BY-PRODUCTS TECHNOLOGY AND WASTE UTILIZATION

by

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Abstract

Fishery by-products in the Philippines are largely derived from fish which cannot be sold. Production of fish paste, fish sauce and fish meal are the methods of waste utilization in the Philippines. The fish sauce and fish paste industries appear to be capable of standing on their own; they are firmly established and the product is indispensable in many households. The fishmeal industry is still in the process of growth and development. Fish silage on the other hand, is still at the research stage.

Although developments are taking place in fisheries by-product technology, the need for more hygienic, practical and efficient processes have to be considered.

INTRODUCTION

Economical and efficient utilization of fish can be achieved only when all the parts are utilized and no wastage is allowed in the industry. Fishery by-products are derived largely from the inedible portions of fish that constitute approximately 40-50 percent of the weight. Neglect of the potential of by-product utilization leads to serious forms of wastage. The proper utilization of by-products or their conversion into products of economic value will not only lead to the better utilization of resources but also result in lower-cost foods which can be a good source of proteins, vitamins and minerals. There are many methods or processing waste but the final choice will depend on the facilities and materials available, the cost of production and the demand for the product. In the Philippines, waste materials are used in the fishmeal, fish sauce and fish paste industries. Other industries which are slowly gaining attention are the production of leather from fish skins, production of fish liver oil, etc.

FISH PASTE

Characteristics

Fish paste or 'bagoong' is a semi-liquid product obtained from the liquefaction of a mixture of fish and salt. This is widely used as a condiment but is also used as a protein food for the poorer section of the population especially in places far from the sea where fresh fish is seldom available.

Raw materials for fish paste production are round scad (Sardinella fimbriata), herring (Spiratelloides japonicus), sardine (Sardinella longiceps), anchovy (Stolephorus indicus), small slipmouth (Leiognathus) and, for 'bagoong alamang', tiny shrimps are used. Most of the raw materials used are whole fish which cannot be sold and those which can no longer be sold as fresh fish. Fish offal can also be used.
Factors affecting quality

Several studies have been conducted on improving the quality of fish paste. Salt purity has been found to play an important role in the rate of fermentation. Impurities present in salt such as magnesium and calcium have been found to retard penetration of salt into the fish. Fish hydrolysis is said to be the result of enzymatic action and therefore the possibility of increasing the rate of fermentation by the addition of enzyme preparations was investigated by Guevara et al. (1973). The enzyme used was pappin obtained from the latex of papaya, Carica papaya Linne. Within the range of concentrations of 0.1-0.5 percent, the rate of fermentation increased with increasing enzyme concentration as shown by the amount of crude protein of the liquid portion of bagoong made from anchovy. The effect of high temperatures (37.5°-55°C) was also studied. Hydrolysis was faster at higher temperatures especially at 45°C. At 55°C however, the rate of fermentation was not accelerated and led to a cooked flavour.

FISH SAUCE

Product description

The clear, straw-yellow to amber coloured liquid that can be drawn off from the liquefaction of a fish-salt mixture is called fish sauce or 'patis'. This is widely used in the Philippines for salting and seasoning food. According to the Food and Drug Administration (1977), fish sauce should meet the following standards of quality:

Specific gravity — 1.20-1.23
Total solids — not less than 32 percent
Salt content — 20-25 percent as sodium chloride
Protein content — depends on the brand:
  Fish sauce for domestic trade
  special — not less than 8 percent
  regular — not less than 4.5 percent
  flavour — 4.5 percent but not below 2.5 percent
  fish sauce for export
  special — not less than 8 percent
  regular — not less than 6 percent

Methods of manufacture

The process of manufacture for fish sauce involves the following basic steps:

(a) Sorting: raw materials are inspected and seaweed and other foreign material are removed;
(b) Mixing: salt is added to the fish in the proportion 1:3 or 2:7 (by weight). They are then mixed thoroughly either by hand or by the use of a shovel;
(c) Packing and storage: the fish-salt mixture is packed in wooden vats, earthenware jars of concrete tanks and temporarily stored for fermentation;
(d) Fermentation: takes about six months to one year;
(e) Extraction: the filtrate is collected by gravity from the fermenting vats through a spigot near the bottom of the container. This is usually carried out from the highest grade to the lowest grade. The residue after the first and second filtrate extraction serves as fish paste or ‘bagoong’ while the residue left after the last extract is used as fish meal. Recent laboratory tests have shown the value of the final residue as fertilizer;
(f) Filtration: separation of clear filtrate by utilizing clean cotton or cheese cloth.

