Valorization of Coffee Waste as a Sustainable Protein Source for Aquaculture Feed

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INTRODUCTION

The increasing demand for aquaculture products has placed significant pressure on the industry to find sustainable alternatives to traditional feed ingredients like fishmeal and soybean meal. With global fish stocks in decline and the environmental impacts of agriculture on the rise, there is a growing need for more eco-friendly, cost-effective, and renewable sources of protein to sustain fish farming. One such promising alternative is the valorization of spent coffee grounds (SCG), a by-product of the coffee industry. SCG are typically discarded as waste despite their rich nutritional profile, which includes proteins, lipids, and fibers. (fig. 1)

The use of SCG in fish feed not only offers a way to recycle organic waste but also provides a potential solution for reducing the reliance on conventional protein sources in aquaculture. This approach aligns with the principles of circular economy, which aims to minimize waste and make the most of available resources. In this study, we explore the feasibility of incorporating SCG as a protein-rich ingredient in aquaculture feed. By analyzing the nutritional composition of SCG and conducting feeding trials with fish, we aim to assess its impact on fish growth, health, and overall performance. Our findings could contribute to the development of more sustainable and efficient fish farming practices, while also addressing the environmental concerns associated with coffee waste disposal.

Fig. 1 Spent coffee grounds (SCG)
https://live.stemfellowship.org/spent-coffee-ground-biodiesel-a-brief-introduction-to-an-alternative-fuel-source-and-its-production/

BACKGROUND

Aquaculture, the fastest-growing food production sector globally, has become a vital source of protein for millions of people. However, this growth has brought with it challenges, particularly in the area of feed sustainability. Traditional fish feeds rely heavily on fishmeal and soybean meal, both of which come with significant environmental and economic concerns. The production of fishmeal contributes to overfishing, while the cultivation of soybeans is linked to deforestation and extensive water use. As the aquaculture industry seeks to meet the rising demand for fish, finding alternative protein sources has become a top priority.

Spent coffee grounds (SCG) offer a unique opportunity in this context. Globally, millions of tons of coffee are consumed annually, producing large amounts of SCG as a by-product. Despite containing valuable nutrients, such as proteins, lipids, and fiber, SCG are often discarded as waste, contributing to environmental pollution. Recent studies have shown that SCG, with a protein content of approximately 15%, could be a viable ingredient in animal feed, including for fish. Incorporating SCG into fish feed aligns with the principles of sustainability and circular economy by recycling organic waste and reducing the reliance on traditional feed components. However, while the nutritional potential of SCG is promising, it is essential to evaluate its effectiveness in aquaculture, particularly in terms of fish growth, health, and feed conversion efficiency. This study aims to explore the feasibility of using SCG as a sustainable, nutrient-rich ingredient in fish feed, contributing to more eco-friendly aquaculture practices.

EXPERIMENTAL APPROACH

Spent coffee grounds (SCG) were sourced from local cafes in Cluj-Napoca. After collection, the SCG were cleaned to remove impurities and then dried in ovens at 60°C, ensuring the reduction of moisture content without affecting their aromatic compounds.

Once dried, the SCG were finely ground into coffee flour using specialized equipment to ensure a uniform particle size. After grinding, the coffee was sifted and refined to eliminate any large particles, resulting in a fine and consistent texture, which is essential for its incorporation into fish feed. The nutritional composition of the SCG was analyzed, focusing on protein, fat, carbohydrates, and minerals.

Using the Tango spectrometer from Bruker (Ettlingen, Germany), samples were measured directly without any extraction

RESULTS

The results showed that SCG contained approximately 17.8% protein (dry weight), making them a promising alternative protein source for fish feed.(Table 1)

Table 1. Floor detergent recipe with plant extract

Crt. No.	Analysis	Units	SCG
1.	Humidity	%	5.67
2.	Lipids	% DW	5.6
3.	Protein	% DW	17.8
4.	Carbohydrates	% DW	22.8
5.	Ash	% DW	2.73

CONCLUSIONS

The analysis of spent coffee grounds (SCG) reveals the following key characteristics:

- **Humidity (5.67%): The moisture content is relatively low, which is advantageous for processing and storage. Low humidity reduces the risk of microbial growth and spoilage, making SCG more stable for use in feed formulations.**
- **Lipids (5.6% DW): The lipid content is moderate, contributing to the energy density of the SCG. Lipids are an important energy source for fish, and this level indicates that SCG could provide some beneficial fats in the diet.**
- **Protein (17.8% DW): The protein content is quite substantial, making SCG a promising alternative protein source. Although it is lower than some conventional protein sources like fishmeal, it still contributes to the overall protein intake in aquaculture feed, aligning with sustainability goals by reducing the reliance on fishmeal.**
- **Carbohydrates (22.8% DW): The carbohydrate content is moderate and can be used as an additional energy source for fish. However, high carbohydrate levels in fish diets can sometimes be a limiting factor in growth, so this content must be balanced in the final feed formulation.**
- **Ash (2.73% DW): The ash content, which represents the mineral content of the SCG, is relatively low. This indicates that SCG does not have a high concentration of inorganic materials, which is beneficial because excessive ash content can reduce the digestibility and nutritional value of the feed.Overall, SCG presents a balanced nutritional profile with moderate protein and lipid content, making it a viable ingredient for fish feed. However, its carbohydrate levels would need to be carefully managed in diet formulations to ensure optimal fish growth and health.**

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