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Aquafeeds

Can grass in fish feeds lead to a greener salmon aquaculture sector?

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By Bonnie Waycott

NIBIO researchers aim to turn grass into protein-rich fish feed to cut soy imports and boost sustainable aquaculture

The Norwegian Institute of Bioeconomy Research seeks to turn grass into protein-rich fish feed in an effort to reduce dependency on soy. Photo by Anette Tjomsland Spilling, courtesy of NIBIO.

Grass may be the primary component of a dairy cow's diet, but feeding grass to fish is unconventional. Yet, researchers in Norway say that grass biorefining could result in a domestically produced protein fish feed that has comparable nutritional profiles to other aquaculture feed ingredients like soy.

The Norwegian Institute of Bioeconomy Research (**NIBIO** (https://www.nibio.no/en)) recently opened Norway's first pilot plant for green biorefining in Steinkjer. The plant processes 2.5 metric tons of fresh grass per hour and presents a host of opportunities from research to feeding experiments and system development. Steffen Adler, research scientist at NIBIO's Division of Food Production and Society, told the *Advocate* that grass could help to address some of the challenges that Norway faces when it comes to feed.

"A lot of feed is imported, so our work opens up the possibility of a domestically produced feed, while for species like salmon, it's crucial to have a high-quality protein feed that meets their nutritional requirements," he said. "We are looking for local protein that could be used in salmon farming, and are trying to find it in plants such as grass and macroalgae. Our challenge is to apply the appropriate processing methods to get a balance of nutrients that meets the animals' requirements."

Grass biorefining begins by cutting and mincing fresh grass in a screw press. This releases valuable nutrients from grass cells, and produces a juice that is rich in protein, sugar and minerals, and a pulp that consists mainly of grass fiber. Any fiber particles in the juice are then removed before the protein is extracted by heating and separated using a centrifuge or decanter. This results in a grass protein concentrate containing approximately 40 percent protein, and a brown juice called grass whey. The grass protein concentrate is put through a flash dryer until it's around 90 percent dry matter and packaged into bags.

The nutrients released during biorefining are also compatible with requirements in aquaculture, according to Gjermund Bahr, senior advisor in the Department of Biomarine Resource Valorisation at NIBIO.

Researchers at NIBIO manufacture a grass protein concentrate containing approximately 40 percent protein, and a brown juice called grass whey. Photo by Anette Tjomsland Spilling, courtesy of NIBIO.

“There is a great need for new feed materials, not only in aquaculture but also in chicken and other livestock production,” he said. “Grass grows locally, and there is plenty of it so why not use it? If you are able to refine grass protein, it has a good amino acid profile that may be suitable for species such as salmonids.”

However, although it could be used as it is in species like carp that have a broad diet, Bahr said more research is required to determine whether it can work on salmonids.

“Some new ingredients are better for certain fish species or applications than others, and we don’t know much about this yet when it comes to grass protein concentrate,” he said. “It’s a very novel protein source, and we need more time to understand its complexity.”

Adler and Bahr add that more research is required before grass biorefining can become economically viable for feed production. They’re also keen to explore whether new high-value feed ingredients could be developed from other biorefining byproducts like grass whey – and how to produce a grass-based feed that can compete with existing protein sources used in aquaculture. Other areas will also need to be studied further, such as the impact on flesh color and fat composition.

“Feeding experiments with chicken that were fed grass protein concentrate found that their fat became yellower the more they consumed,” said Adler. “The same could happen if we feed grass protein to fish. There are likely to be some impacts, perhaps on feed intake, fat composition or flesh color. We have to find out how we can address these, as well as investigate other areas such as the impact of grass protein on astaxanthin receptors in farmed salmon.”

Adler and Bahr’s research comes hot on the heels of previous work carried out in Denmark and Germany between 2020 and 2022. Feed producer **Aller Aqua** (https://www.aller-aqua.com) conducted feeding trials in rainbow trout and Mediterranean species using grass protein concentrate at its research facility Aller Aqua Research. Based on this research, Aller Aqua Norway AS is investigating the nutritional suitability of grass protein feed for Atlantic salmon. The aim is to highlight that grass protein concentrate from Norwegian meadow plants can replace imported raw materials such as soy, without compromising fish performance, welfare and product quality.

