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The use of Licorice waste as fertilizer in Agriculture: Ecological and Economic impacts

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Abstract

This article investigates the impact of using wild-grown licorice (sweet licorice) plant waste in the soil on plant growth in the Saatlı region. Licorice waste naturally possesses many beneficial properties and can be reused in various fields, including agriculture. In this study, the growth processes of plant seedlings were observed concerning the application of untreated licorice waste and biochar in the soil.

Three different experiments were conducted: the first involved 2g and 4g of untreated licorice waste, the second involved soil enriched with biochar, which is obtained from licorice waste, and the third involved soil without any fertilizers. In each experiment, plants were sown under the same conditions, and irrigation was carried out for seven days. The results for days 7 and 14 were also calculated. The study results indicated that the development of wheat grown with licorice waste varied at different levels.

The results of the research show that biochar made from licorice waste and the application of licorice waste in the soil have a positive effect on seedling germination and growth. Plants grown in biochar-enriched soils exhibited better health and growth, while some challenges were observed in soils treated with untreated licorice waste. In conclusion, the reuse of licorice waste in agriculture can enhance soil fertility and may be beneficial for obtaining sustainable yields in farming.

Keywords: Licorice waste, Sweet licorice, Biochar, Soil fertility, Plant growth, Ecological impact, Waste recycling, Effect of licorice waste.

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Introduction

Licorice (*Glycyrrhiza glabra*) is a widely distributed plant in countries such as Azerbaijan, China, India, Iran, Pakistan, Turkmenistan, and Uzbekistan. Its properties, composition, and benefits make it significant both in medicine and environmental protection. Licorice is extensively used in pharmaceutical production, and its waste has the potential for reuse in various fields. This study investigates the agricultural applications of waste derived from the sweet licorice variety found in the Saatlı region.

Licorice plant waste is often discarded in nature, contributing to environmental pollution. However, it can be utilized to improve soil fertility, enhance ecological conditions, and support plant growth. Incorporating this waste into soil in forms such as biochar and fertilizer can yield both ecological and economic benefits.

The primary objective of this study is to assess the effects of sweet licorice waste—both in its raw form and as biochar—on soil fertility and plant growth. Additionally, the study examines how licorice waste influences soil pH, moisture levels, and seed germination. Ultimately, this research aims to contribute to the development of sustainable solutions for repurposing licorice waste in agriculture.

Furthermore, this study discusses the ecological impact of licorice waste and its potential benefits in agriculture. The goal is to demonstrate that the reuse of licorice waste not only enhances soil productivity but also contributes to environmental conservation.

Methodology

In this study, the effects of licorice waste on soil fertility were examined by comparing two forms of licorice waste: untreated and biochar-converted licorice waste. The research focused on the impact of applying sweet licorice (*Glycyrrhiza glabra*) waste, collected from the Saatlı region, to the soil and its relationship with soil pH levels. Differences in plant germination processes resulting from the addition of licorice waste to the soil were also observed.

First, the licorice waste was cleaned and prepared. The untreated licorice waste was simply washed, dried, and ground before being added to the soil. The biochar form was produced by subjecting the licorice waste to pyrolysis in a specialized furnace at a temperature range of 350–650°C for over four hours. During this process, the licorice waste underwent carbonization at high temperatures, reducing its moisture content [1].

Additionally, soil pH levels were measured using both litmus paper and an electronic pH meter. The results indicated a pH value of 7.2, classifying the soil as alkaline [2].

During the experiment, different amounts of licorice waste were added to the soil. These amounts included 2 g, 4 g, and a control sample with no licorice waste added. Additionally, different quantities were tested separately for biochar and untreated licorice waste. All samples were watered regularly, and plant growth was monitored throughout the process.

The results showed that the addition of both biochar and untreated licorice waste improved soil fertility and positively influenced plant growth. Plants grown in soil enriched with biochar exhibited greater height and a higher germination rate. Although untreated licorice waste also had a positive impact, its effect on plant growth was comparatively lower. Furthermore, it was determined that the soil's pH level played a beneficial role in supporting plant development.

Results and Discussion

The aim of this study was to evaluate the impact of licorice waste on soil fertility and to analyze how different forms of this waste (untreated licorice and biochar) affect plant growth. The methodological approach involved adding varying amounts of licorice waste and biochar to the soil, monitoring seedling development, and assessing their physiological condition.