Present situation in the industry

A survey of the fish sauce industry in Manila, covering 34 establishments, was conducted by Tesoro (1969). The results indicated the following practices:

(1) A combination of different species of fish is used by 53 percent of the respondents. This practice has an effect on the flavour of fish sauce because sauce from the small fish will be fully aged before the larger fish disintegrate;
(2) Enzymes are known to shorten the curing period of fish and salt mixture but none of the respondents uses any;
(3) One hundred percent of the establishments use native salt (92 percent NaC1) because of the high cost of the refined salt (99.9 percent NaCl);
(4) Thirty percent of the respondents ferment for eight months, 20 percent for twelve months, 17 percent for nine months, 10 percent for seven months, 7 percent for ten months and 16 percent did not give any answer. Aging was accelerated by using solar energy by 50 percent of the respondents;
(5) Sixty percent make use of artificial colour while 37 percent do not; 3 percent gave no answer. The most common artificial colour used was caramel and a chemical compound sold under the brand name CIBA;
(6) Seventy percent do not sterilize their products while 30 percent gave no answer;
(7) Only two establishments out of the 34 surveyed use sodium benzoate to prolong the keeping quality of the sauce.

Abulon (1971) has classified the methods of manufacturing fish sauce in 58 establishments in the Malabon and Navotas regions:

(a) Traditional class: establishments adopting the traditional process in manufacture with the use of some traditional equipment (50 percent).
(b) Medium class: establishments utilizing some traditional equipment coupled with some improved techniques (48.4 percent).
(c) Mechanized class: manufacture by automated machines and modern techniques (1.6 percent).

Production by mechanized methods is high, 9 million litres, compared with about 3.5 million for the medium class and 40,000 for the traditional producers.

Potential of the industry

It appears that the fermentation industry (fish sauce and fish paste) is capable of taking care of itself; the larger establishments have a good industrial level and the product is indispensable in Philippine households both at home and abroad. The Market Research Unit within the National Food and Agricultural Council has
included consumption of fish sauce and fish paste in two of their surveys in 1970 and 1971. The results have indicated a yearly consumption of about 100,000 tonnes. The Bureau of Fisheries and Aquatic Resources has sent questionnaires to fish processing firms which indicate an annual production corresponding to not less than 100,000 tonnes of fresh fish.

Exports of fish sauce has been increasing, from 44,836 kg in 1974 to 388,073 kg in 1975 (BFAR Statistics, 1975). Importing countries include Canada, Denmark, Hong Kong, Japan, Malaysia, Trust Territory, U.S.A. (including Hawaii) Guam and other countries (see Table 1). The possibilities of creating other export markets should not be neglected.

<table>
<thead>
<tr>
<th>Table 1</th>
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<tbody>
<tr>
<td>Export of fish sauce by quantity and value, 1974-75 a/</td>
</tr>
<tr>
<td>1974</td>
</tr>
<tr>
<td>Quantity (kg)</td>
</tr>
<tr>
<td>44,836</td>
</tr>
</tbody>
</table>

a/ Source: Bureau of Fisheries and Aquatic Resources,

Problems facing the industry

Problems recorded relate to variations in the quality of the finished product brought about by the use of different species of fish as raw material and the marketing of inferior fish. There is the need for standardization of specifications and a central system for quality and hygiene (Norconsult, 1975). There is also the problem of fat floating on the surface of the liquid sauce.

