รศ.ดร.วสันต์ ด้วงคำจันทร์

หน่วยวิจัยการออกแบบกระบวนการอัจฉริยะและการควบคุมอัตโนมัติ

Research Unit of Smart Process Design and Automation (RUSPDA)

About RUSPDA

- มุ่งเน้นการวิจัยที่ตอบโจทย์การพัฒนาอุตสาหกรรมให้ตอบสนองทุกความต้องการตามทันยุคสมัยที่เปลี่ยนแปลงไป
- นำความเชี่ยวชาญของสมาชิกหน่วยวิจัยมุ่งสู่การวิจัยและพัฒนากระบวนการต่างๆโดยครอบคลุมในอุตสาหกรรมไฟฟ้าและอิเล็กทรอนิกส์ สิ่งทอ การบริการ และอาหาร เพื่อยกระดับอุตสาหกรรมไทยสู่ Industry 4.0

วัตถุประสงค์

- **เพื่อพัฒนาองค์ความรู้ใหม่ ด้านการออกแบบกระบวนการและเทคโนโลยีการควบคุมอัตโนมัติในอุตสาหกรรม**
- **เพื่อพัฒนาศักยภาพนักวิจัย ให้มีความเชี่ยวชาญ ด้านการออกแบบกระบวนการและเทคโนโลยีการควบคุมอัตโนมัติในอุตสาหกรรม**
- **เพื่อนำองค์ความรู้จากการวิจัยและพัฒนา ไปถ่ายทอดและให้บริการทางวิชาการสู่ชุมชน**

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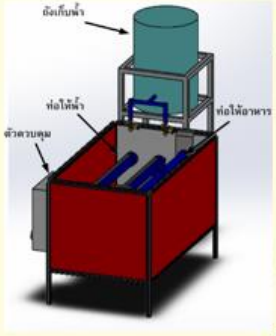
IoT



Biomed

Textile

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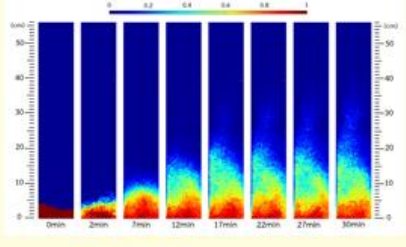

Automation &Robotics

CAE

สมาชิกหน่วยวิจัย

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อ.ดร. คเณศ ถุงออด

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ผลการดำเนินงานของหน่วยวิจัยฯ ผลงานวิจัย/นวัตกรรม/อื่นๆ ใน ปีงบประมาณ 2565 ที่ผ่านมา

เป้าหมาย:

ดำเนินงานวิจัยเพื่อตีพิมพ์เผยแพร่ผลงานวิจัยในวารสารที่เป็นที่ยอมรับในระดับนานาชาติ ประกอบด้วย

1) วารสารที่อยู่ในฐานข้อมูลงานวิจัย ISI (Q3) 1 เรื่อง
2) วารสารที่อยู่ในฐานข้อมูลงานวิจัย Scopus (Q3) 1 เรื่อง

ผลการดำเนินงาน

1) **Chupawa, P., Inchuen, S., Jaisut, D. *et al.* Effects of Stepwise Microwave Heating and Expanded Bed Height Control on the Performance of Combined Fluidized Bed/Microwave Drying for Preparing Instant Brown Rice. *Food Bioprocess Technol* 16, 199–215 (2023). https://doi.org/10.1007/s11947-022-02933-x (ISI Q1)**
2) **Chupawa, P.; Suksamran, W.; Jaisut, D.; Ronsse, F.; Duangkhamchan, W. Combined Heat and Mass Transfer Associated with Kinetics Models for Analyzing Convective Stepwise Drying of Carrot Cubes. *Foods* 2022, *11*, 4045. https://doi.org/10.3390/foods11244045 (ISI Q1)**

Food and Bioprocess Technology
https://doi.org/10.1007/s11947-022-02933-x

RESEARCH

Effects of Stepwise Microwave Heating and Expanded Bed Height Control on the Performance of Combined Fluidized Bed/Microwave Drying for Preparing Instant Brown Rice

Prarin Chupawa[1,6] · Sudathip Inchuen[2] · Donludee Jaisut[3] · Frederik Ronsse[4] · Wasan Duangkhamchan[5,6]

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Abstract
Drying is the most energy-intensive operation in instant brown rice production. The effects of stepwise microwave heating on energy consumption and product qualities were investigated for combined fluidized bed microwave (FDBMW) drying. Red jasmine rice (RJR) was used as the test sample and was dried to the desired level with a variation of microwave power ranging in 0–450 W, while fluidizing air temperature was kept constant at 98 °C. Two drying periods in stepwise modes were predicted using the Page drying equation. An image processing technique was applied to capture the bed kinetics during convective fluidized bed drying and further used to control bed stability in the FDBMW drying process. Energy consumption was reduced by 7 to 23% when the expanded bed height was controlled as a dense fluidization regime in the heat transfer zone. Based on energy saving concerns, FDBMW drying operating with a step-down mode from 300 to 150 W and control of bed stability was the optimal condition to produce instant good-quality brown rice.

