

Research Title

Whey protein and its environmental impact and its role in controlling agricultural
pest and nourishing plant and animal

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<https://jaspps.com>**Abstract**

Whey protein, a byproduct of cheese production, significantly contributes to both human nutrition and environmental sustainability. Once viewed as waste, its effective utilization now helps reduce waste and lower the dairy industry's carbon footprint. In agriculture, whey protein proves to be a valuable resource, aiding in pest control and enhancing plant and animal nourishment. Its use as a bio pesticide offers a natural alternative to chemical pesticides, fostering eco-friendly pest management. Additionally, whey protein supplements in animal feed promote growth and health, while its inclusion in plant fertilizers enhances soil fertility and plant vitality. By converting waste into a multifunctional resource, whey protein supports sustainable agricultural practices and environmental conservation.

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Introduction

Whey protein, also known as whey protein, is a by-product of the cheese-making process and has gained significant importance in the fields of human nutrition and environmental conservation. Previously, it was considered a waste product, but thanks to recent research and innovations, it has found multiple uses that contribute to reducing the environmental impact of the dairy industry. By utilizing whey protein, the amount of waste generated during cheese production can be reduced, which contributes to reducing the carbon footprint of this industry.

In addition, whey protein is a valuable resource in agriculture, as it plays an important role in controlling agricultural pests and feeding plants and animals. Using it as a bio-based alternative to chemical pesticides provides a natural and safe solution for pest control, reducing reliance on harmful chemicals and promoting environmental sustainability. This biological use of whey helps maintain the health of the agricultural ecosystem and reduce chemical pollution.

In addition, whey protein is used to improve the nutrition of animals and plants. Including this protein in animal feed promotes their growth and health, while using it in plant fertilizers helps improve soil fertility and increase plant strength. By turning

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waste into a multi-beneficial resource, whey protein contributes to the development of sustainable agricultural practices and the preservation of the environment.

Objective of research

Given my field work in the Ministry of Agriculture and the specificity of the Karak region in the manufacture of dairy and cheese, and seeing the waste in whey despite its many benefits, as there is no culture in the local community regarding its value, I wanted to prepare this scientific paper.

Question of research

- What is the environmental impact of reusing whey protein in the dairy industry compared to disposing of it as waste?
- How can whey protein contribute as a bio-based alternative to conventional chemical pesticides in agricultural pest control?
- What are the nutritional effects of using whey protein in animal feed on animal growth and overall health?
- How does the use of whey protein in plant fertilizers affect soil fertility, plant growth and productivity?

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- What are the economic and sustainable benefits of using whey protein in agriculture compared to conventional methods?

Importance of Research

Research on whey protein, its environmental impact and its role in agricultural pest control and plant and animal nutrition is of great importance in developing sustainable agricultural practices and innovative environmental solutions. The first importance lies in the ability to convert dairy industry waste into valuable resources, which reduces the environmental impact of this industry. Recycling whey protein and using it in agriculture enhances waste reduction and improves resource management, which contributes to reducing the carbon footprint and enhancing environmental sustainability.

In addition, whey protein has great potential to enhance the overall health of plants and animals. Its use as a bio-alternative to chemical pesticides provides a natural and safe way to control pests, reducing chemical pollution and protecting biodiversity. Moreover, when used in animal feed, it enhances their growth and health, which positively reflects on agricultural production. Its use in plant fertilizers

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also improves soil fertility and increases crop productivity, which supports food security and enhances the sustainable agricultural economy.

Theoretical Framework

The environmental impact of reusing whey protein in the dairy industry

Reusing whey protein in the dairy industry has a significant positive environmental impact, directly contributing to reducing the amount of waste generated in cheese manufacturing processes. Whey is usually considered a waste that must be disposed of, which imposes an additional environmental burden on dairy industries through the need to treat and dispose of this waste in ways that do not negatively impact the environment. By using whey protein effectively, this by-product can be converted into a valuable resource for use in animal feed and the food and sports drink industries, reducing the need for disposal and increasing the efficiency of the use of available resources.