The results of this study indicate that adding licorice waste and biochar to the soil has a positive effect on plant growth. However, the proper management of irrigation and other environmental factors also plays a crucial role in achieving optimal plant development.

The results of the study with untreated licorice waste showed a positive impact on wheat plant growth; however, it also highlighted the importance of irrigation [3]. In the sample where 2 g of untreated licorice waste was added to the soil, the shortest seedling measured 0.3 cm, while the tallest reached 8.2 cm after 7 days, with a total of 14 seedlings observed. However, the average seedling height was 7.5 cm. After 14 days, seedling height ranged between 15 and 19 cm, their color turned light green, and some seedlings dried out and became damaged.

By the end of the 7th day, physiological changes had already become noticeable. The seedlings began to show signs of yellowing, and drying started from the tips. When the soil lacks sufficient nutrients, plants expend more energy to compensate for this deficiency, which negatively affects their growth process. As a result, plant drying, leaf yellowing, and overall growth weakening were observed. This was also linked to uneven water distribution in the soil and the inability of the root system to absorb the necessary nutrients.

In the soil where 4 g of untreated licorice waste was added, the shortest seedling measured 2.5 cm, while the tallest reached 7 cm within 7 days, with a total of 12 seedlings observed. By the end of 14 days, the seedlings grew between 15 and 18 cm, but some began to yellow and showed signs of drying.

This result indicates that while adding untreated licorice waste to the soil can accelerate plant growth to some extent, the imbalance of nutrients and inadequate irrigation negatively affect healthy development. Specifically, although a higher amount of waste initially stimulates growth, it may lead to adverse physical changes in plants in later stages.

Adding biochar to the soil had a more positive impact on plant growth. In soil with 2 g of biochar, after 7 days, the shortest seedling measured 0.3 cm, the tallest reached 7 cm, and a total of 13 seedlings were observed. By day 14, the number of seedlings increased, their height ranged between 12 cm and 19.5 cm, and their color was dark green. This result indicates that biochar helps retain moisture in the soil and supports healthy plant growth. The addition of biochar kept the soil more hydrated, allowing the plants to develop more robustly.

In the sample where 4 g of biochar was added to the soil, after 7 days, the shortest seedling measured 3 cm, the tallest reached 8.6 cm, and a total of 14 seedlings were recorded. By day 14, the seedlings grew to a height between 15 cm and 21 cm, and the soil was observed to retain more moisture. These results indicate that adding biochar to the soil further accelerates plant growth and helps maintain healthy plant development.

In the experiment conducted in the fertilizer-free soil, after 7 days, the shortest seedling measured 0.5 cm, the longest reached 7.8 cm, and a total of 10 seedlings were observed. By day 14, the height of the seedlings ranged from 13 cm to 19 cm, and the total number of seedlings remained 10.

This result indicates that plant development in fertilizer-free soil was relatively limited. The dry condition of the soil and insufficient watering restricted the growth of the plants. As the fertilizer-free soil lacked the necessary nutrients for plant growth, it did not positively impact soil fertility.

The pH value of the soil was also one of the important parameters in the study. Measurements using both litmus paper and a pH meter determined that the soil's pH value was 7.2. This indicates that the soil is neutral. A neutral pH value creates a favorable environment for plant growth, as most plants thrive in neutral pH conditions. This result shows that the pH value of the soil is suitable for plant development and that the addition of licorice waste supports plant growth by altering the structure of the soil.

Table: Effect of Licorice Fertilizer on Wheat Germination

Licorice Amount	Day	Shortest (cm)	Longest (cm)	Germination Count	Soil Moisture	Color	Other Observations
2 g Unprocessed	7	1	8.2	14	Dry	Light green	1 sprout rotted
	14	3	19.5	13	Dry	Yellowing starts	Growth continued
4 g Unprocessed	7	2.5	7	12	Dry	Yellowing starts	Drying at the tips
	14	15	18	12	Dry	Yellowing increased	Growth slowed, more drying
2 g Biochar	7	0.3	7	13	Wet	Dark green	Germination count increased
	14	12	19.5	14	Wet	Dark green	Retains soil moisture
4 g Biochar	7	3	8.6	14	Wet	Dark green	Normal growth
	14	15	21	14	Wet	Dark green	Soil more humid
No Fertilizer	7	0.5	7.8	10	Dry	Light green	Weak growth
	14	13	19	10	Dry	Light green	Soil drier

