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The Current Research Status Of Blanched Garlic Leaves Bundling And Harvesting Technology

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Abstract:
This paper summarizes the challenges and issues encountered in the bundling and harvesting technology of blanched garlic leaves in agricultural production. It conducts a literature review and analysis, consolidating existing machinery for blanched garlic harvesting and vegetable bundling. By integrating the characteristics of blanched garlic cultivation, along with its geometric and physical properties, it examines the current challenges and trends in blanched garlic bundling and harvesting. The paper concludes by outlining the difficulties in blanched garlic harvesting and proposing feasible methods, offering insights for the development of bundling devices for blanched garlic and other vegetables. Future research could explore innovative bundling technologies to enhance both the quantity and quality of blanched garlic production while delving deeper into its environmental impact to foster sustainable development in this field.

Key Word:*The blanched garlic leaves; Vegetable bundling; Harvesting Machinery; Mature harvesting period; Postoperative analgesia.*

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I. Introduction

Blanched garlic leaves are young garlic shoots cultivated by softening garlic cloves in a sealed greenhouse under dark conditions. The cultivation process of blanched garlic leaves is soilless, without any need for pesticides or fertilizers, making it environmentally friendly. Additionally, blanched garlic leaves are rich in nutrients and are widely loved by the public. As people's living standards continue to rise, the demand for blanched garlic leaves in the market is increasing. Consequently, the production methods of blanched garlic leaves are receiving more attention from people. Currently, a team in China has developed a harvesting machine for blanched garlic leaves, but there isn't corresponding bundling equipment available, hindering the bundling process during harvesting[1,2,3,4]. Achieving mechanized bundling throughout the blanched garlic leaves harvesting process will undoubtedly reduce production costs and promote the development of the blanched garlic leaves industry. The present article provides an overview of existing vegetable bundling devices. It combines the characteristics of blanched garlic leaf cultivation and production, analyzes the challenges involved in bundling blanched garlic leaves during harvesting, and explores feasible methods. This aims to offer insights for the development of bundling devices not only for blanched garlic leaves but also for other vegetables.

II. The characteristics of blanched garlic leaves

Cultivation characteristics:

Blanched garlic leaves are commonly planted during the autumn and winter seasons. They are grown in enclosed, light-proof greenhouse hydroponic pools using soilless hydroponic techniques. These hydroponic pools are designed to fit greenhouse dimensions, with a depth of around 30cm. The walls of the pool are patched with mud slurry, and a layer of dry sand or river sand (2-6 cm thick) is spread at the bottom and edges of the pool, covered with a plastic film.

Fig. 1: The environment for blanched garlic leaves.

Production characteristics:

Currently, the seeding, management, harvesting, and bundling processes in blanched garlic leaf production still heavily rely on manual labor. In China, a team has developed blanched garlic leaf harvesting machines suitable for greenhouse use, effectively accomplishing the harvesting task in these environments. However, these harvesting machines lack the bundling function required for the continuous automated bundling and harvesting of blanched garlic leaves[5]. Consequently, the bundling process still necessitates manual intervention before blanched garlic leaves hit the market.

Blanched garlic leaves have a relatively short shelf life under normal storage conditions, with temperature and humidity playing a crucial role in their preservation. Both excessively high and low temperatures can lead to the decay and spoilage of blanched garlic leaves. After harvesting, blanched garlic leaves need to be stored in a dark environment with controlled temperature and humidity to ensure quality and maintain freshness.To reduce the storage costs of blanched garlic leaves, it's essential to minimize the time between harvesting and entering the market. Implementing a bundling harvesting process for blanched garlic leaves would undoubtedly optimize post-harvest handling, facilitating quicker transition to market.

