Innovative bean sprouts basket (iBSB): A conceptual paper on a new dimension of low-cost bean sprout cultivation among agro-community

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Abstract. Sprouts are tiny seedlings that are produced during seed germination and have a short growth period. Across the globe and in Malaysia, more people are consuming bean sprouts due to their awareness of the need to consume "healthy foods". The sprouts are composed of proteins, carbohydrates, and biochemical compounds with a significant amount of the recommended daily requirement for ascorbic acid and riboflavin, as well as a variety of minerals obtained through the consumption of sprouts. Moreover, sprout quality is influenced by the length, thickness, colour, and texture of the hypocotyl and roots, as well as by maintaining characteristics and little water loss after harvest. A modified atmosphere with high carbon dioxide and low oxygen can be used as a sprouting environment to control sprout growth. However, the current issues relating to open sprouting systems are bean sprout disease and high maintenance for open cultivation tanks. Thus, to solve the problem regarding the current domestic bean sprouting system, an innovative bean sprouts basket (iBSB) was innovated to control or reduce bean sprout disease for every production cycle.

1 INTRODUCTION

Bean sprouts, cherished for their crunchy texture, mild flavour, and nutritional density, are significant in global cuisines, from Asian stir-fries to Western salads. Meeting the burgeoning demand for fresh bean sprouts necessitates efficient and reliable production methods. Conventional bean sprouts open tank production systems have emerged as a prevalent approach due to their scalability, efficiency, and consistency in delivering high-quality sprouts. Rooted in traditional agricultural practices, conventional open tank production systems have evolved to integrate modern techniques while upholding fundamental

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principles. These systems rely on large, shallow tanks or trays crafted from food-grade materials as the primary growing environment for sprouts.

The process commences with meticulous selection of premium-quality beans, undergoing rigorous cleaning and sorting to ensure uniformity [1]. These beans are then evenly distributed across the surface of the tanks, forming a dense yet breathable layer conducive to germination. The introduction of water, meticulously monitored for appropriate quality and pH levels, initiates the hydration process critical for sprout development.

Environmental parameters such as temperature, humidity, and ventilation throughout the germination phase are precisely regulated to optimize growth conditions and ensure uniform sprouting. Regular cycles of rinsing and draining are employed to prevent excess moisture accumulation, while stringent sanitation measures mitigate the risk of microbial contamination. The culmination of these efforts yields a harvest of fresh, vibrant bean sprouts, ready to elevate an array of culinary creations with their crisp texture and subtle flavour. From salads to sandwiches, the versatility of bean sprouts makes them a beloved addition to diverse cuisines.

Conventional bean sprouts open tank production systems play an integral role in meeting the demand for fresh sprouts by amalgamating traditional agricultural practices with contemporary techniques. Their efficiency, scalability, and consistency in delivering nutritious sprouts underscore their importance in ensuring a steady supply to global markets.

Despite their widespread adoption and efficiency, conventional bean sprouts' open tank production systems have limitations. One significant drawback is the susceptibility to contamination, primarily from bacterial pathogens such as Salmonella and E. coli [2]. The humid environment of the tanks, coupled with organic matter from the beans, creates favourable conditions for microbial growth, posing a food safety risk if not adequately managed.

Additionally, conventional production systems may require significant water usage, especially during the rinsing and draining stages, contributing to environmental concerns regarding water conservation and wastewater management [3]. This aspect can challenge sustainability and regulatory compliance in regions with limited water resources or stringent regulations.

In conclusion, while conventional bean sprouts open tank production systems offer efficiency and scalability in meeting the demand for fresh sprouts, they also present challenges related to food safety and environmental impact. Addressing these drawbacks through enhanced sanitation practices and sustainable water management strategies is essential to ensure the continued viability of this production method.

In sustainable living and culinary exploration, the innovative Bean Sprouts Basket emerges as a game-changer, revolutionising how we cultivate fresh produce at home. Designed with ingenuity and practicality, this novel gardening apparatus offers enthusiasts and amateurs alike a seamless and rewarding experience in growing nutritious bean sprouts right in the comfort of their kitchen.

The Bean Sprouts Basket offers a modern solution for growing bean sprouts. Its sleek and compact design saves countertop space and adds a touch of modern elegance to any kitchen. Beyond its visual appeal, the Bean Sprouts Basket boasts various features engineered to optimise the sprouting process. Equipped with a precision-controlled watering system, users can effortlessly maintain the ideal moisture levels necessary for sprout growth, ensuring consistently bountiful yields with minimal effort.