In addition, reusing whey protein contributes to reducing the carbon footprint of the dairy industry. Whey disposal processes require additional energy and resources, and often result in harmful greenhouse gas emissions. By converting this by-product into useful materials, these emissions can be significantly reduced.

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Furthermore, these sustainable practices contribute to the circular economy, as materials are returned to the production cycle rather than being wasted, contributing to the overall sustainability of the dairy industry and enhancing its environmental responsibility.

How can whey protein contribute as a bio-alternative to agricultural pest control

Whey protein can contribute as an effective bio-alternative to agricultural pest control due to its natural properties that help reduce reliance on harmful chemical pesticides. Whey proteins contain biologically active compounds that can inactivate pests by inhibiting their growth or reducing their viability. These natural compounds are less harmful to the environment than traditional chemicals, which helps maintain ecological balance and protect non-target organisms such as beneficial insects, soil and microbes.

In addition, whey protein can be used in the formulation of pest control products that are safe for use around humans and animals. The development of biotechnology can improve the effectiveness of these proteins and increase their ability to target specific types of pests with precision. By using these biological

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products, farmers can achieve effective pest control without causing harmful residues to accumulate in food crops or soil, thus enhancing the quality and safety of the final agricultural products.

Furthermore, the use of whey protein as a bio-alternative in pest control can support sustainable and organic agriculture. By reducing reliance on chemical pesticides, farmers can reduce the production costs associated with purchasing and using these materials, while at the same time maintaining soil health and increasing its fertility in the long term. These sustainable practices enhance the reputation of organic agricultural products in local and global markets, opening new doors for trade and promoting economic growth in the agricultural sector. The use of whey protein in this context is not only an environmental solution, but also a sustainable investment that brings long-term economic and social benefits.

Nutritional effects of using whey protein in animal feed on animal growth and overall health

The use of whey protein in animal feed allows for a significant improvement in the nutritional value of feed, which is positively reflected in the growth and health of animals. Whey protein contains all the essential amino acids that animals need for

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healthy and sound growth. By including this protein in the animal diet, muscle building can be enhanced and growth rates can be increased, which is particularly beneficial in raising meat and dairy animals.

In addition, whey protein is characterized by its easy digestion and absorption properties, which ensures that animals benefit from the maximum available nutrients. These properties help improve the efficiency of converting feed into biomass, which means that animals will need less feed to achieve the same growth levels, which leads to reduced feeding costs and improved production efficiency. Furthermore, whey proteins contain biologically active compounds such as lactoferrin and immunoglobulins, which boost the immunity of animals and help fight diseases.

The regular use of whey protein in animal feed also contributes to improving their overall health and well-being. Good and balanced nutrition enhances the vitality of animals and increases their ability to resist stress and diseases, reducing the need for antibiotics and other medications. This is not only beneficial for the overall health of animals but also enhances the quality and safety of animal products such as meat and dairy, meeting the growing consumer demand for healthy and natural

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products. In short, the use of whey protein in feed promotes healthy and balanced growth of animals, which leads to improved productivity and the quality of the final products.

The impact of using whey protein in plant fertilizers on soil fertility, plant growth and productivity

The use of whey protein in plant fertilizers significantly enhances soil fertility and promotes plant growth and productivity. Whey proteins contain a variety of amino acids and essential nutrients that can be added to the soil, improving its structure and increasing its ability to retain nutrients and water. These nutrients are vital for healthy plant growth, as they contribute to enhancing microbial activity in the soil and increasing the availability of essential nutrients to plants.

In addition, whey protein contributes to enhancing the vegetative and floral growth of plants. With its rich ingredients, whey protein can stimulate better root and leaf production, resulting in stronger, healthier plants. This enhanced growth helps plants withstand harsh environmental conditions such as drought and salinity, and reduces the need for large amounts of chemical fertilizers. Therefore, the use of

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whey protein promotes agricultural sustainability by reducing reliance on harmful chemical products.