FISH MEAL

Product description

Fish meal is a dried product, ground to small particle size, with no other ingredients added and processed with or without the extraction of part of the oil. It is an important additive in ready mixed poultry and pig feed. The characteristics which make fish meal a valuable feed supplement have been specified by the Bureau of Animal Industry Administrative Order No. 40 requiring a good fish meal to contain not less than 45 percent protein and not more than 7 percent salt, with the absence of pathogenic bacteria. In addition, fish meal has to have a high digestible protein content, low level of fibre and high content of mineral and accessory growth factors. Fish meal can be made from fish waste (consisting of the head, tail, fins and viscera), scrap and fish that do not command a good price in the market and dried fish that is not saleable on the consumer market for quality reasons.
Methods of production

Local fishmeal processors vary in their methods of production. There are however, two general methods for the production of fish meal, namely: dry reduction and wet reduction.

Dry reduction

The raw material is first ground, then dried and finally packaged. For drying the material is placed in circular drums which are heated with steam until the final moisture content is about 12 percent; this takes about six hours. Sun-dried fish, which have a moisture content of 18-25 percent are in heated flat bed bin dryers at about 90°F for about three hours until the moisture content decreases to about 10 percent. Drying can also be achieved naturally by using solar energy. The cooked dried fish is fed into a hammer mill where it is pulverized before packing.

Wet reduction

The raw material is cooked and pressed, the liquid portion is removed and the residue is placed into the driers. Dried fish are hammer-milled and packaged in polypropylene sacks. This second method is not common in the Philippines because oil extraction equipment is not available.

Present status of the industry

Present production of fish meal in the Philippines is based mainly on waste, rejects and market surpluses. Most of the fishmeal processors use the dry reduction process but many of them have made improvements with regard to the reduction of bacterial load, odour and particle size. Bacterial load is reduced by fumigation in the drying process. Due to the varieties of raw materials used, some processors use a mixer to improve quality by producing a homogeneous product. As far as it is known only one fishmeal plant in the Philippines has oil extraction equipment (Norconsult, 1975).

Potential of the industry

The Philippine fishmeal industry has a very good potential because of the increasing demand for meal as a feed ingredient (see Tables 2 and 3). Domestic production of fish meal reached around 12 000 tonnes/y in 1972 and 1973. Since only about 15-20 percent of the demand is satisfied, national production of fish meal is supplemented by imports of 10-20 thousand tonnes/y (see Table 4). Imports represent an appreciable and constant drain on the foreign currency balance. However, imports have fluctuated considerably due to the practice of adjusting feed blend formulas.

Pricing

Pricing plays a very important role in the fishmeal industry. If local fish meal of about 60 percent protein and 10 percent moisture is sold at P.Ps. 3.90/kg, the fresh fish should be purchased at P.Ps. 0.75/kg, which is extremely low (Lugtu, 1977). When fresh fish purchased at P.Ps. 0.75/kg is dried to about 33 percent, the cost increases to approximately P.Ps. 2.25. An additional P.Ps. 0.35 for labour and transportation costs will lead to a price of P.Ps. 2.60/kg. Further processing will reduce the moisture content up to 15 percent increasing the price to P.Ps. 3.10/kg. The processing cost, depreciation of equipment, cost of packaging, financing and return of investments bring the price of local fish meal to about P.Ps. 3.90/kg. The cost of imported fish meal may range from P.Ps. 4.80 to 5.20.

\*\* P.Ps. 1 = U.S.$ 0.13 (April 1978)
Table 2

Fish meal demand and consumption 1964-73 (in tonnes)

<table>
<thead>
<tr>
<th>Year</th>
<th>Consumption</th>
<th>Calculated demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1973</td>
<td>14,900</td>
<td>27,900</td>
</tr>
<tr>
<td>1972</td>
<td>25,000</td>
<td>26,300</td>
</tr>
<tr>
<td>1971</td>
<td>17,700</td>
<td>25,200</td>
</tr>
<tr>
<td>1970</td>
<td>18,400</td>
<td>23,900</td>
</tr>
<tr>
<td>1969</td>
<td>19,200</td>
<td>24,400</td>
</tr>
<tr>
<td>1968</td>
<td>21,400</td>
<td>24,800</td>
</tr>
<tr>
<td>1967</td>
<td>13,100</td>
<td>22,700</td>
</tr>
<tr>
<td>1966</td>
<td>8,810</td>
<td>22,800</td>
</tr>
<tr>
<td>1965</td>
<td>9,500</td>
<td>17,300</td>
</tr>
<tr>
<td>1964</td>
<td>9,700</td>
<td>15,600</td>
</tr>
</tbody>
</table>