Moreover, the basket's innovative airflow mechanism facilitates adequate ventilation, preventing moisture buildup and reducing the risk of mould or bacterial growth. This thoughtful design element not only enhances the overall health of the sprouts but also prolongs their shelf life, allowing enthusiasts to enjoy their harvest for longer periods.

The Bean Sprouts Basket is not just a tool; it's a catalyst for culinary creativity and nutritional well-being. Whether adding a crunchy topping to salads, enhancing stir-fries, or incorporating them into wraps and sandwiches, freshly sprouted beans offer a versatile and flavourful addition to various dishes.

The Bean Sprouts Basket (iBSB) transcends the conventional boundaries of home gardening, empowering individuals to cultivate a continuous supply of wholesome, organic sprouts year-round, regardless of space constraints or environmental factors. With its intuitive design and transformative capabilities, it heralds a new era of sustainable living and culinary innovation, inviting enthusiasts to embark on a journey of discovery and delight right from their own kitchen countertops. Therefore, this study was conducted to highlight the iBSB's impact on enhancing food security, promoting healthy eating habits, and reducing the carbon footprint associated with traditional agricultural practices.

1.1 Research Objective

The primary objective of this study is to advance the technology associated with bean sprouting systems by introducing innovative concepts and state-of-the-art equipment. Specifically, the aim is to develop strategies for effectively controlling bean sprout diseases and optimising sprout yield production while simultaneously minimising associated costs.

The present innovation is earmarked for implementation as a community-driven endeavour aimed at augmenting the economic resilience of the local populace while bolstering food supply chains by fostering synergistic linkages between farmers, local markets, and dining establishments. This initiative endeavours to cultivate collaborative alliances among farmers, distributors, and retailers, thereby cultivating an equitable pricing framework that safeguards the interests of farmers.

1.2 The principal objectives of this project are outlined as follows:

i. Enhancing the socio-economic well-being of the local community by adopting advanced bean sprout cultivation technologies and developing downstream economic products to optimize financial returns while concurrently advancing principles of environmental sustainability and food security.
ii. Cultivating avenues for entrepreneurial endeavours through the innovation and commercialization of downstream products, including Flour, Bean sprout Kimchi, Spring roll pastry, and Spring roll Bean sprout Kimchi, thereby fostering economic diversification and prosperity within the local community.

2 Literature Review

2.1 Bean Sprouts

Sprouts are fresh, functional, and nutraceutical foods increasingly becoming popular for healthy eating [4]. Sprouts have the potential to contribute to food and nutrition security in cities as they can be easily grown in urban and peri-urban settings where land is often a limiting factor, either by specialized producers or the consumers themselves, independent of seasonal growth cycles, inside or around residential areas. The bean sprouts can be grown in hydroponic media such as cork or cotton.

The agricultural practice of cultivating bean sprouts is still implemented with manual methods which practice open tank system. The growth of bean sprouts requires stable temperature and humidity. Therefore, most farmers cultivate bean sprouts water every 3

hours in 24 hours. It is very convenient to produce bean sprouts at home or on an industry scale, briefly soak the bean seeds in water overnight at room temperature until seeds germinate, transfer the germinated seeds to a bigger container, and sprinkle water during the sprouting process. The sprouts are ready to consume after 4 to 5 days.

However, the sprouts are vulnerable to microbial contamination because they are grown in a nutrient-rich and moist environment [5]. A previous study has shown that aerobic microorganisms were increased by 3 log CFU/g during the sprouting stage, and several foodborne pathogens were isolated at the final production stage [6]. Because sprouts are typically consumed raw, they pose a high health risk to consumers as a vehicle for foodborne disease [7]. Good agricultural practices should be systematically implemented to reduce the potential for microbial contamination of seed for sprout production.

Additionally, conventional production systems may require significant water usage, especially during the rinsing and draining stages, contributing to environmental concerns regarding water conservation and wastewater management [3]. This aspect can challenge sustainability and regulatory compliance in regions with limited water resources or stringent regulations.

Therefore, there is a need for innovation development for sprout production. Innovation is a continuous and sustainable effort that aims to facilitate and improve the efficiency of a process [8]. Innovation development is not only focused on equipment, but it involves new ideas and practices that support the concept of facilitation in human life [9]. A study was conducted by [10] on innovation in rice cultivation techniques using the Rice Intensification System (SRI) among the farmers in Peninsular Malaysia. The findings in their study have shown the acceptance factor of this technique among farmers to increase rice yields, reduce production costs, reduce water consumption, and encouragement and advice from government agencies. Therefore, it can be concluded that this innovation of the SRI rice cultivation technique promotes the development of agricultural innovation and becomes an alternative to increase the farmer's income.

