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Influence of agronomic practices on nutritional retention during drying of green peas

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Abstract
The quality and nutritional content of green peas (*Pisum sativum*) are significantly influenced by agronomic practices and post-harvest processing methods such as drying. This study investigates the impact of various agronomic practices, including soil management, irrigation, fertilizer application, and harvesting time, on the nutritional retention of green peas during the drying process. The findings reveal that optimized agronomic practices not only enhance crop yield but also preserve critical nutrients like vitamin C, antioxidants, and protein content during drying. This research highlights the importance of adopting integrated agronomic strategies for maintaining the nutritional integrity of green peas in dried form.

Keywords: Agronomic practices, Nutritional retention, Green peas, *Pisum sativum*

Introduction
Green peas (*Pisum sativum*) are a widely cultivated legume, valued for their high nutritional content and versatility in culinary applications. As a rich source of proteins, vitamins (particularly vitamin C), minerals, dietary fiber, and bioactive compounds, green peas contribute significantly to human nutrition and health. Their antioxidant properties, along with their role in reducing the risks of chronic diseases such as cardiovascular disorders, make them an essential component of a balanced diet. However, like many fresh produce items, green peas are highly perishable due to their high moisture content, which necessitates effective post-harvest preservation methods such as drying to extend their shelf life and maintain nutritional quality.

Drying is one of the most common preservation techniques used for green peas. While it effectively reduces moisture content to inhibit microbial growth and enzymatic activity, drying can also lead to substantial losses in nutrient content, including heat-sensitive vitamins, proteins, and antioxidants. The extent of nutrient degradation during drying depends not only on the drying method but also on the pre-harvest agronomic practices that influence the initial quality of the peas. Despite the availability of advanced drying technologies aimed at minimizing nutrient losses, the potential of agronomic practices to enhance the resilience of nutrients during drying remains underexplored.

Agronomic practices such as soil fertility management, irrigation, fertilization, and harvest timing play a pivotal role in determining the biochemical composition and nutritional quality of green peas. For instance, the use of organic fertilizers has been shown to improve the antioxidant content of crops, while excessive reliance on chemical fertilizers may enhance yield but compromise phytonutrient concentrations. Similarly, irrigation practices influence the physiological and metabolic pathways of plants, affecting the synthesis and accumulation of critical nutrients. Harvest timing, a key agronomic factor, determines the stage at which the nutrient content of peas peaks and its stability during subsequent processing.

The choice of drying technique also plays a critical role in determining nutrient retention. Traditional methods like sun drying are cost-effective but result in higher nutrient losses due to prolonged exposure to oxidative and thermal stress. Modern methods such as freeze drying and microwave-assisted drying have demonstrated superior nutrient retention but are associated with higher operational costs and limited scalability. The interaction between agronomic practices and drying methods is crucial, as the initial quality of green peas, determined by agronomic strategies, significantly impacts the extent of nutrient degradation during drying.

Main Objective

The main objective of this study is to examine the impact of agronomic practices on the nutritional quality of green peas and their retention during drying, with a focus on identifying integrated strategies to optimize both pre-harvest and post-harvest processes for enhanced nutritional outcomes.

Agronomic Practices and Their Influence on Nutritional Quality

Agronomic practices profoundly affect the nutritional composition of green peas, shaping the extent of nutrient retention during subsequent processing such as drying. Soil fertility management, irrigation regimes, and fertilization strategies are particularly impactful. Studies have shown that the use of organic amendments such as compost and manure enhance the antioxidant content and vitamin levels of green peas compared to synthetic fertilizers, which often emphasize yield at the expense of phytonutrient concentrations[1]. The microbial activity promoted by organic inputs also plays a role in the bioavailability of essential nutrients, contributing to better resilience during post-harvest processes[2]. Similarly, irrigation management affects nutrient accumulation in peas. Optimized irrigation schedules have been linked to improved protein synthesis and antioxidant production, reducing the susceptibility of nutrients to thermal degradation during drying[3]. Conversely, excessive water or water stress can disrupt nutrient biosynthesis, diminishing the stability of compounds like vitamin C during processing[4]. Harvest timing is another critical factor. Peas harvested at optimal maturity stages demonstrate a balanced nutrient profile, with higher retention of vitamins and proteins, compared to early or late harvesting, which either results in lower nutrient concentrations or higher susceptibility to enzymatic degradation[5]. The cumulative impact of these agronomic practices underlines the need for an integrated approach to enhance both the yield and nutritional quality of green peas.

