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Role of Artificial Intelligence in the Processing of Paddy (*Oryza sativa*)

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ABSTRACT

Artificial intelligence (AI) aims to increase production, guarantee safety, and boost overall food processing operations efficiency. AI technologies are becoming more useful for automating post-harvest procedures and decreasing food loss in the food processing sector. Keeping these facts in mind, a system was developed to reduce the broken percent from the processing of paddy (*Oryza sativa*) that is called Ohmic - heating system. In that system temperature sensor and SS electrodes, multi- function meter was used to take reading of temperature, frequency and voltage for uniform heating. Experiments were carried out for paddy variety MTU 1010 with parboiled and raw paddy samples and observations were taken at various voltage - gradients of 24.44, 25, 25.56, 26.11 and 26.67 V/cm in the heating chamber of ohmic system. The milling qualities of paddy obtained by milling of parboiled and raw paddy, the highest head yield of 88.09% and lowest broken yield of 11.90 % at 26.67 V/cm for parboiled samples. Whereas, the raw sample had a head yield of 61.50 and broken of 38.56%. The study concluded that the use of an ohmic-heating system improved the quality of milled paddy that was parboiled. Additionally, it eliminated the need for an entire boiler unit, which reduced the processing cost of parboiled paddy and made the parboiling unit safer and easier to work with.

Key words: Head Rice, Milling ,Ohmic heating, Parboiling, Paddy, Temperature.

INTRODUCTION

The objective of Artificial intelligence (AI) is to ensure safety, enhance productivity and improve the overall efficiency of food processing operations. AI technologies are becoming more operable in automating post-harvest operations and reducing food loss during the processing of food as food losses occur during post harvest processing and management (Sidhu and Mohapatra, 2023). In India, rice processing is the oldest and the largest agro-processing industry. Parboiling (hydrothermal process), where rice is partially cooked while still in the husk. The parboiling of paddy involves three sequential steps-(1) soaking (2) steaming and (3) drying (Anonymous, 2017). In a conventional parboiling plant, the soaked paddy is heated in parboiling tank by directly injecting steam produced in steam boiler, located outside the rice mill in the utility section. The boiler unit comprises a boiler, a fuel tank, water supply system, a water tank and insulated piping extending from the boiler to the parboiling tank. The entire boiler unit requires dedicated maintenance, necessitating the payment of a certified boiler operator and helper year-round, thereby contributing to the processing costs of parboiled rice. If the traditional steam heating, system is replaced with an ohmic-heating system, it would involve simply affixing two electrodes on opposite sides of the parboiling tank. This set-up would facilitate the ohmic/resistant heating of entire mass of paddy soaked in water contained within the parboiling tank. The desired temperature within desired timeframe can be achieved by applying the necessary voltage for the specified distance between two electrodes (Dhingra *et al,* 2012). This will help to eliminate the need of entire boiler unit, water tank piping, fittings, fuel tank, air preheater, economizer, accessories and mountings needed to support operation of boiler. Furthermore, it will lead to elimination of the requirement to pay and maintain a boiler operator and assistant, would also help to lower the processing costs associated with

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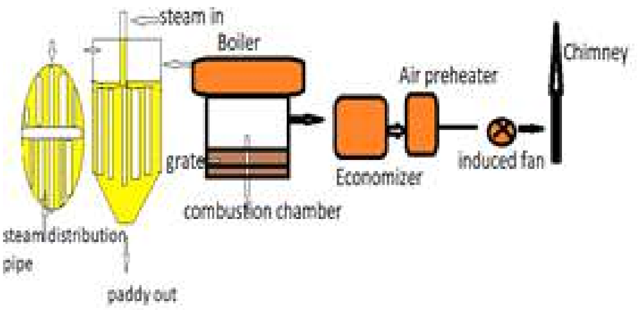