Innovative Beans Sprout Basket (iBSB) has the advantages of being soilless, intelligent, simple operation, and miniaturizing with a closed-tank system. The bean sprouts produced are fresh and free from pesticide residues, which can meet people's demand for fresh bean sprouts.

2.2 Efficiency

Open tank systems have been the go-to for bean sprout cultivation, but the Bean Sprout Basket (IBSB) introduces a novel approach. Vertically suspending the sprouts optimizes space utilisation, potentially increasing yield per unit area. This innovation minimises water usage and labour while maximising output, offering a significant efficiency advantage. Open tank or flow-through systems involve large, open containers filled with water where aquatic organisms are reared. These systems are widely used due to their simplicity, scalability, and adaptability to various aquatic species. Open tank systems provide ample space for fish to grow and are relatively easy to manage. They allow for efficient water exchange, which helps maintain water quality by flushing out water and replenishing oxygen levels.

However, open tank systems have several limitations. They are susceptible to environmental factors such as temperature fluctuations and pollution. Moreover, they require significant amounts of water, which can be a constraint in water-scarce regions. Additionally, open tank systems may pose risks of disease outbreaks and predation, necessitating proper management practices and biosecurity measures.

The innovative bean sprout basket represents a novel approach to aquaculture, particularly in cultivating small aquatic organisms such as shrimp and fish fry. These baskets are typically made of mesh or perforated material and are suspended in water bodies or tanks.

They provide a structured environment for aquatic organisms to thrive, offering protection from predators and facilitating the exchange of nutrients and oxygen.

One of the bean sprout basket's key advantages is its space utilisation efficiency. These baskets can be stacked vertically, maximizing the use of available space and enabling high-density farming. Additionally, bean sprout baskets require less water than open tank systems, making them suitable for areas with limited water resources. Furthermore, their modular design allows easy assembly, disassembly, and maintenance.

2.3 Quality

Bean sprout quality is paramount in culinary applications. Conventional methods often result in uneven growth and susceptibility to contamination. The Bean Sprout Basket, however, promotes uniform growth and reduces the risk of spoilage, ensuring consistent quality and freshness.

2.4 Environmental impact

Water usage and nutrient runoff can pose environmental concerns in conventional open tank systems. The Bean Sprout Basket addresses these issues by employing a closed-loop hydroponic system, reducing water waste and nutrient leaching. Additionally, its vertical design minimizes land usage, making it a more environmentally sustainable option.

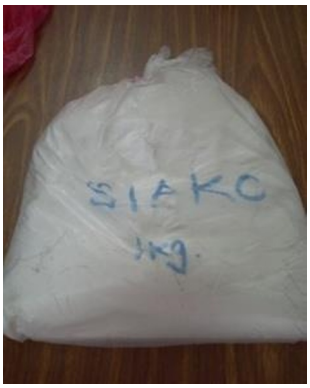
2.5 Control and monitoring

Open tank systems lack precise control over environmental factors like temperature and humidity, leading to inconsistent growth. The Bean Sprout Basket integrates technology for automated monitoring and control, ensuring optimal growing conditions and maximizing productivity.

3 Materials and Methods

A research paper's material and methods section describes the materials used and the methods or procedures employed to conduct the study [11]. The materials or apparatus used and the procedures are as follows:

The materials required for this process include green beans, Sontoso solution (a fertilizer solution for growth), Siako (used to prevent rooting of green beans and also acts as a growth hormone for standardizing size), a clothing basket with holes as a cultivation stand, a plastic container, water, and paper or tissue (Refer to the pictures 1).



i. Green Beans

ii. Sontoso

iii. Siako

iv. Clothing

v. Black plastic begs

vi. Hook

vii. Plastic container

viii. Tap water

Fig.1. Materials.

The method contains a systematic and structured approach that is required for problem resolution and task completion with maximum efficiency and effectiveness. According to [12], researchers can optimize their research processes by carefully selecting and using the most appropriate procedures. This ensures accurate and dependable outcomes. Furthermore, a precisely designed and flawlessly conducted research technique can improve the reproducibility and validity of findings, hence increasing the study's overall reputation. A methodical approach to bean sprout cultivation was undertaken as delineated below (Refer to the Figure 2):

Beans are washed until clean.

Rinse and drain the washed beans until dry.

