presently employed by many processors, more particularly, the SME’s are generally fragmented and inconsistent in quality.

In times of gluts, growers and deboned milkfish processors tend to dump their huge wastes underground for convenience and economic reasons. Deboned milkfish by-products comprise pin bones which makes meat recovering time consuming and difficult. Expansion of the infrastructure facilities, particularly in the cold chain and production lines must be seriously addressed for more successful innovation, sustainability and global competitiveness.

**Quality and Safety**

An area of particular concern in the utilization of tuna and milkfish by-products is its initial quality and safety which is becoming more relevant with the growing export demand. This holds true as the consumers become more affluent and discriminating i.e. how the products have been manufactured, its nutrition and origin.

It may be stated that value-added products derived from tuna sashimi and sushi processing produced by some tuna processors in General Santos City e.g. Citra Mina Seafood Group of Companies are in strict compliance to the Quality Assurance Regulatory requirements i.e. far below the allowable levels of histamine and absence of E. coli and other health significant organisms. This company runs a chain of seafood markets that exclusively sell its own value-added tuna products. Its products are particularly identified for not containing any animal fat and artificial additives (e.g. monosodium glutamate). Furthermore, it has an R&D Department that employs the combined culinary art and scientific principles of product innovations. Most tuna value-added processors are largely dependent on pre-mixes, if not customized by an ingredient manufacturer. As a consequence, the over-all features desired for a specific product i.e. textural integrity in hams and other comminuted products may be difficult to achieve.

**EMERGING TECHNOLOGIES**

Among the identified value-added seafood products that offer the promise of future opportunities for ready-to-cook and ready-to-eat seafood products are the burgers, fish balls, sausages and other thermally processed ready-to-eat meals in cans and in pouches. Other companies have already been producing them but still require some refinements to become commercially feasible in both local and international markets.

Tuna and milkfish value-added products in the Philippines may be generally classified into product groups, i.e. Frozen seafood products (ready-to-cook), ready-to-eat meals (thermally processed) and smoked deboned milkfish.

**Frozen Seafood Products (ready-to-cook)**

Trims from loining, filleting or slicing of tuna intended for sashimi and sushi productions are transformed into ground meat, cubes, and steaks, etc. These products are predominantly exported to U.S.A., vacuum-sealed in nylon packs, frozen and stored at temperatures between -18°C and -20°C. Other frozen ready-to-cook value-added products e.g. tocino, sausages, embotido, burgers, and spring rolls among others had gained about US$ 4.17 M in the local sales of General Santos City (Acharon, 2008). Meanwhile, frozen milkfish products intended for export market are dominated by the whole and gutted milkfish, deboned milkfish fillets and prime cut bellies. Some SMEs has already developed their own product brands mainly for the local market, although some are now slowly venturing into the export market.

Tuna dumplings (siomai and gyoza), sausages, embutido; ham, tocino, and the battered and breaded nuggets, tempura among others are vacuum-sealed in nylon packs in 226 g; 500 g
and 1 kg per pack. The products are frozen and separately placed inside the fitting carton box and stored at -18°C until ready for market distribution. Almost the same forms of value-added products are made for milkfish but dominated by embutido, spring rolls, longanisa and sisig. These products are also packed frozen in microwaveable packs intended both for local and international markets.

**Ready-to-eat-meals (Thermally Processed)**

Tuna and milkfish ready-to-eat meals are processed either in cans, jars or pouches at varying styles e.g. tuna in oil, in brine, and in other common Filipino and Spanish-influenced styles. Thermally processed seafood products in foil pouches are still quite limited in the local market. These are presently dominated by the Mega, and the Citra mina brands, the former being more focused on sardines whilst the Citra Mina brands are on tuna value-added products. The latter has recently launched tuna adobo, sisig, burgers with mushroom sauce, and tuna in black beans sauce, and kare-kare. Milkfish however, are processed mostly in fancy jars and served as gourmets.

**Smoked Deboned Milkfish (Butterfly Fillets)**

Milkfish is formed into butterfly fillets and deboned before it is marinated or brined and then smoked using either a conventional or mechanical type of smokehouse. Small-scale entrepreneurs generally use the traditional smokehouse e.g. drum-type, or the mechanical smokehouse e.g. Torry Kiln. Its tastes are varied e.g. seasoned in garlic and vinegar or in ham-flavored marinades. Export for smoked boneless milkfish is seemingly being dominated by the Alsons Aquaculture Corp under the Saranggani brand. The Aklan’s Boneless Bangus which used to export the same product forms in U. S. A. and Canada is now more focused on the local markets.

