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# Traditional Fish Processing Techniques Applied in the Philippines and Turkey

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**Abstract**

Traditional fish processing techniques (TFPTs) are widely applied worldwide, especially in Asia. In the Philippines, processed fish and fishery products using the traditional methods have been part of the daily diets of many Filipinos who live near the coasts, particularly among low-income families. In Turkey, TFPTs are also commonly practiced for centuries. In this work, we reviewed the existing body of knowledge on TFPTs both in the Philippines and Turkey by utilizing peer-reviewed articles, works, theses, and books published from 1950 to 2021. Our findings revealed that TFPTs such as drying, salting, pickling/marinating, and smoking are commonly applied in both countries, which only differ with regards to finished products and some variations. The Philippines has various and unique processed seafood products produced from TFPs compared to Turkey. This is due to the fact that the Philippines has more rich and diverse aquatic resources than Turkey; hence, Filipinos have a higher consumption rate of fishery products than Turkish people. One of the TFPTs that is only predominantly applied in the Philippines is the fermentation of fishery products, which seems to be uncommon and may be absent in Turkey.

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## INTRODUCTION

The extraction of fishery resources from the wild has been practiced for centuries and utilized as a food source. Aquatic resources' diversity is important for a country and offers not only food but also job opportunities, income, and foreign currency, especially when exploited in a sustainable way. Due to the continuous harvesting of seafood resources, which resulted in overexploitation, production has been decreasing; hence, it is now very much limited to potentially harvesting more products from aquatic environments (Espejo-Hermes, 1998). In 2017, roughly 90% of the world's marine fish stocks were considered completely exploited, overexploited, or depleted due to man-made tragedy (Kituyi, 2017). At the same time, as the world population is rapidly increasing, the demand for seafood products as a protein source is also exponentially growing (Merino et al., 2012). One way of decreasing shortage between the production and demand, as well as post-harvest losses and wastage, is utilizing the aquatic resources sufficiently through effective processing technology application (Espejo-Hermes, 1998).

Fish processing technology refers to the different techniques and processes used in the post-harvest processing, handling, and marketing of aquatic products, which begin from harvesting to final consumption. Processing technology application of aquatic products is primarily aimed at spoilage prevention or retardation caused by microorganisms and enzymes as well as by poor handling of both physical and mechanical means (Espejo-Hermes, 1998). According to FAO, processing refers to chemical, or mechanical operations done on fish to change or preserve them. Processing fish has different ways and working environments. Even just a removal of entrails from fish, such as cleaning or gutting, is already considered a simple processing technique aimed at lengthening the shelf life of fish (FAO, 2021).

Fish processing techniques are classified into two; traditional methods and non-traditional methods. Traditional methods of processing fish are confined to smoking, drying, and salting, while chilling, freezing, and canning are classified as non-traditional fish processing methods (Guevara, 1980; Cain, 2019). Traditional processing methods are usually employed using minimal facilities and services and using low-cost technology, which is normally within the small-scale fisheries value chains. Non-traditional processing methods such as canning, freezing, and chilling are usually used with high investment processing factories and international trade (FAO, 2021). TFPTs have been an important way of preserving or processing fishery products

worldwide (Espejo-Hermes, 1998; Nketsia-Tabiri, 1994; Njai, 2000; Soon-Eong & Sen-Min, 2002; Kışla et al., 2007; Davies & Davies, 2009; Thapa, 2016; Adeyeye, 2016; Akintola & Fakoya, 2017).

The Philippines, being an archipelagic country, is blessed to be endowed with rich fish and fishery resources that Filipinos can inevitably turn to for food and livelihood (Guevara & Camu, 1988). Hence, it is not surprising that Filipinos have been practicing TFPTs for various seafood products for centuries. Fishery products are the main source of protein in the Philippines, and every Filipino consumes about 37 kg year$^{-1}$ of protein from fishery products (Tahiluddin & Terzi, 2021). Of these, 78% are fresh fish, and the remaining 22% are from processed fish, e. g., smoked/canned, dried, and salted fish (Garcia et al., 2005). Traditional fish processing is extensively used particularly in the poor families in the country (Cain, 2019). Later, the fish processing industry of the country expanded into modern processing techniques, done commercially to supply a massive amount of preserved products across the nation and for export purposes (Guevara & Camu, 1988).

