Determining nutritional quality and chemical changes during storage of fish silage produced using different combinations of undersized quota species

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Fishery byproducts are often underutilized, even though they form an excellent source of nutritional proteins and fats. A problem concerning fishery byproducts is that these materials are very unstable and processing methods such as freezing or drying are often expensive, requiring large volumes before they become feasible. Producing fish silage could be an alternative for countries with smaller fishing communities, such as Belgium.

Fish silage implies the liquefaction and stabilization of minced whole fish or fish offal by the addition of mineral and/or organic acids. It is considered a low-investment, low-cost and easy-to-produce fish meal substitute. Fish silage quality is strongly influenced by the initial composition and quality of the raw materials. Therefore, according to the industry, a steady supply of fresh, low-variety raw materials is required to ensure product uniformity and quality. However, many of the European demersal fisheries are mixed fisheries, thus supplying a large variation of raw materials.

During this research the nutritional value was determined and chemical changes were monitored in four types of fish silage, each produced using a different combination of undersized Belgian quota species. The following nutritional parameters were investigated: degree of hydrolysis (DoH), dry matter (DM), crude protein (CP), crude lipid (CL), ash, amino acids (AA), fatty acids (FA), total volatile basic nitrogen (TVB-N), trimethylamine (TMA), and thiobarbituric acid reactive substances (TBARS). The goal of this research was to determine the stability of the fish silages over a 3-month time period and to ascertain the effect of raw material combination (RMC) on fish silage quality.

There was no difference in initial CP (74%DM) and in all fish silages CP decreased over time. However, CP of the less complex RMCs levelled off at approximately 64%DM after 3 weeks, whereas the more complex RMCs exhibited a stronger decrease in CP over time and dropped to levels below 60%DM after 3 months. Accordingly, these complex RMCs also displayed a slower but longer DoH compared to less complex RMCs, 73.5% and >85%, respectively. Extended hydrolysis leads to a loss of protein-N in the form of NH_3 and a decrease in nutritional value.

Initially there were slight differences in CL between the fish silages, ranging from 5.0 - 9.3%DM. After 3 months all silages had a similar CL of approximately 5.8%DM. Ash decreased slightly (2.8%DM) and DM increased slightly (1.2%) in all fish silages during the 3-month storage period. The low DM of approximately 24.6% negatively influences the economic value of the silage.

All silages seemed to be a good source of essential and non-essential amino acids. The fatty acid profile showed a large amount of polyunsaturated fatty acid (PUFA). However, the relatively low CL values signify that the silages are not an ample source of PUFA.

TVBN – an indicator for the freshness of the raw materials – is the product of NH_3 and TMA, and increased significantly during storage. The relatively stable TMA values in all the fish silages indicate that the increase in TVBN is mainly due to the production of NH_3, which corresponds with the CP decrease. Initial TVBN and TMA values were slightly above the limits of 35 mg/100g and 8 mg/100g, respectively. TBARS remained below the limit of 8 mg/100g in all fish silages indicating that there was limited lipid oxidation.

There seems to be an effect of RMC on the nutritional value of fish silage and a decrease in quality during storage. The decrease in quality is mainly based on the changes in the protein fraction since this was the most dominant change and fish silage is often used as protein source in animal feed. Product pasteurization could limit hydrolysis, thus minimizing protein losses. Fresher raw materials should be used in the future to minimize TVBN and TMA. Also, a concentration step could be added to increase the DM content.

Keywords: fish silage; nutrition; fishery byproducts; valorization; fishmeal substitute