Automation Of the Fruit Drying Process

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ABSTRACT

This dissertation focuses on the automation of the fruit drying process, aiming to enhance efficiency, improve product quality, and reduce labor costs in the fruit processing industry. The study investigates the implementation of automated systems and technologies in the various stages of the fruit drying process, including fruit selection, preparation, drying, and packaging. The research also examines the impact of automation on product characteristics such as color, texture, and nutritional content. The findings indicate that automation offers significant advantages in terms of increased productivity, reduced manual labor, consistent quality, and improved overall efficiency. The dissertation concludes with recommendations for future research and the practical implications of automating the fruit drying process.

Keywords: automation, fruit drying process, efficiency, product quality, labor costs, technology, implementation, productivity, consistency, implications

Introduction. Controlled heating of food products to evaporat equantified amount of moisture that is originally present is known as drying or dehydration. Drying of selected food products is essential to reduce the weight for easy transportation and to enhance the shelf life of the product without quality losses over an extended period of time. Drying involves the simultaneous application of heat and removal of moisture from foods.The main parameters that control the rate at which foods,vegetables and fruit sare dried are air temperature, relative humidity and air velocity as variable processing conditions, based on nature of food and particular dryer design [1]. Using some empirical relations the parameters that control the drying rate are interrelated in this study. However, for most of the agricultural materials, literature on empirical relationships is not available and they have to be developed experimentally [2]. In the drying process, the generated hot air provides necessary heat to evaporate the moisture and carries it away from the materials. The difference between the core and surface moisture creates a pressure gradient which becomes the driving force to remove water from food [3]. The main limitation of the vacuum and freeze drying methods is the need of vacuum evacuation system, increasing the invest- ment in high operating and fixed costs of equipment with need of skilled manpower. It is not economical to freeze or vacuum dry all fruits and vegetables due to technical and investment constrains but it is cost-effective for value added foods like meats. Problems in controlled humidity storage of freeze dried products can be another disadvantage of freeze drying processes. In the freeze drying process, original shape and size of the food will remain almost the same and extra storage space is required compared to heat dried foods where the size and shape of the food

products are reduced considerably. If freeze dried foods are not stored properly its quality will deteriorate very rapidly [5]. Among various hot air drying methods, FBD drying offers significant advantages like high heat and mass transfer, uniform moisture reduction with less drying time and high drying rate [6]. FBD dryers increase efficiency of these processes by enabling the entire surface of the product to behave like molten lava and mixing solid materials efficiently with the drying air (Fig. 1). The drying curve of an individual product represents the drying characteristics of that product with respect to specific temperature, velocity and pressure conditions [7]. A typical drying curve has three different periods (Fig. 2); the initial period is when sensible heat is transferred to the wet product to pre-heat it. In the second or con- stant rate period, the free moisture at the surface starts evaporating and this period continuous till all surface moisture gets evaporated to material critical moisture content. In falling rate period the moisture from the internal interstices of the particle is to be diffused to the outer surface and it takes more time and higher driving force. The loss of moisture weight reduction from the wet solid perunit time(drying rate)is the method to measure the dryer performance [8,9].

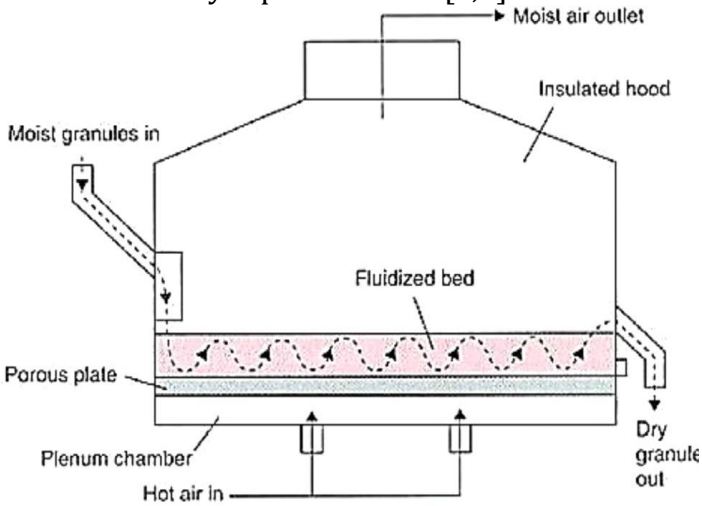

Fig. 1. Schematic diagram of a typical FBD dryer

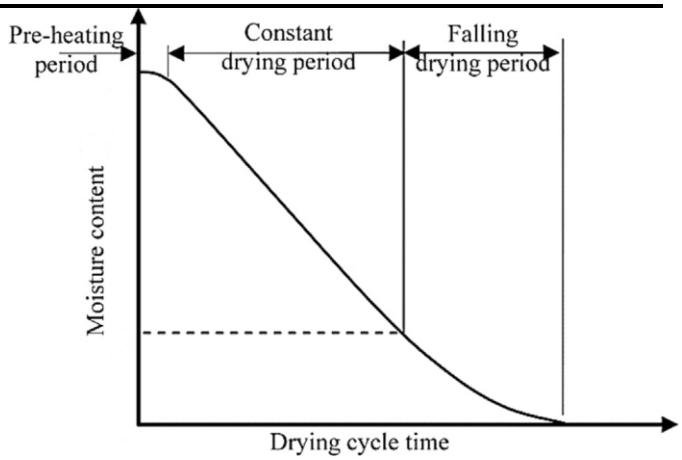

Fig. 2. Drying curve.

Any fruit adds nutritional value to a health- conscious diet, but apples enjoy special attention worldwide because antioxidant concentration per serving size is high in apples (USDA report 2004). Generally, FBD drying of apples using hot air will result in loss of quality due to its heat-sensitive nutritional characteristics but some special techniques such as pretreatment with organic solvents and pretreatment with microwave or ultrasound energy are successfully used to dehydrate apples in FBD dryers.

Material and methods. The research methodology employed in this study involved a combination of primary and secondary data collection. Primary data was gathered through field observations, interviews with industry experts, and experimental trials. Secondary data was collected from relevant academic literature, research papers, and industry reports. The collected data was analyzed to evaluate the impact of automation on efficiency, product quality, and labor costs in the fruit drying process.

Results. Automated fruit sorting systems have revolutionized the selection process, enabling efficient sorting based on size, color, and maturity. These systems utilize advanced imaging and machine learning algorithms to accurately identify and sort fruits, reducing manual labor and increasing productivity. Furthermore, automated fruit preparation techniques, such as cutting, peeling, and de-

seeding, have improved process efficiency and consistency.

Discussion. The implementation of automation in the fruit drying process offers substantial benefits to the industry. Increased productivity, reduced labor costs, consistent quality, and improved efficiency contribute to the competitiveness and profitability of fruit processing businesses. However, challenges such as initial investment costs, technological complexities, and the need for skilled personnel must be carefully considered. Industry stakeholders should actively explore the adoption of automation to enhance their operations and maintain a competitive edge in the market.

Conclusion. Automation has revolutionized the fruit drying process, offering numerous advantages over traditional methods. The implementation of automated systems and technologies in fruit selection, preparation, drying, packaging, and storage stages has improved efficiency, product quality, and overall process performance. As the technology continues to advance, it is crucial for industry players to embrace automation and harness its potential to drive growth, reduce costs, and meet the increasing demand for high-quality dried fruit products.

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