In addition to improving soil fertility and plant growth, the use of whey protein in fertilizers can significantly increase crop yields. Plants that receive good and balanced nutrition are able to produce higher quality and larger crops. This increases farmers' economic returns and improves food security. Furthermore, the use of whey protein as fertilizers enhances food safety, reducing chemical contamination and contributing to the production of healthy and safe crops for human consumption. Overall, whey protein is a sustainable and effective option for improving agriculture and enhancing crop productivity.

Economic and sustainable benefits of using whey protein in agriculture

The use of whey protein in agriculture provides significant economic benefits by improving production efficiency and reducing costs. Whey protein is an effective alternative to expensive chemical pesticides and fertilizers, reducing operational costs for farmers. In addition, improving the health and growth of plants and animals through the use of whey protein leads to increased productivity and quality of agricultural products. This enhances the economic return for farmers by increasing

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the quantities produced and improving the quality of products, enabling them to achieve better prices in local and international markets.

Environmentally, the use of whey protein contributes to agricultural sustainability by reducing reliance on harmful chemical products. Chemical fertilizers and pesticides can pollute soil and water and harm the ecosystem as a whole. In contrast, whey protein offers a natural and safe solution that helps maintain healthy soil, water and plants. This enhances ecological balance and reduces the negative environmental impacts of conventional agriculture, thus helping to preserve natural resources for future generations.

In addition to the economic and environmental benefits, the use of whey protein contributes to enhancing social sustainability in agricultural communities. By improving plant and animal health and increasing crop productivity, farmers can achieve sustainable income and improve their standard of living. The use of sustainable agricultural practices also enhances the reputation of agricultural products and increases demand for them in global markets that prefer environmentally friendly products. This can open new doors for trade and enhance

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economic development in rural areas, supporting social stability and sustainable development in the long term.

Previous studies

Study (**Bacenetti et al., 2018**): The production of cheese yields various byproducts, with whey being the most abundant by volume, although traditionally considered waste. However, whey contains valuable components like lactose, proteins, and fats. This study focused on assessing the environmental impact of producing whey protein concentrate (WPC) through ultrafiltration, adopting a life cycle perspective. The study evaluated three types of WPCs with varying protein concentrations (WPC35, WPC60, WPC80). A scenario analysis was conducted to understand how pre-concentration of whey in a pretreatment plant, aiming for a dry matter content of 20%, could mitigate environmental impacts. Two sensitivity analyses were carried out, one altering the transport distance of whey and the other employing a different allocation method.

The life cycle assessment identified transportation as a significant hotspot, contributing 28–70% of the environmental impact, with electricity use accounting for 18–20%. Interestingly, the alternative scenario involving whey pre-concentration

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resulted in impact reductions ranging from 0.9% to 14.3%. Pre-concentrating whey closer to the cheese factory effectively lowered the environmental burden despite potential increases in energy consumption due to smaller, less efficient equipment used in pre-concentration.

In conclusion, implementing whey pre-concentration in a nearby pretreatment plant proves beneficial, significantly reducing the overall environmental footprint of the process. This approach demonstrates a viable strategy to mitigate environmental impacts associated with whey production, even with potential trade-offs in energy consumption during pre-concentration.

Study (**El-Aidie & Khalifa, 2024**): Effective management of industrial waste is paramount in preserving environmental sustainability. The dairy industry (DI), known for its substantial water consumption, produces considerable whey dairy effluent, rich in organic matter and posing a significant pollution risk. This effluent, characterized by high biological and chemical oxygen demands, presents environmental challenges. Stringent governmental regulations, environmental statutes, and growing consumer health awareness necessitate responsible handling

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and repurposing of whey waste. Thus, this study delves into sustainable strategies for optimizing DI waste utilization.