Turkey, on the other hand, with its advantageous geographic position between the Mediterranean Sea and the Black Sea, has access to fishery resources from these bodies of water. The country is also favored with plentiful river systems and inland waters with crucial aquaculture and capture fishery potential (OCED, 2021). Despite these, not all Turkish people incorporate fish into their diet compared to Filipinos. In Istanbul, for example, nearly 16% of surveyed Turkish people never consumed fish due to taste and odor (Erdogan et al., 2011). Hence, fish consumption of Turkish people is nearly 6 kg per person annually (Sagun & Sayğı, 2021). Fish processing provides ease of consumption to Turkish consumers by lengthening its shelf life and adding added value to the products (Sagun & Sayğı, 2021). Historically, fish processing in Turkey has been a practice for decades. Some evidence shows that fish processing in Turkey took place in the fifth century BC (Çakırlar et al., 2016). Today, Turkish people are giving attention to processed seafood, including those produced from traditional methods (Sagun & Sayğı, 2021).

Despite the difference in geographical settings of the Philippines and Turkey, which offer both abundant fishery resources and different fish consumption behaviors, it is worth investigating to compare these two countries in terms of TFPTs since both countries applied TFPTs for decades. Thus, in this work, we reviewed the existing body of knowledge on TFPTs both in the Philippines and Turkey. The study utilized peer-reviewed published articles, works, theses, and online books from 1950 to 2021. The method of the study mainly used Google seach and Google scholar to search keywords such as traditional fish processing, fisheries production, Turkey, Philippines, salting, salted fish, pickling/marinating, pickled/marinated fish, smoking, smoked fish, drying, dried fish, fermentation, fermented fish both in English and Turkish.

## Fisheries Production in the Philippines and Turkey

Table 1 shows the total fisheries production (aquaculture, municipal and commercial fisheries) of the Philippines and Turkey from 2014 to 2018. The Philippines has more than 4 million tons of fishery production from 2014 to 2018, whereas Turkey has only more than 500 000 to more than 600 000 tons. This is due to the fact that the Philippines mostly contributed by cultivated seaweeds, milkfish, and tilapia, whereas Turkey's fisheries production is dominated by fish from capture fisheries such as anchovies, sardines, horse mackerel, and Atlantic bonito.

**Table 1.** Total fisheries production (Aquaculture, municipal and commercial fisheries) of the Philippines and Turkey from 2014 to 2018 (tons).

| **Country** | **Year** | | | | |
|---|---|---|---|---|---|
| | *2014* | *2015* | *2016* | *2017* | *2018* |
| **Philippines** | 4 689 065 | 4 649 313 | 4 355 792 | 4 312 099 | 4 356 875 |
| **Turkey** | 537 345 | 672 241 | 588 715 | 630 820 | 628 631 |

Source: PSA (2019); TAGEM (2019)

## Traditional Fish Processing Techniques in The Philippines and Turkey

### Salting

Salting is one of the TFPTs and is considered as the earliest technique used to preserve fish and other fishery products (Sampels, 2015). The mechanism and principle of preservation through salting are the same across all fishery products regardless of the used method variation. Osmosis and diffusion processes are the two crucial processes in lowering and discharging the amount of moisture content of the fishery products to the level where enzymatic and bacterial activities are being slowed down, thereby lengthening the shelf life of salted products (Espejo-Hermes, 1998; Erdem et al., 2015; Güngörmez et al., 2017).

