Mussel meal production based on mussels from the Baltic Sea

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Description

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Abstract
Mussel farming provides an ideal way of removing nutrients and improving transparency in the water. Mussel meal has also been shown to be a valuable high protein feed component in feeds for e.g. poultry and fish. Mussels contain the essential amino acids methionine, cystein and lysine which are important in feeds. Mussel meal contains ca 65 % of protein and 8 % of fat, providing an excellent nutritional content for use in fish feeds. A newly invented lysis process of making mussel meal has shown a very promising result when using Baltic mussels. Mussels are at the second step on the food chain and a replacement of fish meal for mussel meal involves an ecological benefit. With increasing prices for fish meal and fish oil mussel meal might in the future become a competitive ingredient for fish feeds.

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Mussel meal, mussel farming

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Cover page picture taken by Petra Granholm of Sixten Strömblom's mussel farm

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1. Introduction

Many coastal areas and sites suffer from eutrophication caused by the discharge from farm land and aquaculture operations. Baltic blue mussels (*Mytilus trossulus* or *Mytilus edulis*) are a promising blue catch crop, which provide an ideal way for recirculation of nutrients in the Baltic Sea. Mussels require no feed, but filter phytoplankton from the water and thus remove nutrients and improve transparency of the surrounding waters. Mussels are at the second step on the food chain and a replacement of fish meal for mussel meal involves an ecological benefit. When the mussels are harvested, the negative effects of the eutrophication are counteracted. At the same time the nutrients are recycled from sea to land and can then be re-used in the form of mussel meal in feeds. Mussel farming, further, has a positive public image, which allows for easier acceptance of the farming and keeps it on the agenda. During recent years investment in research has considerably improved production and processing methods.

Mussels contain the essential amino acids methionine, cystein and lysine which are important in feeds. The dried mussel shells are a high quality source of calcium. The potential of mussel meal in feeds is huge. Mussel meal, which is dried and grinded mussel meat, has been shown to have properties similar to fish meal and to be possible to use in a number of different feed applications. Mussel meal has successfully been tested as a high value protein feed component for layers and for chicken breed. In order to produce mussel meal at a large scale a robust, energy saving and cost effective process is required. The technical process of separating the mussel meat from the shells is then essential.

The Aquabest project invested in mussel meal processing in order to study the potential for mussel meal to become a component in fish feeds used in the Baltic Sea. Using mussel meal in the fish feeds would reduce the inclusion of other imported ingredients and thus help in closing the nutrient loop in Baltic Sea aquaculture.

2. Mussel farming in the Baltic Sea

The different mussel farm trials carried out in the Baltic Sea have shown that it is possible to farm mussels up to about the Åland archipelago. Further to the north the salinity becomes too low for the growth of the mussels. The farm trials have demonstrated that farming on coarse nets seemed to be the most suitable farming technique. The greatest challenge to overcome will be to secure that the farming installation not is damaged by ice. Mussels in the Baltic Sea also have rather weak byssus threads and thus may drop from nets through wave action and during handling and harvest. The most likely solution to this problem will be to lower the mussel farm below the surface, at least during winter. Also, the farming equipment has to be developed in order to be able to handle the small and fragile Baltic mussels. A more comprehensive report on mussel farming in the Baltic can be found in SUBMARINER Mussel Perspectives (March 2013), as well as in Aquabest reports 4/2013 and 5/2013 (Bonardelli 2013, van Deurs 2013).

Both wild mussels as well as cultured mussels are available for seafood from the southwestern part of the Baltic Sea (with a mussel farm in operation in the Kiel Bay). With decreasing salinity levels towards the eastern and northern parts of the Baltic Sea, the mussels become too small to be used for traditional seafood purposes. Thus, this application will not become of major importance within the Baltic Sea Region.