“First and foremost, we need raw materials that meet the nutritional requirements of farmed fish,” said Dr. Florian Nagel, head of research at Aller Aqua. “Grass is widely available and can therefore reduce aquaculture’s CO_2 footprint and its dependency on raw material imports. Improving domestic production by using local ingredients aligns well with our sustainability goals, but first, we have to make sure that using those ingredients results in healthy growth in fish.”

The color of salmon: How fish farmers can add value by focusing on pigmentation

Are Norwegian salmon fillets getting paler? Researchers there are poring over pigmentation data to find commonalities in the color of salmon.

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To do this, Aller Aqua has invested much time and effort to study novel ingredients, explained Nagel.

“It starts with the nutritional profiles,” he said. “Which amino acids are pronounced? What is the fatty acid spectrum? How much fiber is present in the raw material? How can we fit that into our recipe formulations? We also investigate the physical properties of raw materials and their influence on pellet production, before conducting digestibility trials. We need to ensure that the nutrients remain in the fish and not end up as pollutants in the surrounding environment. We also have to pay close attention to undesirable side effects such as discoloration or impaired palatability. Finally, we produce a feed batch and test the ingredient under farm conditions to see if the data confirm our lab results.”

Feed from grass protein concentrate could be a radical innovation, with grass biorefining potentially contributing to local and regional value creation and increased self-sufficiency. For a country like Norway, which imports more than 90 percent of its aquafeed ingredients, domestically produced grass protein may one day be essential. Two-thirds of feed raw materials fed to Norwegian farmed salmon are obtained from south of the equator, while current global insecurity means that any ambitions for growth in Norway cannot be based on access to feed that relies on international supply chains, said Bahr. He believes that although a portfolio of new feed ingredients in Norway is key, the first step will be to enable these to exist with more conventional ones like fishmeal or soy.

“When it comes to grass, words such as high sustainability or low carbon footprint will bring fish farms and feed companies on board immediately,” he said. “In fact, we are already in contact with feed


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NIBIO will be fine-tuning and optimizing the grass protein concentrate, conducting additional tests to improve its quality and determine the final nutritional specifications. Photo by Anette Tjomsland Spilling, courtesy of NIBIO.

companies that are interested in grass as a protein source, but it's currently not possible to completely replace an ingredient like soy protein with grass. Its protein content is too low, but nevertheless, it has a very good amino acid profile. Significant time will be required to make small adjustments so that it is perfect for species such as salmon."

Adler and Bahr are hopeful that Norway will see a more widespread adoption of different feed ingredients in the future. Going forward, NIBIO will be fine-tuning and optimizing the grass protein concentrate, conducting additional tests to improve its quality and determine the final nutritional specifications, and researching ways to use other products generated from biorefining, such as grass whey. It will also be looking into upscaling the grass biorefining process.

"One of the important things is to get enough interest and gain some momentum because grass protein is a very promising ingredient," said Bahr. "We have a lot of work ahead, for example selecting the optimal type of grass and getting the ideal protein content balance. It will take many years, but we know that it is possible to feed salmon some percentage of grass protein. Although grass protein concentrate is not yet produced on a large scale, it's important to invest in it, and take those first steps to make fish feed greener."

"Based on the results of our research, I am optimistic that large-scale feeding trials with Atlantic salmon in Norway will confirm our previous findings, that grass protein can be a suitable component in salmonid feeds," said Nagel. "We are convinced that with further improvements, especially in standardized processing and price, grass protein will, at least, partially reduce the dependency on conventional ingredients such as soy. That would be a significant step forward in upscaling the utilization of grass protein in aquafeeds."

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Correspondent Bonnie Waycott became interested in marine life after learning to snorkel on the Sea of Japan coast near her mother's hometown. She specializes in aquaculture and fisheries with a particular focus on Japan, and has a keen interest in Tohoku's aquaculture recovery following the 2011 Great East Japan Earthquake and Tsunami.