Plate 1. Traditional parboiling system with boiler

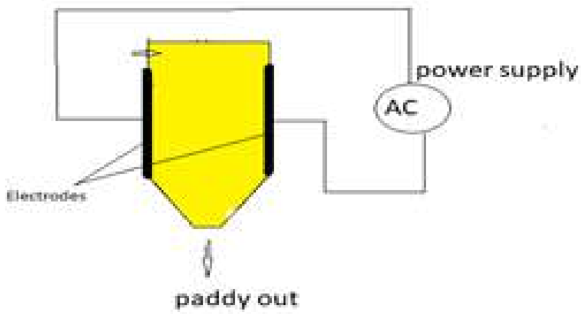

Plate 2. Ohmic-heating system

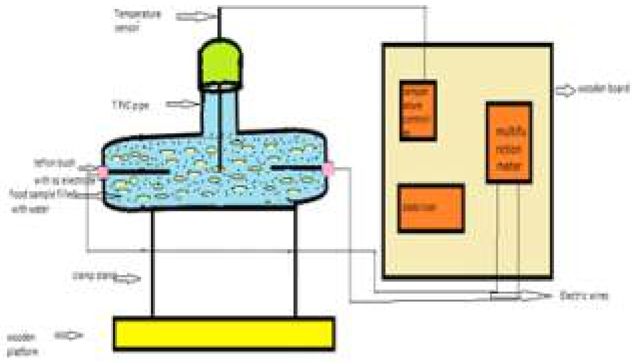

Plate 3.Conceptual drawing for ohmic heating set-up

parboiling paddy and make the parboiling unit more secure and user-friendly. The conceptual drawings given in plate 1 and 2 to explain the concept.

Principle of Ohmic Heating

Ohmic heating operates on the principle of Ohm's law. When an electric current passes through a conductive food material, and generating heat as the electrical resistance of food (Zell et al. 2009).

$$V \propto I$$

$$V = RI,$$

Where V is Voltage (V), I is Current (A), R is Resistance (Ω).

This innovative technology for food processing, known as ohmic heating. represents an excellent alternative heating method, (Sakr and Liu, 2014).

MATERIALD AND METHODS

This study was conducted at the College of Agricultural Engineering, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur. The conceptual drawing (Plate 3) illustrated specific guidance for constructing an ohmic heating set-up for parboiling paddy. Based on this conceptual drawing, an experimental ohmic heating set-up (Plate 4a, 4b) was fabricated for the parboiling process. During the process of parboiling, ten samples were chosen, each consisting of a ratio of 1:3 of paddy and water, with each sample being introduced into the ohmic heating chamber. A total of 10 kilograms of paddy, specifically the MTU1010 variety (medium-sized grain), was utilized for each sample. The power was supplied to the ohmic heating system, and observations were noted at voltage gradients of 24.44, 25, 25.56, 26.11, and 26.67 V/cm within the ohmic heating chamber. These observations were recorded at 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160, 170, and 180-minute intervals in the T-type PVC ohmic heating chamber (plate 5). The time taken to reach the temperature of 96˚C for parboiling the paddy was recorded, following which the power supply was turned off, and the sample was allowed to remain in the ohmic- heating chamber for ten minutes.