3. Mussel meal pilot plant

A pilot plant for testing production processes of mussel meal was set up during 2011 and first half of 2012 in Ellös, situated on the Swedish west coast. This pilot plant had a capacity of processing 1 ton of fresh mussels per day, which resulted in about 40 - 50 kg of mussel meal and 400 – 500 kg of shell with some dried mussel meat attached thereon. Besides locally produced (fresh) mussels, steamed and frozen mussel meat with origin from south-western Baltic was processed. In September 2012 a first trial was carried out processing barely a ton of small and fragile Baltic mussels from the Åland Islands. In February and March 2013 a second trial using Baltic mussels was made with 10 tons of mussels which had been farmed at Kumlinge situated in the eastern Åland Archipelago.

The mussel meal used by the Aquabest project feed trials was produced in June 2012 at the pilot plant in Ellös. This pilot plant was operated by the project “Pilot Plant for the Production of Mussel Meal” having the Swedish Rural Economy and Agricultural Societies as project owner.

Figure 1. Mussel pilot line in Ellös, Sweden, at winter 2013.

The Aquabest mussel meal was produced by using fished mussels from southern Danish waters as raw material. The mussels were steamed open and the meat and shells were separated at the Royal Frysk GmbH factory close to Flensburg in Germany. The mussel meat were sorted into A-grade quality for human consumption (sea food market) and B-grade quality which were frozen in 5 kg bags to be used as fish food in aquariums or for other uses. About 1.8 ton of the B-grade frozen mussel meat was delivered to Ellös to be used for the production of the Aquabest mussel meal.

For drying, a wood chips heated rotating drum-dryer was used, designed by AB Torkapparater in Stockholm. The capacity of the small pilot dryer was about 300 – 400 kg of mussel meat per 24 hours, which resulted in 60 – 80 kg dried mussel meat (ca 20% of wwt). Altogether about 350 kg mussel meal was manufac-

tured. As a mean, about 5 % of the weight of a fresh mussel can be dried to mussel meat. The corresponding original amount of fresh mussels dried could thus be estimated to ca 7 ton.

Figure 2. The rotating dryer and the surrounding equipment.

During the drying process, the temperature was slowly raised so that the mussel meat at the end reached a temperature of 80 - 85 °C for 30 minutes or more. Most of the mussel tissue had then turned into 10 – 20 mm rather hard particles or pellets. After cooling, this material was grinded using a small grain mill and then poured into 25 kg sacks. Before closing the sacks, samples were taken for testing on the occurrence of Salmonella. Finally, the Aquabest mussel meal was loaded on a pallet and sent, together with a certificate that no Salmonella had been detected, by truck to Finnish Game and Fisheries Research Institute, Laukaa Finland, where the fish feed pellets were manufactured.

4. A new process for mussel meal production

During the trials of making mussel meal at the pilot plant a new process was developed which was based on lysing. The trials showed that the mussel meat could be transformed into a liquid, or suspension, when the fresh or frozen mussels were treated in a certain way. It was soon discovered that this process had several advantages compared to the first used process, where the mussels had to be steamed, and meat and shells separated before dried to meal.

In the new process the mussels are cracked and de-watered, where after the mixture of meat and shells are gently heated under agitation. Due to this treatment a lysis process takes place and is maintained until the mussel meat has become liquefied. The mussel slurry is drained and shell pieces are removed by separating techniques. At the last step the slurry is heated and dried by e.g. a drum dryer. A patent application has been submitted to EPO.