Salting of fish and fishery products is extensively practiced worldwide. In the Philippines and Turkey, salting is one of the essential TFPTs. Dry and wet salting are both present in the two countries, while *Binoro*, *Tinabal*, and *Guinamos* are some of the unique salted products in the Philippines (Table 2). Salted anchovy and pear mullet are the common salted products in Turkey that can achieve good quality and long storage using clean, thick, and non-iodous salt (Güngörmez et al., 2017). Nowadays, the salting of fish using different methods is heavily studied in Turkey, dwelling on its nutritional quality, chemical composition, and storage methods (Erdem et al., 2005; Bilgin et al., 2007; Koral, 2016). Salted fish in the Philippines generally commands a lower price compared to dried fish (Garcia et al., 2005). Salted sea urchin is another popular salted product in the

Philippines, and the procedure for this salted product can be found in the paper of Espejo-Hermes (1998). Characterization of salted sea urchin in terms of physicochemical and microbiological has been analyzed by Aming (1986).

**Table 2.** Types of salting of fishery products.

| Type of salting | Method | Practicing country (Philippines or Turkey) | Reference |
|---|---|---|---|
| Dry salting (Kench process) | Rubbing salt directly into the fish | Both countries | Avery, 1950; Espejo-Hermes, 1998; Erdem et al., 2015; Güngörmez et al, 2017 |
| Wet salting (Brining, Pickle curing) | Placing fish in a salt and water solution just before packing, and each fish layer is sprinkled with used salt. | Both countries | Avery, 1950; Espejo-Hermes, 1998; Erdem et al., 2015 |
| Kench-cured fish (*Binoro*) | Sardines, mackerels, or other small fish are brined, drained for several hours, and then packed in dry salt. | Philippines | Avery, 1950; Espejo-Hermes, 1998 |
| Visayan salted/fermented fish (*Tinabal*) | Large fish such as parrotfish and frigate tuna are cleaned, brined for hour/s, drained for minutes, salted, packed, re-drained, and re-packed. | Philippines | Avery, 1950; Espejo-Hermes, 1998 |
| Shrimp cake (*Guinamos*) | Shrimp is being cleaned, partially dried for 24 hours, salted (2:3) while mixing and pounding, dried for 24 hours, and formed into cubes or round shapes. | Philippines | Espejo-Hermes, 1998 |

**Drying**

Drying is one of the ancient methods of preserving fishery products (Doe & Olley, 2020). Drying generally means removing water from the fishery products either by means of evaporation or other techniques (Espejo-Hermes, 1998; Oğuzhan, 2012; Sampels, 2015). Drying fishery products at below 15% moisture content (MC) hinders spoilage from numerous microorganisms, while drying products at 10% MC can entirely suppress the growth of molds, thereby extending the shelf-life (Espejo-Hermes, 1998). The drying rate of fishery products during the drying process is influenced by important factors such as product thickness, salt content, fat content, drying temperature, air velocity and relative humidity (Sampels, 2015).

In the Philippines, the drying of fishery products is the most famous TFPT among coastal villagers (Espejo-Hermes, 1998), especially when caught fish landed does not fall into the category of fresh fish due to a lack of sufficient cold storage facilities (Sevilleja & McCoy, 1979). Drying in Turkey is the most common and oldest way of preserving seafood products (Oğuzhan, 2012). As shown in Table 3, the traditional drying technique in both countries are similar, either contact or air drying (sun drying) or drying with the use of salts as an additional flavor and preservative agent. Whole or round fish and split-salted fish are the two types of dried fish widely done in Turkey and the Philippines (Espejo-Hermes, 1998; Oğuzhan, 2012).

Dried fishery products are not only local diets among Filipinos but also exported to other countries such as the USA and Canada (Cañet, 2020). One of the most prominent dried fish products is those small-like fish like anchovies and small scaly fish (Espejo-Hermes, 1998; Andot & Pobar, 2017). Other desired dried products in the Philippines are dried squid and fish jerky (Espejo-Hermes, 1998). Despite its popularity, traditional sun-drying in the Philippines faces numerous problems, such as losses through spoilage, fly infestation, uneven drying, improper handling, and insufficient storage facilities (Carpio, 1982; Ahmed et al., 1987; Andot & Pobar, 2017).

