COMPLETED PROJECT CASE STUDY

HEMP BY-PRODUCTS AS A PROTEIN SOURCE FOR SCOTTISH SALMON

PARTNERS

University of Stirling's Institute of Aquaculture | Rare Earth Global

PROJECT LEADS

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BACKGROUND

The continued sustainable development of the aquaculture sector is reliant on successfully establishing alternative protein sources to fulfil the demand for commercial aquafeeds. Currently, production and processing of soy protein, the main protein included in aquafeeds, carries a higher than desired CO2 footprint. Hempseed protein has been identified as a competitive protein source to soy and project partner, Rare Earth Global (REG), has established a UK model for supplying locally and sustainably produced hemp protein, aiming to reduce carbon footprint by fitting into UK farmers' existing crop rotation schedules.

This feasibility study brings together leading research team at the University of Stirling's Institute of Aquaculture with commercial partner Rare Earth Global, co-funded by the UK Seafood Innovation Fund along with contributions from the Sustainable Aquaculture Innovation Centre (SAIC). It represents the first step in determining the suitability of UK-produced hemp seed by-product as a protein source for the Scottish Atlantic salmon sector. Previous research into hempseed protein has determined its high digestibility in humans and mice, as well as a favourable nutritional profile in terms of the amino acid and fatty acid composition. This makes it a prime candidate material for the aquaculture sector following an assessment of its digestibility value in salmon.

Commercial hemp production and processing has grown in recent years, with projections to increase the amount of commercial hemp up to 80,000 Ha, in the UK alone, within the next 10 years. As a crop, hemp can be used across a range of sectors such as food, fuel and construction. It offers several environmental benefits including soil bioremediation, fast growth, and highly effective CO2 sequestering. Furthermore, there are currently over 80 varieties of hemp registered in the UK, which could allow for custom selection of amino acid and nutrient profiles to fulfil the specifications for salmon.

AIMS

The overall objective of this study was to assess the quality of locally produced protein sources derived from a by-product of commercial hemp production for inclusion in aquafeeds for the Scottish Atlantic salmon sector. This will help achieve long-term benefits for the UK finfish aquaculture sector by ensuring a locally available and sustainable source of protein to underpin the feed needs of the sector as it continues to grow. As such, the first main step in this process was to validate that hemp seed is a suitable protein source for salmon by assessing digestibility value, as limited evidence of its use exists in fish.

In this feasibility study, project objectives were categorised into distinct work packages focusing on hempseed production, nutritional characterisation, and nutritional evaluation to address the following main aims:

1. Selection of the right variety of hemp and processing options to improve its quality.
2. Defining the apparent digestibility of hempseed meal and how this relates to its nutritional quality.

SUPPLY OF HEMP PROTEIN

Variability in the nutritional quality of feed ingredients is common and can be caused by differences in varieties, growing conditions, location, or season. Moreover, the specific processing and production parameters used can also lead to differences in nutritional composition that are directly linked to their nutritional value. REG has access to more than 80 different hemp cultivars with varying nutrient composition, allowing for a level of tailored selection to meet the specifications in terms of amino acids, fatty acids and non-digestible carbohydrates of this raw ingredient.

The method of preparation of hemp protein includes harvesting, drying, cooling, dehulling, cold pressing, and milling to refine. The fibre content of the final ingredient can be adjusted by increasing or reducing the hull content, while amino acid and fatty acid content can be adjusted based on amount of hemp seed oil left in the product and/or the milling technique. In order to meet the requirement for use in salmon aquafeeds, the protein content must be greater than 35%.

Three different hempseed meal (HM) and one hempseed oil (HO) products, originating from different cultivars and processing technologies, were provided by REG for nutritional analysis.

NUTRITIONAL CHARACTERISATION OF HEMPSEED PRODUCTS

Nutritional and biochemical characterisation analyses were performed by Nutritional Analytical Services (NAS) at the University of Stirling on the three hempseed products provided by REG. The analysis included the estimation of moisture, oil, protein, ash, minerals, fatty acid and amino acid profiles in the HM samples, and fatty acid profile in the HO sample. In addition, antinutritional factors including phytic acid and glycosylates were analysed.