Plate 4a. Experimental system

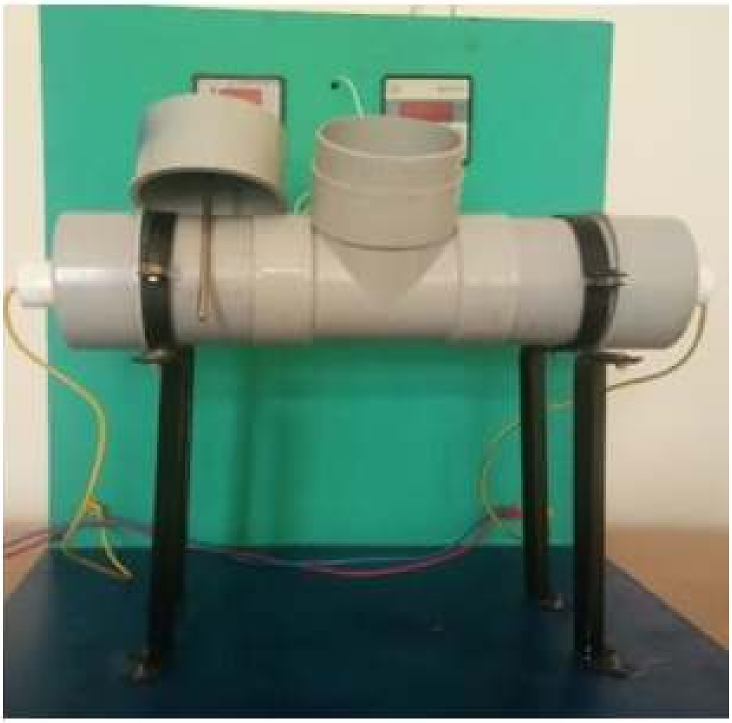

Plate 4b. Temperature sensor in set-up

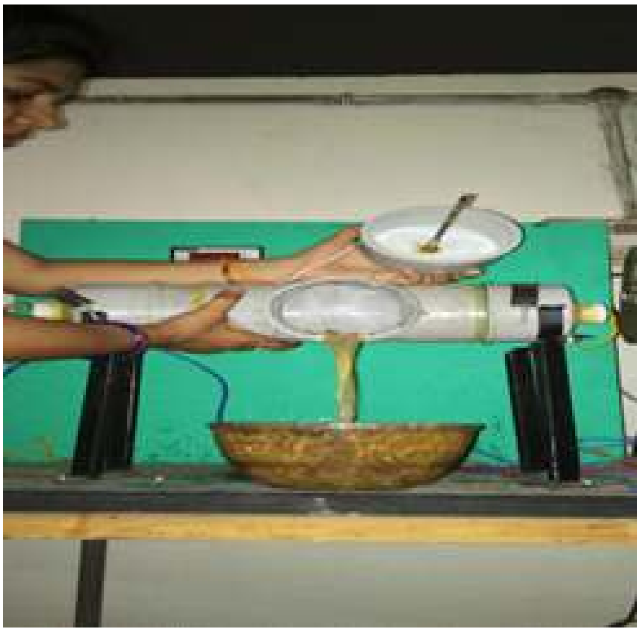

Plate 5.Parboilied paddy with water mixture

Plate 6. Laboratory model of paddy sheller

The paddy was extracted, and the excess water was drained. Observations were taken at every voltage gradient after parboiling the paddy using ohmic heating. The initial sample was sun-dried for one hour in sunlight and subsequently, the process of shade drying was conducted. Samples were dried at 14% mc (wb) before being taken to the milling stage. Milling was performed on the treated paddy at the concluding phase of the process. To determine the milling characteristics, 100g samples of paddy extracted, and experiments were conducted in the laboratory of Food Science department and put, JNKVV, Jabalpur, (M.P.). Plate-6 displays the laboratory model Indosaw