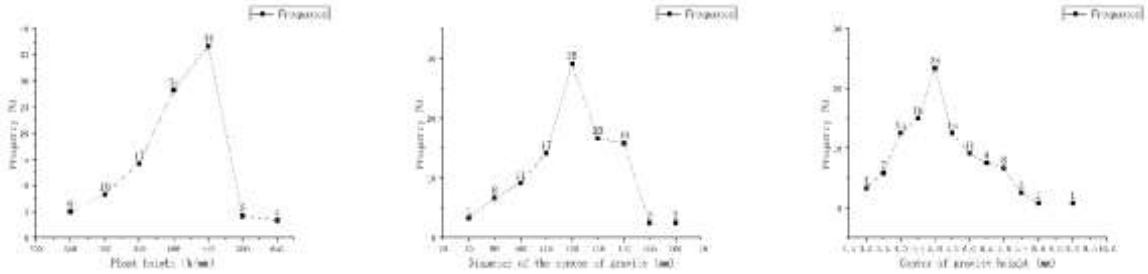
physical characteristics:

120 samples of harvested blanched garlic were selected to measure their geometric properties: plant height (L), center of gravity height (G), and diameter at the center of gravity (d_g). The relevant data was recorded and processed using Excel to obtain frequency distribution histograms for the plant height (L), center of gravity height (G), and diameter at the center of gravity (d_g) of harvested blanched garlic.

During harvesting, the height of the blanched garlic ranged approximately between 400mm to 600mm, reaching a maximum of 610mm, with an average height around 550mm;

The center of gravity height after harvesting the blanched garlic primarily ranged between 100mm to 140mm from the cutting position, with an average of 120mm;

The diameter at the center of gravity of the blanched garlic ranged between 3mm to 7mm, reaching a maximum of 6mm, with an average diameter of 5mm.



a.Frequency distribution graph of the stem plant height of blanched garlic leaves.

b.Frequency distribution graph of the centroid height of blanched garlic leaves.

c.Frequency distribution graph of the centroid diameter of blanched garlic leaves.

Fig. 2: The geometric characteristics parameters of blanched garlic leaves.

III. The current status of mechanization for bundling and harvesting blanched garlic leaves.

Currently, research on mechanized harvesting of blanched garlic leaves is gradually advancing. In the field of agricultural mechanization, teams are dedicated to designing and improving machinery for harvesting blanched garlic leaves to enhance production efficiency and reduce labor costs. While some harvesting machinery can reliably complete the task, there are ongoing technical challenges, such as effectively achieving continuous bundling during harvesting. Despite advancements in increasing blanched garlic leaf production

efficiency through these harvesting machines, further research and innovation are needed to refine these devices and meet the growing market demands.

The current status of research on blanched garlic leaf harvesting machines:

In 2020, Song Jie and his team at Weifang Vocational College developed a wheel-type blanched garlic leaf harvesting machine[6]. This machine comprises mechanisms for seedling separation, cutting, and conveying. It is propelled manually to control its forward direction and speed, while the seedling separation mechanism at the front effectively separates and gathers the blanched garlic leaves. The cutting mechanism operates through an independent switch control. Harvested blanched garlic leaves are transported by the conveying mechanism to a collecting basket at the discharge outlet, facilitating an orderly process of cutting, conveying, and collection.

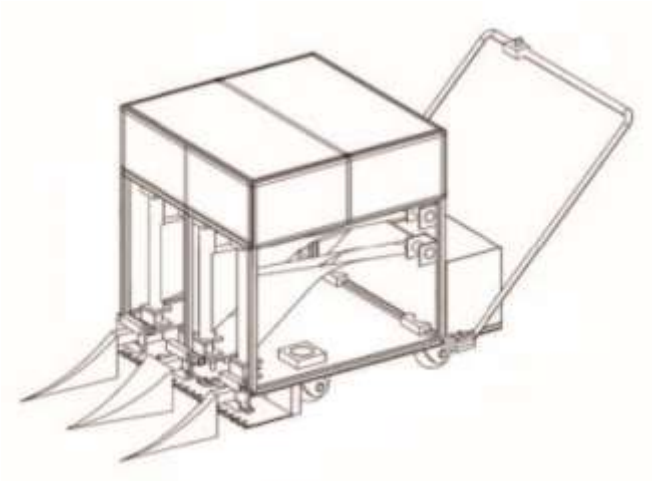


Fig. 3: Wheeled Blanched Garlic Leaves Harvester

In 2021, Feng Rui and collaborators at Shandong University of Technology designed a blanched garlic leaf harvesting machine[7]. This machine comprises a weed removing device, cutting device, horizontal conveying unit, and vertical conveying unit. It is capable of achieving systematic cutting, conveying, and collection of blanched garlic leaves.