With the aim of increasing the shelf life of dried fish in the Philippines, the development of a more advanced method of drying has been tested against the traditional sun-drying and indicated that cabinet-type dehydrators produced the best quality dried product (Guavara et al., 1986). However, mechanical and sun-drying obtained nearly similar attributes in terms of physicochemical, microbiological, and sensory quality (Gabriel & Alano-Budiao, 2015). At the same time, other studies focused on monitoring and assessing the histamine level in dried-salted fish (Amascual et al., 2020).

**Table 3**. Types of traditional drying of fishery products.

| Types of drying | Method | Practicing country (Philippines or Turkey) | Reference |
|---|---|---|---|
| Contact or air drying (Sun-drying) | Fishery products are cleaned and directly placed under the sun for hours or days, depending on the products. | Both countries | Espejo-Hermes, 1998; Oğuzhan, 2012 |
| Drying with salts | Fishery products are cleaned, brined, or dry-salted and placed under the sun for certain duration. | Both countries | Espejo-Hermes, 1998; Erkan, 2011; Oğuzhan, 2012 |

**Smoking**

Smoking is a timeworn preservation method used extensively in many developing countries (Sampels, 2015; Espejo-Hermes, 1998). The preserving mechanism of smoking is by the combined effects of salting, drying, heat treatment, and chemical deposition produced from wood burning (Espejo-Hermes, 1998). Typically, the smoked products have a pleasant smoke aroma formed by the processing of burning the sawdust or wood and the effect of volatile compounds, thereby increasing the shelf life of the smoked products (Öksüz, 2021). The smoking of fish is generally done using a smokehouse in order to control the proper burning of wood (Küçükgülmez et al., 2010; Espejo-Hermes, 1998).

The two types of traditional smoking are hot smoking and cold smoking, which are both applied in the Philippines and Turkey (Table 4). There are varieties of smokehouses present in the Philippines like clay pot (*Pelon*), drum-type and its variation, concrete type and its variation with a metal chamber for the smoking tray (Espejo-Hermes, 1998). In Turkey, a small-scale traditional smoking process used a simple drum-type smokehouse. However, highly sophisticated mechanical smokehouses are present in both countries.

Smoking of fishery products in the Philippines have reported to vary from place to place attributed to the variation of consumers' preference in terms of fish species; however, according to sensory evaluation, the level of acceptability of smoked fish produced from different methods was similar (Anenias et al., 1987). Due to the lack of cold storage and limitation in the rapid and smooth transportation of fresh fish in most regions in the Philippines, those newly caught fish that are classified as non-fresh fish are normally processed into smoked fish (Sevilleja & McCoy, 1979). Recent research continues developing the smoking of fishery products in the Philippines. One study, for instance, aimed to produce a prototype of a semi-automatic brining machine for smoked production (Paulino, 2021). Other studies focused on keeping high-quality smoked fish by using vacuum packaging (Bigueja & Bigueja, 2010).

In Turkey, the utilization of smoked fish is less compared to European countries. However, as more consumers are exposed to and taste smoked fish, consumption continuously rises (Ceylan & Şengör, 2015). Hence, more and more researchers are interested in investigating TFPTs such as smoking. In the course of improving the smoked products in Turkey, the number of researches on this aspect is increasing day by day (Kaya & Erkoyuncu, 1999; Kaba et al., 2009; Aydin & Yalçın, 2018); and continues to attract the attention of the scientific community to provide and contribute the better quality of smoked fish and fishery products in different regions.

**Table 4.** Types of traditional smoking and their methods.

| Types of smoking | Method | Practicing country (Philippines or Turkey) | Reference |
|---|---|---|---|
| Hot smoking | Smoking fishery products at a high temperature of 70-80 °C. The finished products are usually cooked, juicy, and flavorful. | Both countries | Espejo-Hermes, 1998; Aydin & Yalçın, 2018 |
| Cold smoking | Smoking fishery products at a temperature not exceeding of 30 °C. Smoked products are not cooked and may require an additional cooking process. | Both countries | Espejo-Hermes, 1998; Emel, 2020 |

**Pickling/Marinating**

Pickling or marinating is another ancient TFPT where the preservation actions are owed by the combined effects of salt and vinegar/acetic acid (Espejo-Hermes, 1998; Sampels, 2015; Kadak and Çelik, 2015; Çetinkaya, 2017). The presence of vinegar/acetic acid lowers the pH of the products, thereby retarding the growth of spoilage-causing microorganisms (Sampels, 2015). In addition, the inhibitory effects of these substances on enzymes and bacteria are higher at greater concentrations (Espejo-Hermes, 1998; Çetinkaya, 2017). However, generally pickled/marinated products have a short shelf life and are thereby considered as semi-preserve unless stored in a chilled environment, which can last for several months (Espejo-Hermes, 1998; Sampels, 2015).

