

## **Fish silage**

Fish silage is an excellent protein source having high biological properties for animal feeding. Fish silage is a liquid product made from whole fish or parts of fish that are liquefied by the action of enzymes in the fish in the presence of added acid. The enzymes present in the acidic medium breakdown fish proteins into smaller soluble units while the acid helps to speed up their activity and prevent bacterial spoilage. Fish silage can be made from spoiled fish, sub-utilized species, by-products from marine fish, commercial fish waste and industrial residues from the filleting industry. The proteins present in the fish silage can also be hydrolysed to free amino acids, making the silage the most available source of amino acids for protein biosynthesis. During fish silage preparation, the raw material is chopped into small pieces and a 3% by weight solution of 98% formic acid is added and mixed well and then stored for 48 days. The pH of the mixture should be less than 4 to prevent bacterial action. Fish silage can also be prepared by a fermentation method in which fish is chopped, minced and mixed with 5% (w/w) sugar beet molasses. A culture of *Lactobacillus plantarum* is inoculated into molasses and incubated until a population of  $10^7$  bacteria per g of molasses is obtained. This culture is then added in the ratio of 2 ml/kg to the minced fish. The inoculum is incubated at 30°C for 7 days inside sealed plastic buckets. The autolysis is later stopped by heating the silage at 90°C for 30. Fish silage can be mixed with wheat bran and oven dried at 105°C. Co-drying fish silage with cereals reduces the drying times of the silage and improves the nutritional content of the silage. To prevent spoilage of the dried silage it should contain low moisture content

Water levels greater than 120 g/kg can support bacterial, mould and yeast growth. Many bioactive products including peptone, oil and pepsin can be obtained from fish silage. Fish like Atlantic cod and salmon have high amounts of pepsin in the stomach. The optimal storage conditions for the recovery of pepsin are pH of 3 and 25°C for 3 days. By ultra-filtration and spray drying, the stomach silage can provide crude pepsin corresponding to 0.5-1 g of pure pepsin per kg. The purity of the crude pepsin extracted ranges from 2-10%. The cod stomach and viscera silage can also provide 100 g low molecular weight peptone per kg of the raw material.