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AN OVERVIEW OF FISH SILAGE: TECHNIQUES OF FISHERY WASTE UTILIZATION

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ABSTRACT

The fish silage is a liquid product made up with fish waste which treated with an acid and as a result liquefaction caused by several enzymes present in fish body. It is an effective alternative to fish meal. Silage can be produced with two methods: acid-preserved silage and fermented silage. Silage showed similar nutritional properties to fish meal, but show higher digestibility. Silage can be utilized as animal feeds, pellet production and as fertilizer.

KEYWORDS: Fish silage, Fish meal, Oil, Liquefaction, Acid, Feed.

INTRODUCTION

Primarily fish is produced to obtain meat (Sachindra & Mahendrakar, 2015). The whole fish or parts or products which not used for human consumption are termed as byproducts, while waste includes products which cannot be used for feed or value added products (Rustad et al. 2011). Fish byproducts have often termed as fish offal (Sachindra & Mahendrakar, 2015). The yield of byproducts from finfish processing ranges from 3.0% (fins) to 21.1% (head with gills) and the total byproducts constitute 49.3% of whole body weight (Sachindra & Mahendrakar, 2015). Fish market wastes (viscera, fin, skin and flesh) contain high amount of protein, lipid and minerals. There is a need for developing methods for use of these valuable wastes into human food or animal feed to reduce aqua-production costs and increase benefit (Hossain & Alam, 2015).

Fish silage may be described as a liquid product which produced when whole fish, or parts of fish, are treated with an acid, usually either formic or a mineral acid (Tatterson, 1982). Liquefaction is caused by enzymes that is present in the fish, and is accelerated by the acid which in addition to creating the right conditions for the enzymes to work, helps to break down bone and inhibit the growth of spoilage bacteria (Tatterson, 1982). Organic acids are most commonly used for silage production from fish (Arason, 1994). Silage can be produced by adding sugar or sugary grains along with lactobacilli to fish and fish waste. Lactobacilli convert sugar into lactic acid which preserves the fish and creates favorable conditions for the silage (Petersen, 1953; Nilsson & Rydin, 1963).

PRINCIPLE OF SILAGE PRODUCTION

Converting fish waste or by-products into silage, preserves the raw material and

increases the bioavailability of the nutrients. This makes fish silage an excellent way of reducing waste and at the same time converting the waste into a valuable product both in terms of nutrition and in terms of economy. The first step in silage production is preservation of the raw material. This is done by first grinding the fish and parts of fish into small sized particles. Then an acid is added to reduce the pH to ensure the product is preserved. Enzymes from the fish active in the acid pH-range will immediately start a process of hydrolysis, breaking down the protein into peptides and amino acids. When hydrolysis is complete, a liquid product is ready for use or storage (Toppe et al. 2018).

METHODS OF SILAGE PRODUCTION

There are two methods for production of fish silage:

1. **Acid-preserved silage** :

By adding acid, inorganic and/ or organic, which lowers the pH sufficiently to prevent microbial spoilage. The fish silage becomes liquid because the tissue structures are degraded by enzymes naturally present in the fish (Raa et al. 1982).

2. **Fermented silage** :

By bacterial fermentation, initiated by mixing minced or chopped fish with a fermentable sugar which favors growth of lactic acid bacteria. These bacteria may be naturally present in the fish. It may be advisable, however, to add the bacteria as a starter culture. The lactic acid bacteria produce acid and antibiotics which together destroy competing spoilage bacteria. Sugar contributes to the preservation effect during the initial stages of fermentation by repressing bacterial production of enzymes which liberate ammonia from amino acids (Raa et al. 1982).

SOURCES FOR SILAGE PRODUCTION

1. By-Catch on Shrimp Trawlers
2. By-Products of Fish Processing
3. Slaughter house Waste

*Source: Raa et al. 1982

PROCESSING OF SILAGE

The fish silage production is a simple process in which the raw material is comminuted and mixed with preservatives, depends on the material and intended use (Arason, 1994). The enzymes which are present in fish will liquefy the fish mass and form a stable liquid with a malty odor and very good storage characteristics (Arason, 1994).

For the production of fish silage, first of all the good quality raw material is minced with a grinder by which it able to produce as small particles as possible, but no greater than 3-4 mm in diameter (Arason, 1994). Mincing is necessary to distribute the enzymes which is present in material that are distribute throughout the mass of fish and also to ensure thorough blending of the acid (Arason et al. 1990; Windsor & Barlow, 1981).

Then the well minced raw material went through acid preservation. For acid preservation, the mineral acids, organic acids or mixture of the both acids are used (Arason, 1994). Th quality of mineral acid required the pH of 2 (Raa et al. 1982). Generally, the organic acids are more expensive than the common mineral acids but their use gives stabilization at a high pH (around 4.0) than stabilization with mineral acids. Therefore, the silage which produced with organic acids can use in feed without neutralization (Tatterson & Windsor, 1974). It is very important that the acid sufficiently enter into all the material and the dispersion has to be

completely homogeneous (Petersen, 1953; Raa et al. 1982; Arnesen et al. 1981). After the acid has been added, immediately the pH reading will be lowered artificially due to the fact that the acid enters the cell structure within a short period (Petersen, 1953; Raa et al. 1982; Arnesen et al. 1981). Formic acid is most commonly used for fish silage production because during processing of silage all process equipment should be designed in stainless steel due to the use of formic acid (Arason, 1994).