Pickling or marinating is a common TFPT utilized in both the Philippines and Turkey (Table 5). In the Philippines, the most common pickled/marinated fishery products are pickled anchovies, marinated mussels, and marinated fried sardine or mackerel. In Turkey, pickling/marinating is classified into cold, cooked, and deep-fried marinades. Despite the difference in terms of pickling types, it is noted based on the method that most pickling techniques are common and similar in both countries. Pickled anchovies and marinated mussels of the Philippines are similar to the finished products of cold marinades of Turkey. Additionally, both countries have in common preparing marinated fried fish or deep-fried marinades. Filipinos do not normally cook pickled products, whereas Turkish tends to have another way of preparing marinated fish, which is being cooked (deep-fried) to extend the shelf-life.

**Table 5**. Types of pickling/marinating, pickled/marinated products, and their methods.

| Types of pickling/marinating, pickled/marinated products | Method | Reference |
|---|---|---|
| **Philippines** | | |
| Pickled anchovies<br>Marinated mussels | The fishery products are washed, soaked in a salt solution for 1 hr, removed the bones, rinsed with salt solution, immersed in strong acetic acid solution, and stored in a cool room for up to 3 weeks. | Espejo-Hermes, 1998 |
| Marinated fried sardine or mackerel | Fillet fish are washed, soaked in a brine solution for hr/s, rolled in flour and fried, and packed in a hot marinade (spices and vinegar). | Espejo-Hermes, 1998 |
| **Turkey** | | |
| Cold marinades | Fresh fish or fishery products are matured in salt solution and acetic acid, and heat is not applied during the process. | Baygar, 2010 |
| Cooked marinades | Fishery products are cooked in acetic acid and salt solution at 85 °C to kill or inactive most bacteria and enzymes. | Kılınç & Çaklı, 2004 |
| Deep-fried marinades | Fishery products used are fried prior to packing in acetic acid and salt solution. | Çetinkaya, 2017 |

The main ingredients of pickling/marinating are vinegar (acetic acid), salt, spices, and sugar (Espejo-Hermes, 1998), which is commonly applied in the Philippines. In Turkey, improvement of marinated products is made evident from recent studies. For example, incorporating natural additives in marinating the fish enhanced the overall sensory qualities, shelf-life, and nutritional values (Duyar & Gülüm, 2020). Another study investigated the acceptability in terms of sensory evaluation of marinated crayfish (*Astacus leptodactylus)* using various sauces: tomato, curry, and carrot sauces. Research findings revealed that carrot sauce gained significantly higher preference (Duman et al., 2010). Similarly, marinated anchovy preserved with addition of rosehip sauce showed better quality than olive oil, which lengthened its shelf life (Bilici, 2020). However, using a sauce made of sunflower oil, tomato paste, pepper paste, salt, mint, garlic, black pepper, and cumin, with the addition of olive was more preferred than without olive oil (Nanli, 2010). Baygar (2010) of Turkey suggested that sea bass (*Decentrarchus labrax*) in scaleless form is appropriate for marinating when considering the optimum maturation period.