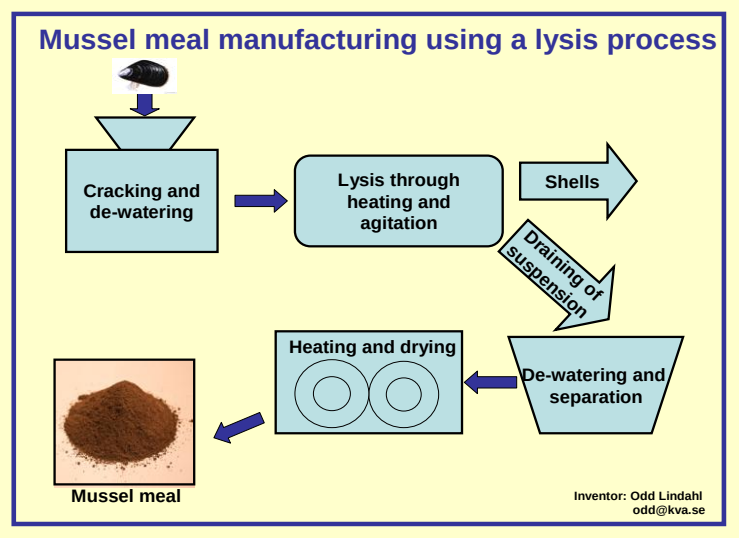

Figure 3. Lysis process for producing mussel meal.

The lysis process is regarded as especially useful and important when fragile and thin-shelled Baltic mussels shall be processed to mussel meal. All the different process steps have been tested one by one at a laboratory scale and have been found to work well. Next developmental step is to scale up and to connect the different steps into one continuous production process.

5. Mussel meal for use in fish feed

Mussel meal contains ca 65 % of protein and 8 % of fat, providing an excellent nutritional content for use in fish feeds (Lindahl *et al.*, 2005). The blue mussel has a high content of the essential sulphur-rich amino acids methionine, cysteine and lysine, which match the content in fishmeal (Table 1). They can, when shells are included in the feed, also provide calcium carbonate. At the same time, mussels are an excellent high protein feed for poultry as well as in fish feed, the fresh mussel meat have a fat content of about 2% (40% of which are Ω3 long-chain fatty acid molecules). 20 kg of raw blue mussels are about needed to produce 1kg of mussel meal (Lindahl & Kollberg, 2008). Mussel meal contains about 1% nitrogen and 0.1% phosphorus (Lindahl *et al.*, 2005). The mussel meal has shown no evidence of containing POP's, as long as the farming of the mussels is not placed close to a polluting source. A more comprehensive description of mussels as a resource for mussel feed production can be found in Lindahl (2011).

Table 1. The content of protein and share of sulphur-rich amino acids and lysine in mussel and fish meal and some other commonly used feedstuff products (Berge and Austreng, 1989; Johansen, 2008).

	Mussel meat	Mussel meal	Fish meal	Rape cake	Peas	Soy cake	Wheat
Protein, g kg^{-1} DW	645	764	670	237	265	520	120
Methionine, % of protein	1,8	2,5	2,8	2,0	1,0	1,4	1,6
Methionine + Cystine, % of protein	2,6	4,2	3,7	4,5	2,4	2,9	3,9
Lysine, % of protein	6,0	7,7	7,4	5,6	7,1	6,2	2,8

6. Conclusion

Baltic blue mussels are generally in the size range 10 – 30 mm and have a fragile and thin shell. Consequently, these mussels break easily and meat and shell cannot be separated by using the methods used for bigger and more thick-shelled mussels of marine origin. It is absolutely necessary to remove 90 – 95 % of the shells if a high qualitative mussel meal shall be manufactured and which can replace fish meal in feeds for use in e.g. fish farming. The newly invented lysis process of making mussel meal has shown a very promising result when using Baltic mussels. However, up-scaling of the process from laboratory level to industrial scale still remains to be carried out.

Mussel farming and mussel meal production in the Baltic is currently difficult to scale up because of the production and transportation costs. Current small production volumes do not allow for mussel meal to be incorporated into fish meal on a Baltic Sea region wide industrial scale. However, with ever increasing price for fish meal and fish oil mussel meal might in the future become a competitive ingredient for fish feeds. Mussel farming still provides an ideal way of removing nutrients and improving transparency in the water and mussel meal has been shown to be a valuable high protein feed component in feeds for e.g. poultry and fish.

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