After the acid preservation of fish mince, it became slightly stiffen due to the addition of acid (Windsor & Barlow, 1981; Arason et al. 1984). Now the liquefaction will proceed. The silage gradually liquefies because of the activity of tissue degrading enzymes which is present in fish naturally and because of that the pH decreases sharply about 4 (Raa & Gildberg, 1976). The mixture is stirred continuously at this time and the temperature is chosen for the right rate of autolysis (Windsor & Barlow, 1981). Generally silage which is made up from fresh white fish offal, take about 2 days to liquefy at 25°C, but it take 5-10 days at 15°C to liquefy (Windsor & Barlow, 1981).

After liquefaction, the silage can be stored in a tank and stirred occasionally (Arason et al. 1990). In the storage tank, silage can separate into three phases (Arason, 1994): A lipid-protein emulsion – on top, An aqueous soluble phase – in middle andA small sediment of heavy and insoluble fragments – at bottom

After liquefaction, the de-oiling of silage should be take place as soon as possible. In this process the first step is heating the silage in a heat exchanger at 70-90°C (Windsor & Barlow, 1981). Then the coarse suspended solids are removed by decantation or by screening and the oil is then removed from silage by centrifugation (Windsor & Barlow, 1981). Heating or pasteurization at 85°C for 2 min will help to inactive the enzymes (Arason, 1994).

After cooling, the mixture is acidified at pH 4 to prevent spoilage. These liquefied proteins are more stable and better utilized than the conventional silage (Arason, 1994). To reduce the transport and storage cost of silage, produce concentrated silage because the concentrated silage has better nutritional value than the ordinary silage (Arason et al. 1990).

EQUIPMENTS USED IN SILAGE PRODUCTION

The equipment used for silage production is not highly sophisticated, but regular checks, cleaning and maintenance is needed to ensure good quality silage, and a cost efficient process. The equipment needed can be from small and low cost manual units to bigger automated plants (Toppe et al. 2018). Equipments used in silage production are following (Toppe et al. 2018):

1) Grinder: to grind the raw material during first step of production.
2) Mixing tank: it is used to mix the grinding meat with the acid or antioxidant. It should be made up of acid resistant material such as plastic, fiberglass or stainless steel.
3) Pump: use to move silage from production tank to storage tank and also used for circulating the product to ensure that all fish particles are exposed to acid and enzymes.
4) Storage tank: use to store the silage. The storage tank made up with the material which is resistant to corrosion and could be of plastic, fiberglass or even steel, but galvanized materials not to be used.

NUTRITIONAL VALUE OF SILAGE

Several workers have successfully utilized acid-preserved silage which obtained from different raw materials in diets for different animal species. The amino acid composition of saithe waste silage is similar to that of the protein of white fish meal (Gildberg & Almås, 1986). Autolysis and ensiling does not alter the amino acid composition significantly so that it indicates that tryptophan is unstable in acid conditions and it is apparently the first limiting amino acid in the fish silage (Gildberg & Almås, 1986).

Feeding trials on rainbow trout diets which contain 60% silage preserved with HCl observed growth equivalent to that on a diet of fresh fish (Lall, 1991). Silage produced with propionic acid, either alone or combination with formic, sulfuric or other acid, not palatable to Atlantic salmon (Lall, 1991). The digestibility of silage produced from whole herring, dogfish and cod indicate that all the three types of fish silage efficiently utilized by Atlantic salmon (Lall, 1991). Fish silage has similar nutritional properties to fishmeal, but with a higher digestibility due to the hydrolyzed proteins. In addition, the organic acid in the silage has antibacterial properties in the intestine of the animal, in addition to serving as a preservative in the silage itself (Toppe et al. 2018). Fish silage is a good source of Nitrogen (from the protein), Phosphorus, Potassium, Calcium, and Magnesium (particularly from the bone structure) (Toppe et al. 2018).

ADVANTAGE OF FISH SILAGE OVER FISH MEAL

The world market always looks for an alternative to fish meal (Nogueira et al. 1997). Therefore, fish silage is an attractive alternative to fish meal. The advantages in the production of silage instead of fish meal are following (Arruda et al. 2007): The process is independent from the scale, The technology is simple, The little investment, even in large scale production, It reduced effluents and odor problems and Faster process in tropical climates.

UTILIZATION OF FISH SILAGE

Directly as feed: Due to low acidity, fish silage can fed directly without any treatment. This has been done successfully as part of daily feed of pigs and result in higher growth rates, improved health and reduced mortality (Toppe et al. 2018).

Mixed with other feed ingredients: It is also mixed with other ingredients such as grains or other dry feeds (Toppe et al. 2018).

Use in pellet production and extruded feeds: Due to the highly hydrolyzed proteins, silage has a high level of free amino acids and peptides, which shown to improve growth performance. Use of fish silage for extruded feed is showed good results (Toppe et al. 2018).

Use as fertilizer: The silage can also be used as a fertilizer, if it does not meet the quality requirements for feed purposes. The application of fish silage as a fertilizer can be done as a part of the irrigation process by adding directly around 2-5% liquid silage to irrigation water (Toppe et al. 2018).

CONCLUSION

The fish silage is excellent alternative to the fish meal. The production of silage is an interesting possibility to make use of fish waste (Arason, 1994). It is possible to produce better quality fish oil from liver silage than silage mixed with liver (Arason, 1994). Fish silage or fish meal for animal

feed should be made only from fish not suitable for human consumption (Raa et al. 1982). At the present large resources of fish protein are being discarded and there is no immediate possibility to utilize this waste as human food. These resources are the main part of the by-catches (Raa et al. 1982).

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