**PRODUCT INNOVATION AND DIVERSIFICATION**

Consumers have already some ideas or expectations of the sensorial attributes for a specific food commodity. Any deviations from these expectations could be directly related to differences in quality. For instance, the surimi-based products are known for its chewiness and gumminess in texture. The natural taste and color of the product are also very important concerns. The overall characteristic profile of the product may be designed based on consumer’s preferences. Consequently, a golden brown color formation in smoked milkfish product may be directly associated to an efficient processing performance. The complexity in nature of the meats recovered from the tuna and milkfish by-products is a crucial factor that must be addressed. Attributes desired for product innovations may be difficult to achieve more particularly, if pre-mixes or customized ingredients are employed.

Fish processing by-products are highly perishable that require equal importance in preserving its quality and safety from any contaminations. Strict adherence to freshness, cold temperatures, and very high levels of sanitation is of paramount importance. Trims and backbones from milkfish deboning are normally mixed together and set aside during the normal processing operations. Deboners tend to soak the pin bones with adhering flesh in water while deboning the milkfish. This practice gives a clogged and mushy meat and faded color and taste that can largely influence the overall integrity of the product.

A slightly different approach in the value-addition of tuna by-products may be noted. These by-products appeared to vary in forms and properties. For instance, the tuna black meat which accounts to about 22% of the total value of the tuna by-products is very unappealing in terms of color, texture and general appearance. It appears to be very fatty and exhibits a strong fishy odor, but may be containing high amounts of omega-3 fatty acids similar to the yellow fin tuna heads and eyeballs (Panggat and Shindo, 2003). These undesirable properties
of tuna black meat may however, be improved by employing some technical treatments without compromising the nutritional value.

Innovations involving product improvement and process minimization for cost reduction need constant deliberations between R&D and the Marketing departments. The former serves as the key player in any technological innovations. The Marketing then needs some skills and technical background of the product and the process highlights for more efficient deliveries of the new innovations into the market chains. Evidently, a close coordination between the R&D and Marketing is crucial in ensuring a successful innovation and diversification of products. Moreover, selection and designing of appropriate packaging technologies for tuna and milkfish value-added products becomes an important segment in product innovations.

Among the laboratory-tested value-added products developed for tuna and milkfish by-products that may have great potential markets are presented below (Panggat, 2003):

**Seafood Terrines**

Seafood terrine is a new seafood product that originated in France and is now becoming popular in Japan, although with still very limited market. A high quality terrine has a smooth and elastic texture with mild taste and aroma similar or close to Foie gras. This product is believed to be very suitable to the need of the growing ageing population in Japan and maybe in other parts of the world.

Recovered flesh from milkfish deboning is initially mixed with salt to form a pasty texture. The paste is then mixed with cream, spices, fresh vegetables (e.g. carrots, celery) and a binder. The mixture is screened, molded then steamed or baked. Its color and taste depend on the vegetables used. Carrots, celery or other herbs can render some natural colors and taste to the product (Fig. 10). The flesh recovered from tuna ribs, brown meat as well as the black meat may also be transformed into seafood terrine after some pre-treatments (Fig. 11). Panggat (2003) did not find any significant differences between terrine derived from the fresh whole fish and the flesh recovered from its by-products in terms of color, taste and texture. Seafood terrines may be stored frozen but is best served when chilled.

**Longanisa (Philippine sausage)**

Longanisa is one of the most commonly manufactured value-added products derived from tuna and milkfish by-products. Recovered flesh is mixed with salt, spices, binder and fruit juice. Addition of animal fats and artificial additives is optional. The mixture is then stuffed into the casing, cooked, packed and frozen. This new innovation transforms the by-product into a healthy sausage-type seafood product. The proximate composition of milkfish-based terrine and longanisa are presented in Table 1.

![Fig.10. Milkfish-based terrine.](image)

![Fig.11. Tuna-based terrine.](image)
Table 1. Percentage proximate composition of milkfish seafood terrine and longanisa:

<table>
<thead>
<tr>
<th>Product</th>
<th>Terrine</th>
<th>Longanisa (Philippine sausage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture</td>
<td>76.07</td>
<td>63.61</td>
</tr>
<tr>
<td>Protein</td>
<td>13.64</td>
<td>15.51</td>
</tr>
<tr>
<td>Lipid</td>
<td>8.34</td>
<td>6.74</td>
</tr>
<tr>
<td>Ash</td>
<td>1.28</td>
<td>2.26</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>0.63</td>
<td>11.88</td>
</tr>
<tr>
<td>Estimated market price (US$ = PhP 44)</td>
<td>3.33 per pack (250g)</td>
<td>0.75 per dozen</td>
</tr>
</tbody>
</table>


Spanish Sausage (from Tuna Black Meat)

Tuna black meat may be transformed into a high-end product type like sausages. This product is characterized for its cohesiveness, chewiness and elasticity so that black meat needs some initial technical procedures in order to achieve the required texture.

