PERFORMANCE EVALUATION OF THE PHILRICE INFRARED HEATING SYSTEM FOR BROWN RICE HEAT TREATMENT

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ABSTRACT

OSOTEO, KATE C. and PALTEP, AMELIA, Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, **June 2023, PERFORMANCE EVALUATION OF THE PHILRICE INFRARED HEATING SYSTEM FOR BROWN RICE HEAT TREATMENT.**

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Grains are the staple food served on the table, paired with different dishes, or recreated as several marketable products in the commercial industry. However, it would only be kept within optimum conditions with proper storage mechanization for longer shelf life and further utilization. As a result, the Philippine Rice Research Institute - Engineering and Mechanization Division designed and fabricated the Infrared Heat Treatment Machine (IHTM) to improve the nutritional content and extend shelf life by passing through heat treatment controlled by temperature, conveyor speed, and the distance of the heater from the grain, which is specifically for brown rice, affecting its moisture content (MC).

The general objective of the study was to conduct a performance test and evaluation and cost analysis of the Infrared Heat Treatment Machine for Brown Rice. The Infrared Heat Treatment Machine for Brown Rice was tested and evaluated by the researchers to determine the grain throughput or drying capacity, the brown rice moisture content reduction rate, the machine efficiency, and the optimum combination of infrared heater temperature, the distance of heater from brown rice layer/bed on a conveyor belt,

and conveyor belt speed which would result in the following desired results: highest grain temperature, highest grain moisture content reduction rate, and highest grain throughput. Cost analysis was considered in the operation process to determine a fair and reasonable production cost.

The performance test and evaluation of the Infrared Heat Treatment Machine have been accomplished by analyzing data, considerations, and available materials in the facility. Therefore, it was tested and evaluated to observe and implement optimum performance for brown rice. Infrared Heat Treatment Machine was tested using 1.5 kg of samples; the number of samples prepared was 81 samples. The dependent variables included the final moisture content of the brown rice sample after heat treatment, the temperature of the heat-treated brown rice samples, and grain throughput. The independent variables were the temperature of the infrared heater (250°C, 300°C, 350°C), the distance of the heater from the conveyor belt (12.5cm, 17.5cm, and 22.5cm), and the time of exposure of the brown rice grains to infrared heat (27sec, 31sec, and 35sec); time of exposure of the brown rice grains to infrared heat depends on the linear speed of the conveyor belt, which in turn depends on the size of the driven conveyor pulley used. The experiment was laid out in a 3 x 3 x 3 factorial in completely randomized design (CRD). Data on performance parameters were analyzed using Analysis of Variance (ANOVA) and for factors or treatments found significant at $p<0.05$, Tukey post hoc test of means was done. Response surface analysis was carried to determine the optimum combination of the independent factors that would result in the highest drying efficiency.

Statistical analysis results showed that the drying time affects the grain throughput or drying capacity of the machine. The highest grain throughput obtained was

71.24kg/h at a drying time of 0.021hr. The ANOVA showed that 350°C, the highest infrared heater temperature, and 0.02m/s, the lowest linear speed of the conveyor, significantly influenced grain temperature after heat treatment. Grain moisture content reduction rate was significantly affected by the lower values of infrared heater temperature, 250°C and 300°C, and the highest values of the distance of the infrared heater to the conveyor, 17.5cm and 22.5cm. Using the Response Surface Analysis, the optimal treatment combination (Combination 1) for maximizing the grain temperature after heat treatment was one with a mean infrared heater temperature of 350°C, a conveyor's linear speed of 0.026m/s, and a 22.5cm distance of the infrared heater to the conveyor. For maximizing the grain moisture reduction, the optimal treatment combination (Combination 2) has a mean infrared heater temperature of 350°C, conveyor belt linear speed of 0.02m/s, and a 12.5cm distance of the infrared heater to the conveyor. For maximizing the grain moisture content reduction rate, the optimum combination (Combination 3) has a mean infrared heater temperature of 250°C, conveyor's linear speed of 0.02m/s, and the 22.5cm distance of the infrared heater to the conveyor. Lastly, for maximizing grain throughput the optimum combination (Combination 4) has a mean infrared heater temperature of 250°C, a conveyor's linear speed of 0.026m/s, and a 12.5cm distance of the infrared heater to the conveyor. The machine's drying efficiency was determined to be highest with Combination 4, which has 47.57%; it has an infrared heat temperature of 250°C in 0.026m/s with a distance of 12.5cm.

Finally, cost analysis shows that the total cost of the operation in testing and evaluating the Infrared Heat Treatment Machine for Brown Rice amounted to Php

197,702.98/yr or Php 760.40/day (Php 95.00/h). This includes the investment cost of the machine.

Keywords: brown rice; drying efficiency; infrared heat treatment machine (IHTM); moisture reduction; optimum heat treatment parameters

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