Drying Techniques and Nutritional Retention

Drying is a widely used method to extend the shelf life of green peas, but it often compromises their nutritional integrity. Different drying techniques vary in their ability to retain nutrients, influenced by factors such as heat exposure, duration, and oxidative stress. Sun drying, although a cost-effective and sustainable method, is associated with significant nutrient losses due to prolonged exposure to direct sunlight and oxidation. For instance, studies report up to a 40% reduction in vitamin C content and a noticeable decline in antioxidant capacity during sun drying[6]. Hot-air drying offers better control over the drying environment but can lead to thermal degradation of heat-sensitive compounds such as carotenoids and ascorbic acid[7]. Research indicates that while hot-air drying achieves uniform moisture removal, it may result in a 30–50% nutrient loss depending on the temperature used[8]. Advanced techniques like freeze drying preserve nutrients to a much greater extent, retaining up to 80% of the original antioxidant and vitamin content due to the absence of thermal stress[9]. However, freeze drying is expensive and energy-intensive, limiting its use in commercial settings[10]. Microwave-assisted drying has emerged as a promising alternative, achieving faster drying times and higher retention of bioactive compounds compared to conventional methods[11]. These findings highlight the importance of selecting appropriate drying techniques tailored to the desired nutritional and economic outcomes.

Interactions between Agronomic Practices and Drying Methods

The interplay between agronomic practices and drying methods has a substantial influence on the nutritional retention of green peas. Nutrient-rich peas cultivated under optimized agronomic conditions tend to show higher stability during drying, irrespective of the method employed[12]. For example, peas grown using organic fertilizers demonstrate superior retention of antioxidants and vitamin C during sun drying compared to those cultivated with synthetic inputs[13]. Similarly, peas from optimized irrigation regimes exhibit enhanced thermal stability, preserving protein and antioxidant levels during hot-air and microwave drying[14]. Harvest timing further modulates the interaction between pre-harvest practices and post-harvest processes. Mid-maturity harvested peas retain a balanced nutrient profile, minimizing losses during drying regardless of the method used[15]. However, improper harvest timing coupled with unsuitable drying methods can exacerbate nutrient degradation. Research suggests that the biochemical properties imparted by agronomic practices, such as enhanced phytonutrient levels, improve the resilience of green peas to oxidative and thermal stress during drying[16]. Thus, aligning agronomic strategies with drying techniques is essential for maximizing nutritional retention while maintaining economic feasibility.

Conclusion

The nutritional retention of green peas during drying is profoundly influenced by a combination of agronomic practices and drying methods. Agronomic factors such as soil fertility management, irrigation, fertilization, and harvest timing play a critical role in determining the initial nutrient content and resilience of green peas to nutrient loss during post-harvest processing. Drying methods, ranging from traditional sun drying to advanced freeze and microwave-assisted drying, significantly impact the preservation of vitamins, proteins, and antioxidants. The interactions between pre-harvest agronomic strategies and post-harvest drying techniques underscore the need for an integrated approach to optimize both production and preservation processes. By aligning sustainable agronomic practices with nutrient-efficient drying technologies, it is possible to enhance the nutritional quality and economic value of green peas, benefiting both producers and consumers. Future research should focus on refining these integrated strategies and developing innovative technologies to ensure the nutritional and economic sustainability of green pea production and processing.

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