CONSTRAINTS, CHALLENGES AND OPPORTUNITIES

Constraints and Challenges

Control of the quality of raw materials i.e. by-products, from its origin through the processing site is of paramount importance. A very important factor then is the handling of by-products on-sites of harvest and at the initial preparations; and while waiting for further processing. Optimal strategies in handling the bulk of by-products must be correspondingly addressed e.g. access to automated machineries; improved and expanded refrigeration facilities, etc.

Factors constraining the successful marketing of value added tuna and milkfish products include the following:

1. Lack of initiatives for new product innovations

There is a wide array of tuna and milkfish value-added products manufactured in the country, but still appears to be very limited and highly conservative in terms of product differentiation. The range of product types for both tuna and milkfish by-products are practically similar. There seems to be no concerted efforts to diversify and introduce new products. The SMEs, in particular have very limited resources and capabilities to engage in intensive product innovations. The SMEs has to be flexible, low cost bearing, innovative and persevering.

2. Inefficient marketing and packaging strategies for value-added seafood products

Marketing of tuna and milkfish value-added products are very demographic. For instance, marketing of tuna value added-products are more concentrated in General Santos City while the milkfish-based are found largely in the markets of Metro Manila, Panay and Central Luzon, where respective producers are situated. There is obviously, uneven distribution of products hence, limiting access to consumers. Moreover, attractive packaging plays a major role in successful marketing. Many of the SMEs that process both the tuna and milkfish by-products have no existing brand yet, hence no appropriate packaging to boost the products. A number of packaging manufacturers including the government’s packaging center are available for some technical assistance. But because of the large minimum volume requirement per order of the packaging material, many SMEs find it too expensive and difficult to cope with. With the emergence of ready-to-eat meals, innovative packaging i.e. in pouches will certainly have a great market potential. Appropriate packaging will undoubtedly
broaden and strengthen the market appeal and position of the product in the seafood market chain.

3. Consumer demand

Facing the seafood industry is just as difficult as meeting the consumers demand for new product innovations, improved packaging technologies and product differentiations. More recently, a few of the tuna value-added processors have started redefining their ready-to-eat meals in pouches by integrating the kitchen-type recipes e.g. kare-kare, adobo, sisig, etc.; and integrating some ethnic twists to create more of the “gourmet style” products. However, the existing value-added products do not seem to be largely attuned to the current trends. Technically, the marketing does the trending and determines the consumers demand for a seafood commodity. The R&D then develops the product and conducts consumers testing to determine its acceptability and market feasibility. But what actually happens at times is when the top management overrules both departments in deciding which product to develop and market rather than based on consumers general preferences. This intervention could be based more on the sure profit that the company can gain.

4. Lack of appropriate machineries and other facilities

Capital investments in support of infrastructure are a critical activity in making value added chains competitive. Some of the identified facilities are cold chains and common testing laboratories. It will however, be a huge action on the part of the government to subsidize the costs for the infrastructures and other facilities that may be required to support the growth of the industry just like in other countries. The presence of the EU-accredited Fishing Port Complex in General Santos City is however, a big advantage to the tuna industry.

5. Policy issues on Tariffs and Trade Liberalization

The imposition of the General Agreements for Tariffs and Trade Liberalization has brought some difficulties among food processors, including the value-added seafood products with high tariffs. However, reduction of tariffs for seafood products including value-added products from 24 % to 12 % has been successfully negotiated through the concerted efforts of the government and the private sectors in the country (12th National Tuna Congress, 2010).

OPPORTUNITIES

Value adding of tuna by-products has always been envisioned to prosper in General Santos City for many years now. The availability of cheap workforce, abundant resources and relatively lower utility rates in the region boosts the growth of the industry. Enhanced opportunities are due to the presence of the airport, concrete wharf and the well expanded and improved fish port in General Santos City. The numerous numbers of tuna fishing vessels in the region ensures continues supply of raw materials, including the by-products. There is also a certainty on the availability of raw materials for milkfish value-adding with the growing milkfish industry in the country. Majority of the existing milkfish processors have provisions for refrigeration facilities and other required machineries thus, demanding higher capital investments.

At present, the producers seem to recognize the relevance of advocating new product innovations and differentiations to their success. The ability to identify and broaden its market niches both locally and internationally is also a major area of opportunity for the growth of the industry. Health factors such as omega-3 fatty acids in tuna and milkfish are also a great advantage for the utilization of its by-products. Access to the technical expertise and other government resources including research results on seafood product developments by several institutions will further enhance the horizon of the industry in the global market.
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