Following analyses, the two HM with highest protein content (HM1: 42% and HM2: 46%) were selected for the follow-on digestibility trial.

DEFINING FACTORS AFFECTING VARIABILITY IN THE NUTRITIONAL QUALITY OF HEMP PROTEIN

An in-vivo digestibility trial was carried out at the University of Stirling's Marine Experimental Research Laboratory at Machrihanish, using three experimental feeds (two experimental and one control). The experimental feeds were produced by an external supplier, Pontus Research, following specifications provided by the Institute of Aquaculture. The two experimental diets each included 30% of the respective hempseed meal and a control diet without this raw ingredient. Yttrium oxide was also included in both diets as an inert marker in order to estimate the apparent digestibility of hempseed meal.

A total of 360 Atlantic salmon smolts, with an average body weight of 802.0±15.9 g and 40.3±4.5 cm, was distributed into nine tanks (three per treatment) and fed the experimental feeds for two weeks. After this, fish were humanely euthanised, and faeces collected by gentle massaging of the fish abdominal area. Intestinal samples were also collected to evaluate intestinal integrity.

Results were positive, indicating protein digestibility of the test diets at 84% and 87% for HM1 and HM2, respectively. The protein and amino acid digestibility of the two test ingredients was also generally high and in many cases was 100%. Digestibility results from the test ingredients were complemented by a follow-on in vivo digestibility trial, using an artificial salmon gut (SalmoSim® - the result of a previous SAIC-funded project) to assess the bioaccessibility and bioavailability of nutrients of the two HM diets.

Results from both the in vitro and in vivo trials prove that the digestibility of both hempseed meal products was excellent. They would therefore have the potential to be used as a novel ingredient for hot-extruded feeds for Atlantic salmon.

IMPACT

The vulnerability of our food system has highlighted the need to establish alternative and sustainably sourced ingredients, with hempseed meal identified as a potential candidate due to its nutritional characteristics and availability as an industrial by-product. This feasibility study represents the first look at the nutritional characterisation of UK-grown hempseed meal, and has proven its potential as an ingredient for salmon aquafeeds as a highly digestible ingredient in a short-term digestibility trial. Further investigations are now required to understand the impact that long-term feeding can have on fish health and welfare, growth performance and fillet quality.

Rare Earth Global, as project partner for the feasibility study, is now set to lead a full-scale R&D project aiming to commercialise this research and further investigate not only the nutritional and performance-related characteristics of hempseed meal, but also to determine the most sustainable and cost-effective methods for its production. Furthermore, REG will look to assess the impacts of hempseed meal production

on the environment through an independent lifecycle analysis with an overall aim to meet an initial annual target production of 65,000 tonnes of hemp protein for the UK feed market.

The use of hempseed meal, as a by-product of commercial hemp production, offers a sustainable solution to offset the carbon footprint associated with its production, while creating a new feed category to be used across the finfish aquaculture sector. Furthermore, scaling up the supply of UK-produced hempseed meal will require additional jobs in farming and manufacturing, helping to support local employment.

This project has set the foundation for future collaboration between REG and project partners at the University of Stirling. Additionally, through REG's initiative to commercialise a more sustainable aquafeed, Mowi – Scotland's largest salmon producer – has shown its support for this work, and will look to offer support in the long term as a partner and, subsequently, a customer for REG.

> *"There is a necessity to find locally-produced protein sources capable of reducing the export of soy protein concentrate for its inclusion in fish feed. Hempseed meal has an excellent nutritional profile and digestibility, and with projections to increase its UK production, seems to be an excellent candidate to take part in the basket of raw materials used for aquafeed production. In addition, being a by-product means that its price is expected to be lower than soy and also contribute to making Scottish salmon a sustainable industry, what will be further explored in our newest project".*
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> *Monica Betancor, Institute of Aquaculture*

ADDITIONAL INFORMATION/ PRESS COVERAGE

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