Table 3

Projections of consumption of and demand for fish meal (in tonnes) a/

<table>
<thead>
<tr>
<th>Year</th>
<th>Projected consumption</th>
<th>Nutritional demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>18,800</td>
<td>33,300</td>
</tr>
<tr>
<td>1980</td>
<td>33,800</td>
<td>51,700</td>
</tr>
<tr>
<td>1985</td>
<td>60,800</td>
<td>80,300</td>
</tr>
</tbody>
</table>

a/ Source: Margubat, 1974

Table 4

Import data on fish meal, 1971-75 a/

<table>
<thead>
<tr>
<th>Year</th>
<th>Quantity (kg)</th>
<th>Value (P. Ps.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1971</td>
<td>10,134,158</td>
<td>10,142,424</td>
</tr>
<tr>
<td>1972</td>
<td>11,602,247</td>
<td>12,141,199</td>
</tr>
<tr>
<td>1973</td>
<td>13,222,345</td>
<td>2,624,410</td>
</tr>
<tr>
<td>1974</td>
<td>8,347,155</td>
<td>18,655,451</td>
</tr>
<tr>
<td>1975</td>
<td>28,707,283</td>
<td>54,517,213</td>
</tr>
</tbody>
</table>

a/ Source: BFAR, 1975
Problems facing the industry

(1) Shortage of raw materials: Fishmeal operations cannot obtain a reasonably priced supply of fish for the following reasons:

(a) Lack of awareness in the main fishing sectors of the country about the viability of supplying fresh or dried fish to fishmeal processors. Most of the trash fish that could be used for fish meal are channelled instead to the fish paste and fish sauce manufacturers where there is greater profitability. As a result, much of the current supply is managed through middlemen; this leads to higher prices.

(b) Lack of an established system for the supply of fish. The proportion of fish that is converted to fish meal is very small because Filipinos are a fish-eating people. At present, fishing boat operators give higher priority to the supply of fish for human consumption.

(c) There is still a need for more efficient fishing techniques and equipment although efforts are being made by the Government, through the Bureau of Fisheries and Aquatic Resources and other research institutions, to increase the fish catch.

(d) The fishermen are unaware of the value of unpopular species of fish; although not acceptable for human consumption, this could be a potential source of raw material for fish meal.

(e) Seasonal nature of fishing.

(2) Lack of equipment such as that used for oil extraction: this would help lift the economic status of the fishmeal industry.

(3) Pricing difficulties: Unstable pricing for raw materials and virtually inflexible acquisition-price structure from users (Lugtu, 1977). It must be noted that fishmeal pricing depends on its quality, in terms of nutritive value.

(4) Variable standards: There is a need for more strict enforcement of quality control in the industry. Efforts, however, are being made by the Bureau of Animal Industry to enforce quality control. Producers who add copra meal, feather meal or corn gluten to the fish meal are ordered to close temporarily. Operators also lack sufficient knowledge of the theoretical, practical and economic aspects of fishmeal production.

(5) Uncertain future: If the fishmeal industry cannot supply the needs of feed mills, it will face an unstable future (Lugtu, 1977). This has happened in the past when some manufacturers have set up facilities to fill the need which is now supplied by massive fish meal imports.

FISH SILAGE

Prospects for fish silage

Fish silage is a new development in the production of animal feeds. However, in the Philippines this product is still at the research stage. The use of fish silage in the Philippines has been studied; Flores (1974) mentioned that fish silage production is possible in Philippine conditions since there are waste materials from
canneries. However, for this industry to flourish, there is still the need for more raw materials. The importance of this product will have to be studied further.

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