Keywords Quick cooking · Microwave heating · Fluidized bed drying · Two-stage drying · Step-up heating · Image processing

Introduction

Drying is the most energy-intensive step in the production of instant rice and plays an important role that directly impacts rehydration and organoleptic properties (Dutta & Mahanta, 2014; Gaewsondee & Duangkhamchan, 2019; Le & Jittanit, 2015; Prasert & Suwannaporn, 2009; Rewthong et al., 2011). Drying consumes 20 to 25% of the energy used by the food processing industry, and many attempts have been made to explore innovative drying techniques with improved energy efficiency. Stepwise is an intermittent drying made that is considered one of the promising solutions for improving energy efficiency and product quality without increasing the capital cost of the drier (Kumar et al., 2014). Stepwise drying can be achieved under different drying air conditions by varying the flow rate, temperature, humidity, operating pressure, and drying periods (Xanthopoulos et al., 2019). Bórquez et al. (2015) successfully employed step-down microwave power to control the sample temperature in the microwave vacuum drying. The results showed a 13.5-time increase in process efficiency with high-quality dried strawberries in terms of color and structure. In contrast, Chong et al. (2014) reported that using

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Article

Combined Heat and Mass Transfer Associated with Kinetics Models for Analyzing Convective Stepwise Drying of Carrot Cubes

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Abstract: Stepwise drying is an effective technique that promotes energy saving without additional capital cost. The stepwise drying mode was investigated for energy consumption and dried product qualities using a coupled heat and mass transfer model associated with kinetics equations of volume shrinkage and degradation of β-carotene in carrot cubes. Simulations were performed using a finite element method with extension of a chemical species transport. Validation experiments were carried out under constant drying modes at 60 °C, 70 °C and 80 °C using a lab-scale convective hot air dryer. The verified models were subsequently employed to investigate the effects of two step-up drying modes (60 to 70 °C and 60 to −80 °C). The optimal drying condition was determined using the synthetic evaluation index (SI) with criteria of high specific moisture evaporation rate (SMER), low shrinkage ratio and β-carotene degradation. Simulated results showed comparable agreement with experimental data of moisture content, shrinkage ratio and β-carotene ratio. Step-up drying of 60 to 70 °C gave the highest SMER of 0.50×10^{-3} kg of water evaporated per kWh, while the operation at constant temperature of 80 °C gave the lowest value of 0.19×10^{-3} kg of water evaporated per kWh. Model-predicted results showed less shrinkage of carrot cubes, but higher degradation of β-carotene under step-up drying compared to single-stage drying under temperature of 60 °C. Based on the highest SI value (0.36), carrot cubes were optimally dried under step-up mode of 60 to 70 °C.

Keywords: finite element; kinetics modeling; optimization; drying simulation

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Citation: Chupawa, P.; Suksamran, W.; Jaisut, D.; Ronsse, F.; Duangkhamchan, W. Combined Heat and Mass Transfer Associated with Kinetics Models for Analyzing Convective Stepwise Drying of Carrot Cubes. *Foods* 2022, *11*, 4045. https://doi.org/10.3390/foods11244045

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1. Introduction

Carrots are a popular vegetable and have a long-chain polyene structure [1–3]. When newly harvested carrots contain high moisture content, this needs to be reduced to a safe level to inhibit the growth of microorganisms and prolong shelf life during storage [4]. Drying removes water from the wet materials by means of simultaneous heat and mass transfer mechanisms. Removal of water or other liquids from solid materials due to evaporation causes changes in dried product qualities [5,6]. Convective drying is most widely used for fruits and vegetables due to its simplicity and operational cost effectiveness [4].

During drying, the water mass transfer mechanism occurs in two stages involving a constant-rate period and a falling-rate period controlled by external and internal mass

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แผนการดำเนินงานและเป้าหมาย

1. Investigation of hydrodynamics of moist particles in fluidized-bed drying combined with microwave heating using CFD model and image processing method (ISI Q1)
2. Quality attributes of instant riceberry as affected by fluidized-bed drying combined with microwave heating (Scopus Q3)
3. Modeling heat and mass transfer in rotary drying combined with microwave for quick-cooking grains (ISI Q3)
4. Controlling air condition in solar dryer for reducing moisture-gradient of rice cracker (Scopus Q3)

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THANK YOU

Any Question?