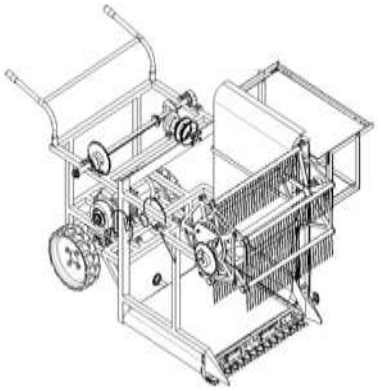


Fig. 4: Blanched Garlic Leaves Harvester

Although these studies focus on harvesting blanched garlic leaves, they haven't covered mechanisms for bundling, thus hindering continuous harvesting and bundling. Currently, there's no specialized bundling and harvesting machine or device worldwide specifically designed for blanched garlic leaves. However, analyzing various existing bundling mechanisms or devices can serve as a reference and inspiration for the future design and development of a blanched garlic leaf bundling and harvesting machine.

The Current Status of Bundling Machinery for Leafy Vegetables:

Currently, the vast majority of vegetable harvesting machinery worldwide still involves mechanical harvesting followed by manual bundling. There are various types of bundling machinery and devices available in the market, primarily categorized into two types: industrial bundling machines used for materials like steel

bars, and agricultural bundling machines used for shrubs, straw, mainly for crops used as feed. Neither of these two types of bundling machines is suitable for bundling leafy vegetables.Several companies and research institutions have been conducting research on bundling for vegetables. However, there are few devices that combine bundling with harvesting for leafy vegetables.

Currently, the bundling machine commonly used in supermarkets is the most prevalent vegetable bundling device, suitable for various fields such as food, vegetables, and packaging. It features a simple structure and easy operation. However, it requires manual placement of vegetables into the bundling machine for tying, making it difficult to integrate with harvesting machines and thus challenging to achieve automated harvesting and bundling processes.

Fig. 5: Vegetable bundling machine.

In 2018, Liu Di and Yang Pei from Yancheng Institute of Technology designed an electric vegetable bundling system[8]. This system encompasses processes such as twine storage, conveying, winding, tightening, knotting, cutting, and automated vegetable descent. The bundling system utilizes twine for bundling, where after winding, a knotter ties the vegetable bundle. During the bundling process, a winding device rotates the twine around the vegetables, and a knotting mechanism ties the wound twine around the vegetables. This bundling system boasts a high bundling rate, compact bundling, and notably efficient bundling effectiveness.

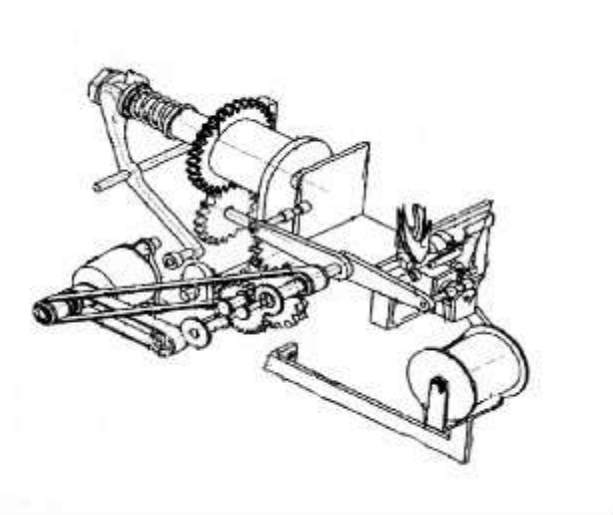


Fig. 6: Electric Vegetable Cutting and Baling Machine

In 2021, Liu Shimang, Yin Xuchao, and their team at Shenyang Agricultural University designed a bundling machine for leafy vegetables[9]. It primarily comprises a frame, conveyor belt, motor, transmission chain, clamping device, winding device, and hook needle. This bundling machine achieves effective bundling

for Chinese leeks, ensuring stable bundling. However, the integration of this bundling machine with Chinese leek harvesting machines has not been optimized yet.