Utilizing a systematic review methodology, the research uncovers that innovative technologies enable the conversion of dairy byproducts into renewable, high-quality, value-added food items. These advancements offer promising avenues for sustainable waste management in the dairy sector while also aligning with economic interests. The study's primary objectives encompass evaluating the environmental impact of dairy waste, exploring the diverse nutritional and health advantages of cheese whey, and investigating various biotechnological approaches to creating value-added, eco-friendly dairy whey-based products for potential incorporation into different food items, thereby promoting economic sustainability.

In conclusion, this work spans theoretical insights, and practical applications, and outlines future research avenues crucial for advancing the sustainable management of dairy waste. It underscores the importance of adopting innovative technologies and holistic approaches in addressing environmental concerns and enhancing economic viability in the dairy industry.

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Study (**Riseh et al., 2023**): Climate change, water and soil salinity, drought, the emergence of new pest and pathogen species, industrialization, and environmental pollution are factors that constrain agricultural productivity. The reliance on chemical inputs like fertilizers, pesticides, and fungicides to combat biotic and abiotic stresses has limitations and environmental repercussions. A shift towards natural substances and beneficial microorganisms is imperative to mitigate the adverse effects of synthetic agrochemicals. Plant biocontrol bacteria, for instance, require protective coatings to enhance their efficacy and resilience against harsh conditions. Whey protein, derived from the cheese industry, stands out as a valuable natural polymer with high protein content, safety profile, and biodegradability. Its versatility makes it suitable for various agricultural applications, including encapsulating bacteria for pest and disease control in plants.

Whey protein's amino acid richness activates plant defense mechanisms and enzymes, further bolstering plant resilience. This review explores whey protein's potential as a coating for fruits and vegetables, enhancing their shelf life and protection against phytopathogens. By leveraging whey protein's encapsulation properties, agricultural products can withstand environmental stresses and reduce

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dependency on chemical interventions, aligning with sustainable agriculture practices.

Study (**Chojnacka et al., 2021**): The pursuit of sustainable agriculture yields both environmental conservation and economic advantages. A pivotal aspect of modern agriculture is enhancing the efficiency of nutrient utilization, particularly nitrogen, which exerts substantial environmental pressure. This underscores the importance of producing highly digestible protein feed with optimal bioavailability, thereby minimizing biogenic element losses in animal waste. This review assesses the latest developments and their potential applicability in sustainable agricultural practices, highlighting the imperative to mitigate agriculture's adverse environmental impacts.

Utilizing local protein sources for animal feed reduces greenhouse gas emissions linked to transportation. The adoption of highly digestible fodder contributes to curbing environmental pollution stemming from excessive nitrogen runoff. Moreover, strategies like reducing feed protein content and supplementing with essential amino acids can mitigate ammonia emissions from livestock farming. These approaches, when implemented effectively, foster enduring positive changes

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that promote environmental sustainability, enhance animal welfare, and safeguard human health.

Methodology

The descriptive analytical approach was used in this research to describe the research terms and concepts. Secondary data was used, which is entirely based on scientific studies and research published on the Internet. Through it, the most important results and recommendations were extracted.

Results and Recommendations

– Results

1. Using whey protein as a biomaterial in agricultural pest control can help reduce reliance on harmful chemicals and limit environmental pollution.
2. Adding whey protein to animal feed can enhance animal health and improve their growth and productivity.
3. Application of whey protein in plant breeding can improve soil quality and enhance plant growth and productivity.
4. Using whey protein in plant nutrition can reduce the use of chemical pesticides and enhance plant growth naturally.

5. Developing techniques to increase the size of whey protein particles can help improve the effectiveness of its use in biological control of agricultural pests.

– Recommendations

1. Encourage research and development to improve techniques for using whey protein to effectively and sustainably control agricultural pests.
2. Raise awareness of the benefits of using whey protein in plant and animal nutrition and encourage farmers to adopt these techniques.
3. Support applied research to evaluate the impacts of using whey protein on the environment and human and animal health.
4. Develop strategies for using whey protein in plant breeding effectively and sustainably.
5. Enhance cooperation between the scientific and agricultural sectors to exchange knowledge and apply best practices in using whey protein to achieve sustainability in agriculture.

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