The use of licorice waste in agriculture offers several important ecological benefits. Firstly, since these waste materials are organic in nature, they enhance soil fertility [4]. Specifically, when applied in the form of biochar, they improve the soil structure and help retain water and nutrients over the long term. This property optimizes the water demand of plants under drought conditions, allowing for more effective regulation of irrigation. Biochar also increases the activity of soil microflora and creates a favorable environment for beneficial microorganisms, which stimulates the biological activity of the soil [5].

The results of this research show that licorice waste processed in the form of biochar has a positive impact on soil fertility and plant development. Specifically, the more intensive growth of seedlings in biochar-enriched soil, the more stable soil moisture levels, and the observed differences in plant color all demonstrate the significance of this effect.

This research can be considered a new approach in the reuse of waste materials in agriculture and ecological sustainability. Although biochar's ability to increase the water retention capacity of soil

and improve plant development dynamics aligns with previous studies, the application of licorice waste in biochar form represents a new scientific approach. Therefore, the results obtained can be regarded as an important scientific innovation regarding the use of biochar-enriched soils in agriculture.

One of the ecological benefits of licorice waste is its ability to prevent soil pollution. Due to the sorption properties of the licorice plant, when the waste is added to the soil, it reduces the leaching of heavy metals and other harmful substances from the soil [6]. This can particularly contribute to preserving soil quality in areas affected by industrial and intensive agricultural activities [7]. Furthermore, the addition of licorice waste to the soil increases its carbon sequestration capacity, which may help mitigate the impacts of climate change. This process ensures the retention of carbon in the soil, leading to a reduction in the amount of carbon dioxide in the atmosphere. This method is significant in terms of preventing environmental pollution and also helps in preventing soil erosion and degradation [8].

Economically, the use of licorice waste in agriculture offers farmers cost-effective and long-term economic benefits. In a period of rising synthetic fertilizer prices, the use of licorice waste as an alternative organic fertilizer source can help reduce costs and establish a more efficient production process. The increase in soil's water retention capacity through biochar reduces irrigation costs, thereby optimizing energy and resource usage. Additionally, maintaining soil fertility contributes to long-term productivity growth, which results in higher incomes for farmers.

The economic efficiency of licorice waste can also be enhanced by recycling it into a commercial product. For example, the production of biochar and its sale as a soil conditioner can create new sources of income in the agricultural sector. This process ensures the conversion of waste into a valuable product, supporting the transition of agriculture to a circular economy model. Overall, the use of licorice waste combines environmental sustainability and economic benefit, offering an eco-friendly and efficient alternative for agriculture [9].

Conclusion and Overall Evaluation

The results indicate that the addition of untreated and biochar-processed licorice waste to the soil had different effects on the germination and development indicators of wheat. In the samples where biochar was applied, the soil retained moisture for a longer period, the seedlings were darker green, and overall development indicators were more positive. This can be linked to the biochar's ability to enhance the soil's water retention capacity, as well as its role in more efficiently storing nutrients in the soil and effectively meeting the water requirements of plants.

However, the excessive addition of untreated licorice waste to the soil has caused some negative effects. Specifically, by the 14th day, yellowing and drying of the seedlings were observed, and in some cases, the seedlings stopped growing altogether. This process may be a result of the salinity and chemical imbalance that the fertilizer can create in the soil. While the excessive organic matter provides a favorable environment for soil microorganisms during decomposition, the substances formed as a result of this decomposition can negatively affect plant roots in some cases.

The measurement of the soil's pH level revealed that it was close to neutral (pH 7.2). This level is considered optimal for most agricultural crops, including wheat. This indicates that the licorice waste did not significantly affect the soil’s acidity, but other factors may influence plant development.

Overall, the results of this study show that the impact of licorice waste on soil fertility and wheat development depends on its form of processing and the amount applied. When used properly, biochar improves soil structure, retains moisture, and supports healthier plant growth. However, uncontrolled use of untreated licorice waste can lead to certain negative effects, highlighting the importance of determining optimal quantities when applying such natural fertilizers in agriculture.

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