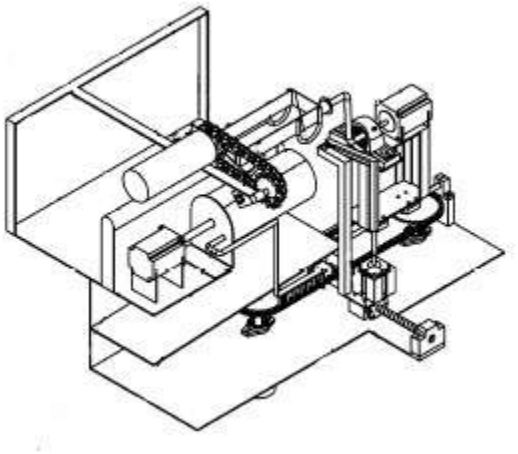


Fig. 7: Stem-leafyVegetable Baling Machine

In 2022, Xin Lu, Zhang Mei, and others from Qingdao Agricultural University designed a combined harvester for Chinese leeks[10]. This machine operates in a single-row harvesting mode, featuring a self-propelled electric structure. It consists of components including a blade-grassholder, cutting device, clamping conveying device, intermittent conveying device, bundle collection device, and bundling device. The harvester clamps the Chinese leeks using the clamping conveying device, transporting them backward from a vertical to a horizontal position before releasing them onto the intermittent conveying device. Once a set quantity is reached, the leeks are conveyed to the bundle collection device for bundling, completing the harvesting process. This combined harvester for Chinese leeks enables the coordinated harvesting of a single row with relatively low damage, ensuring higher-quality and organized bundling.

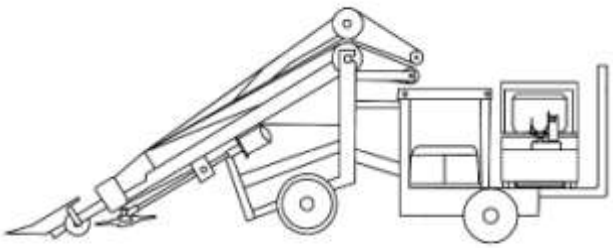


Fig. 8: Chinese Chives Combine Harvester

IV. Analysis of Challenges in Bundling and Harvesting Blanched Garlic Leaves

The bundling and harvesting of blanched garlic leaves pose unique challenges compared to other stem-leaf vegetables like leeks or celery. Blanched garlic leaves are densely and irregularly grown in enclosed hydroponic pools within greenhouses, lacking the orderly rows typical of other crops. They are cultivated in sealed greenhouses, limiting air circulation, and precautions need to be taken to avoid the accumulation of harmful gases during agricultural machinery operations, as this can harm both the growth of blanched garlic leaves and the health of farmers. Opting for electric blanched garlic harvesting machines can mitigate the impact on the greenhouse environment. While blanched garlic is categorized as a stem-leaf vegetable, there are few bundling and harvesting machines specifically designed for this category. Common harvesting machines for stem-leaf vegetables like leeks or rapeseed often rely on tractor-driven systems, which are unsuitable for use within enclosed greenhouse conditions. The dense and irregular growth pattern of blanched garlic leaves makes it challenging for conventional single or multiple-row harvesters to avoid damaging unharvested portions of the crop.

V. Conclusion

The bundling apparatus for stem-leaf vegetables has consistently posed a challenge in the realm of vegetable harvesting. When discussing bundling in agricultural machinery, the immediate references are often round balers or square balers used for bundling straw or hay. These bundling machines primarily employ rigid bundling methods that can potentially damage blanched garlic leaves when applied to bundling, affecting their storage and sale. Particularly in the domain of vegetable bundling, especially for stem-leaf vegetables, existing bundling devices are predominantly utilized in supermarkets and factories for vegetable packaging. There's a scarcity of bundling devices that are compatible with harvesting machinery in this domain.

Blanched garlic, commonly found in China and certain Southeast Asian countries, is a widely cultivated and consumed vegetable appreciated for its clean, nutritious, and flavorful characteristics. Its production involves seeding, management, harvesting, and bundling, which are currently reliant on manual labor. While there are garlic harvesting machines available, they haven't been widely adopted. As for bundling and harvesting machines specifically for blanched garlic, they are still in the research phase. The development of bundling devices for blanched garlic operates independently of the harvesting machinery. However, the adaptation of bundling devices for garlic harvesting machines is a significant trend in current and future research.

Given the expanding market for blanched garlic, the research into bundling and harvesting machinery becomes increasingly crucial. As blanched garlic shares many similarities with other long-stem leafy vegetables like leeks and Chinese chives, the study of bundling and harvesting machinery for blanched garlic can also be relevant to the development of machinery for these vegetables

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