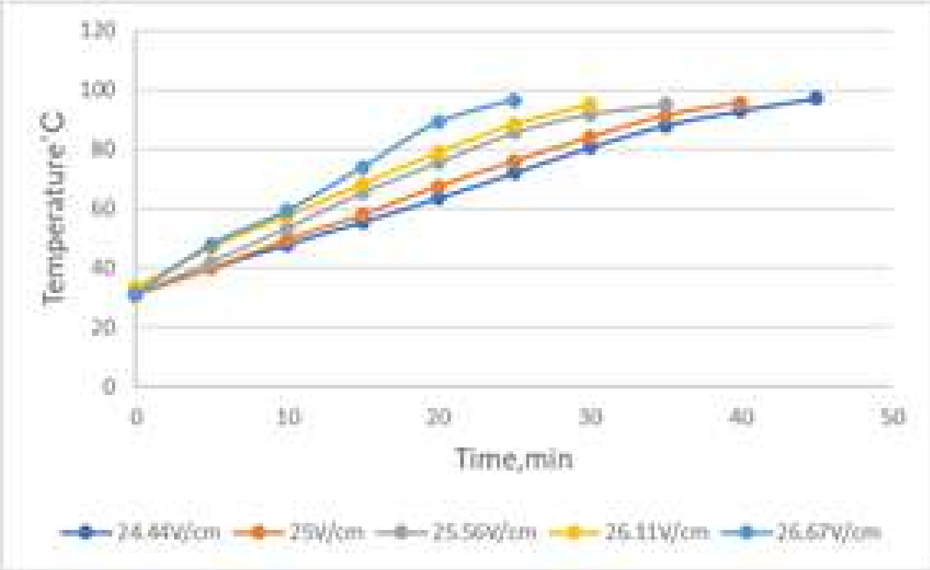

Fig. 1. Relationship between temperature and time at 24.44, 25, 25.56, 26.11 and 26.67 V/cm

rubber roller paddy sheller utilized for de-husking the paddy.The head yield and broken portions were determined by weighing the samples at each milling stage.The output of milled paddy, obtained from various openings (Husk, broken and head rice), was collected and analyzed. This data was then compared with the results of milling raw rice under similar conditions to evaluate the effects and advantages of the ohmic-heating system.

RESULTS AND DISCUSSION

The time and temperature profiles (Fig.1) showed that as the voltage gradient, increased, the temperature also rose, leading to a reduction in the parboiling time of samples. This indicates that the curve's slope for higher was steeper compared to that for lower voltage. At higher voltage, the current flowing through the sample also intensified, resulting in faster heat generation.

Milling analysis of parboiled and raw paddy

The milling efficiency percentage, head rice percent and broken rice percentage of raw paddy and parboiled paddy by ohmic heating were calculated as follows

$$\text{Milling recovery \%} = \frac{\text{Weight of total rice}}{\text{total weight of paddy}} \times 100$$

$$\text{Head rice \%} = \frac{\text{Weight of head rice}}{\text{Weight of milled rice}} \times 100$$

$$\text{Broken rice \%} = \frac{\text{Weight of broken rice}}{\text{weight of milled rice}} \times 100$$

The performance of milling process is judged by total yield, head yield and broken rice percentage (Table 1). Experiments were conducted for variety of MTU 1010 paddy with raw and parboiled samples and observations were taken at voltage gradients of 24.44, 25, 25.56, 26.11 and 26.67 V/cm in the ohmic heating chamber at the time interval of 0, 5, 10, 15, 20, 25, 30, 35 and 40 min in the ohmic heating chamber. The data on milling qualities of paddy obtained by milling of raw and parboiled paddy which indicated the highest head yield of 88.09% and lowest broken yield of 11.90 % with a highest milling efficiency of 74.96% for parboiled samples at 26.67 V/cm. Whereas, the raw sample had a head yield of 61.50 and broken of 38.56% with a milling efficiency of 73.35%. Thus, brown rice head yield of parboiled paddy was found higher (26.66%) than that of raw paddy. These results are in conformity with those of Lbukun (2008) who reported that as the longer the parboiling duration the higher the percentage of breakages of paddy rice during milling.

CONCLUSION

The heating rate increased considerably with the increase in voltage. Both the soaking and steaming process were conducted within the ohmic- heating chamber for parboiling the paddy.

Table 1. Milling efficiency, head rice, broken rice percentage of raw and one hour sun dried parboiled paddy.

Milling analysis	Raw paddy	Parboiled paddy one hour sun dried (26.67 V/cm)
Milling efficiency (%)	73.35	74.96
Head rice (%)	61.50	88.09
Broken rice (%)	38.56	11.90

Paddy milling qualities procured from milling of parboiled and raw paddy, the parboiled samples showed the highest head yield of 88.09% and the lowest broken yield of 11.90% at a voltage gradient of 26.67 V/cm. Whereas, the raw sample had a head yield of 61.50 and broken of 38.56%. The results indicated that there was an improvement in milling quality of parboiled paddy by ohmic heating also reduced the processing cost of parboiling paddy and made the parboiling unit safer and easier.

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