**Fermentation**

Fermented fishery products are well-known and well-liked preserved products in Asia, particularly in the Philippines; this is due to the fact that they have characteristic flavors and are cheaper than other processed products such as canned and frozen fishery products (Olympia, 1992; Hajeb & Jinap, 2012). Fermentation may fall under the salting technique; however, some products undergo fermentation with a small amount of salt added. Fermentation is the breakdown of organic substances into simpler components primarily through the enzymatic action aided by microorganisms. Fermented fish can be differentiated from salted fish due to the loss of the fish's original shape in the partly liquefied product. The salt added to the fish (1:3 ratio) is adequate to saturate the flesh and retards spoilage during fermentation (Espejo-Hermes, 1998). Fermentation offers food an array of tastes, flavors, textures, sensory attributes, and therapeutic and nutritional values (Mehta et al., 2012). Fermented fishery products are nutritious. For instance, shrimp paste contains varying amounts of protein, saturated fatty acids, and monounsaturated and polyunsaturated fatty acids (Pilapil et al., 2016). Fermented products are rich in amino acids and peptides (Hajeb & Jinap, 2012; Pilapil et al., 2016).

Fermentation of fishery products is one of the popular TFPTs that is part of the daily diets of Filipinos as food or condiments. However, in Turkey, no available articles report the fermentation of fishery products. Generally, fresh fishery products are the used raw materials for fermentation. However, some studies utilized dried fishery products such as dried anchovy to prepare salted *bagoong* (Martin & Sulit, 1955). As shown in Table 6, there are three types of fermented products produced in the Philippines: paste or *bagoong*, sauce or *patis*, and fermented products with added carbohydrates such as cooked rice (*burong isda* and *balao balao*). *Bagoong* is the undigested residue of partially hydrolyzed shrimp, shrimp roe, fish, or fish roe. It has a salty, slightly fishy, and cheesy smell. The product's characteristics differ from region to region, ranging from completely ground and soured to partially fermented without liquid (Olympia, 1992; Espejo-Hermes, 1998; Joshi & Petricorena, 2012). *Patis* is a clear, amber-colored liquid sauce formed from the separation of the fermented salted fish by pressing out (Espejo-Hermes, 1998; Joshi & Petricorena, 2012). *Burong isda* is a well-known traditional fermented fish product in central Luzon, Philippines. Freshwater fish is usually used to prepare this product. During the fermentation process, the flesh of the fish becomes soft, and the bones become soft similar to cartilage when cooked. It is sauteed in oil, onion, and garlic before serving on the table. It is consumed either as a main dish or as an appetizer, similar to *balao balao* (Olympia, 1992).

**Table 6.** Types of fermented products and their methods practiced in the Philippines.

| Types of fermented products | Method | Reference |
|---|---|---|
| Paste (*Bagoong*) | Fishery products such as shrimp, whole or ground or whole fish, fish roe, and shellfish are added with salt added and allowed to ferment for periods (weeks to more than a year). | Olympia, 1992; Espejo-Hermes, 1998; Joshi & Petricorena, 2012 |
| Sauce (*Patis*) | This product results from the slow digestion or fermentation of salted fish and the subsequent separation of the solids from the liquid portion of the hydrolysate. | Olympia, 1992; Espejo-Hermes, 1998; Joshi & Petricorena, 2012 |
| Fermented Products with Added Carbohydrates such as Cooked Rice (*Burong isda* and *Balao balao)* | Shrimp or fish are used to make this product by adding salts and rice, and then let ferment for more than a month. | Olympia, 1992; Espejo-Hermes, 1998 |

## CONCLUSION

Fish processing techniques are essential for food security and for the economic development of a country, especially for the Philippines. The diversity of traditional fish processing techniques in the Philippines is greater and produces a wide array of processed seafood products than in Turkey. This is due to the fact that Filipinos, who live in an archipelagic country with diverse fishery resources, have a higher fish consumption rate compared to Turkey. Hence, it is interesting to duplicate the Filipino unique traditional fish processing techniques such as fermentation of fishery products and see how the perspective of Turkish people to these peculiar processed products.

### Compliance with Ethical Standards

#### a) Authors' Contributions

A. B. T., A. E. K.: Designed the study
A. B. T. : Drafted the paper.
A. E. K. : Review and editing.

#### b) Conflict of Interest

The authors declare that there is no conflict of interest.

#### c) Statement on the Welfare of Animals

Ethical approval: For this type of study, formal consent is not required

#### d) Statement of Human Rights

This study does not involve human participants.

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