Fg 2. A methodical approach to bean sprout cultivation

The process of bean sprout cultivation was conducted meticulously through a series of steps. Initially, 500g of green beans were weighed and washed thoroughly with water until the effluent ran clear, indicating their cleanliness. The cleaned beans were subsequently placed in a container and submerged in 2.0 litres of water. Then, 5ml of Sontoso solution was added to the container and mixed well to ensure thorough distribution. The beans were left

to soak in the solution for 8-12 hours. After the soaking period, the beans were drained using a strainer and left to air dry for 2-3 minutes. Once dried, 10ml of Siako liquid was mixed with the beans until a homogeneous mixture was achieved. The container housing the bean mixture was then covered with tissue to prevent contamination and placed in a shaded area to avoid direct sunlight exposure, where the beans remained undisturbed for another 8-12 hours. Following this, the beans were transferred into a fabric basket planting bin equipped with a timer set to provide automatic watering every 90 minutes, with each cycle lasting 5 minutes. After a cultivation period of 4 days, the bean sprouts reached maturity and were ready for harvest, with the average length of the harvested bean sprouts measuring 6.8 cm.

4 Results

The cost of production and the resulting profit margin were analysed in the study. 500 grams of green beans were priced at RM 4.00. It was observed that from every 500 grams of green beans, 4 kg of bean sprouts could be produced. One kilogram of bean sprouts was valued at RM 4.00. Consequently, the total income generated from the sale of bean sprouts amounted to RM 16.00. The calculated profit was determined by subtracting the cost of production, which was RM 4.00, from the total income, resulting in a profit of RM12.00.

Cost Production:
500g green peas = RM4.00/1 USD
500g green peas produce = 4 kg bean sprouts

Profit:
1 kg bean sprouts = RM4.00/1 USD
Sale of bean sprouts RM4 x 4kg = RM16.00/4USD
Profit RM16.00 - RM4.00 = RM12.00/3USD

Apart from that, this iBSB product innovation has the target market consisting of a number of areas, such as urban residents, households, and cafes and restaurants. This wide range of possible buyers suggests that the product will be popular and have a wide audience. Household users are people and families looking for wholesome, fresh products to cook at home. People who live in cities, especially professionals with hectic schedules, are drawn to quick and healthful eating options that fit their hectic schedules. In addition, cafés and restaurants are potential consumers looking to source premium bean sprouts to complement their menu items and satisfy picky patrons. This diverse target market highlights the product's adaptability and marketability to various consumer preferences and environments.

Furthermore, green beans are helpful for more than just making bean sprouts; they are an essential component of many other items produced later on. Green bean skins are one of these goods; they are used in various culinary applications and meal preparations. Furthermore, the beans' flour, called green bean flour, can accommodate dietary preferences and constraints by acting as a gluten-free substitute in baking and cooking. Furthermore, green bean paste is a mainstay of Asian cooking, contributing distinct flavour and texture qualities to savoury and sweet meals. In addition, green bean noodles, renowned for their chewy texture and healthful qualities, provide a healthy substitute for conventional wheat-based noodles. Green beans have many downstream products, highlighting their potential to cater to a wide range of consumer preferences and dietary needs and their importance in the culinary world.


KIMCHI ROLL


GREEN BEAN FLOUR

5 Conclusion

Using green beans in conjunction with cloth basket planting barrels is a promising method for efficiently generating high-quality bean sprouts. This approach not only offers cost-effective advantages but also expedites the sprouting process. However, despite its merits, several challenges may arise, potentially impeding the successful production of bean sprouts.Firstly, the risk of insufficient moisture looms large, particularly if green beans are allowed to dry out. Adequate hydration is pivotal for initiating the germination process and sustaining healthy sprout growth. Conversely, prolonged soaking of green beans in water can lead to suboptimal sprouting conditions, potentially resulting in mold formation or decay. Furthermore, extreme temperature fluctuations pose a significant threat, as excessively high or low temperatures can disrupt the delicate germination process. Maintaining a stable and moderate temperature regime ensures optimal sprout development.

Moreover, inadequate rinsing practices may introduce impurities or contaminants, compromising the quality and safety of the sprouts. Thorough and frequent rinsing is essential to remove debris and maintain hygiene throughout sprouting.

Lastly, limited airflow within the planting barrels presents a notable concern, as proper ventilation is essential for facilitating gas exchange and preventing excess moisture buildup. Insufficient airflow can impede respiration and lead to undesirable microbial growth, adversely affecting the overall health and quality of the sprouts.

In conclusion, while using green beans and cloth basket planting barrels offers a cost-effective and efficient approach to bean sprout production, addressing and mitigating potential challenges is imperative. By implementing proper moisture management, temperature control, rinsing protocols, and ensuring adequate airflow, growers can optimize conditions for healthy sprout development, thereby maximizing the yield and quality of the final product. Through diligent attention to these factors, the benefits of this method can be fully realized, facilitating the sustainable production of high-quality bean sprouts to meet consumer demand at the household level.

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