Evaluation of paddy quality dried with zeolite under medium temperature

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Abstract. Drying becomes important role to obtain good quality product in post-harvest treatment for paddy. Adsorption drying process taken place on medium operation temperature can be an option to enhance paddy quality. The aim of this study was to evaluate the quality of paddy dried with zeolite as adsorbent. In case, paddy from local farmer in Semarang was dried from initial moisture content 23% (wet basis) under different temperature 40 and 60˚C, both with and without zeolite. Moisture content was observed by gravimetry every 15 minutes during 60 minutes drying time. Furthermore, the quality of paddy represented by percentage of head rice and proximate was analyzed after drying process completed. Results showed that compared to conventional drying without zeolite, the adsorption dryer was more superior in term of drying time as well as product quality improvement and there are no much differences in proximate analyzed result.

Keywords: paddy, drying, zeolite, quality, proximate

1. Introduction
Paddy is one of the major economic crops for consuming and producing in many countries. In global, paddy is the most phytocomestible that give energysupply and the second protein source, following wheat [1].

Drying becomes important role to obtain good quality product in post-harvest treatment for paddy. The air temperature had the most superior effect both on product quality and drying rate [2]. Nowadays, there are two methods of paddy drying: direct sunlight dryer and dryer by conventional heating. Direct sunlight dryer is commonly used by farmer because it has cheaper and more simple method than dryer by conventional heating [3]. Conventional dryer such fluidized bed has more advantages: shorter operational time, no dependency on the climate, low product contamination, and smaller space usage [4, 5, 6, 7]. Fluidized bed dryer is commonly and commercially used in several country for short time food drying, sensitive food drying, and homogenous moisture content product of drying [8].

The operation temperature must be set in order to keep paddy quality and energy efficiency of drying. The temperature upper 90°C can reduce the paddy quality [9]. Food products are sensitive to the heat load during drying. For example the color of tarragon (Artemisia dracunculus L.), changes to brown when drying occurs at too high temperatures [10]. Air dehumidification by adsorbent such as
silica and alumina can be used. The zeolite is an alumino-silicate compound with tetrahedral bound linked by oxygen that has high affinity to the water. By activation using KOH or NaOH, the adsorbing capacity can be enhanced up to 0.15-0.20 g water/g zeolite [11].

From those explanations above, paddy drying should be done at low-medium temperature. The application of zeolite in order to decrease the air dryer humidity and improve paddy quality were become an advantages we could get in this research. The aim of this study was to evaluate the quality of paddy dried with zeolite as adsorbent. The differences of final moisture content, head rice yield, and proximate composition content indried paddy with and without zeolite were also observed from this research.

2. Material and Methods

2.1. Material

Paddy from local farmer in Semarang was dried from initial moisture content 23% (wet basis) under different temperature 40 and 60°C. 220 grams of Zeolite 3A (provided by Zeochem, Switzerland) were used as adsorbent in purpose to decrease the relative humidity of air dryer. Petroleum ether, boiling point 40–60°C was used for fat analysis. While carbohydrates analysis used 52% perchloric acid solution: 279 ml perchloric acid (specific gravity 1.70) in 100 ml distilled water; Sulphuric acid solution: 760 ml of H₂SO₄ (specific gravity 1.84) in 330 ml distilled water; Anthrone reagent. Have enough Anthrone reagent ready by preparing a 0.1% sulphuric acid solution to used the same day; Standard glucose solution. Dissolved 100 mg glucose in 100 ml water; Standard diluted glucose solution. Diluted 10 ml standard glucose solution in 100 ml distilled water (1 ml = 0.1 mg glucose).

2.2. Experimental set-up

This drying process used fluidized bed dryer from Teknik Kimia Universitas Diponegoro, Semarang. Paddy grains were fluidized in fluidized column (Figure 1). Ambient air with relative humidity 70-80% and temperature between 29-33°C was heated in the heater completed with PID controller to reach dryer temperature (40°C with zeolite at first experiment). The air dryer flow was set at 5.51 m.s⁻¹. It was measured with an KRISBOW Instruments Anemometer KW06-562. Moisture content was observed by grain moisture meter G-Won GMK-303RS every 15 minutes. 250 grams of paddy are used for 60 minutes of drying process. The process was repeated for the inlet air dryer temperature 60°C and operation without zeolite (at 40 and 60°C). The quality of paddy represented by percentage of head rice yield (HRY) was obtained by observing the paddy with rice grader or pinset and proximate was analyzed after drying process completed. The proximate composition content analysis included ash content (ash analysis), fat content (soxhlet method), protein content (kjedahl method), and carbohydrate content (gravimetric method).

The ash analysis was used to determine ash content in feedstuffs by calcination. The steps of this analysis were: place 2.5 to 5 g of dry sample in a crucible previously calcined and brought to constant weight. placed the crucible in a furnace and heated at 550°C for 12 hours; left to cool and transferred to a dryer. Then weighed the crucible again with the ash.

In the soxhlet method, the fats were extracted from the sample with petroleum ether and evaluated as a percentage of the weight before the solvent was evaporated. Steps of soxhlet method: removed extraction flasks from the kiln without touching them with the fingers, cooled in a dryer and weighed to within milligrams; Weighed 3 to 5 g of dry sample to within milligrams in an extraction thimble, handling it with tongs and place in the extraction unit; Connected the flask containing petroleum ether at 2/3 of total volume to the extractor; Brought to boil and adjusted heat to obtain about 10 refluxes per hour; The length of the extraction would depend on the quantity of lipids in the sample; Very fatty materials would take 6 hours; When finished, evaporated the ether by distillation or in a rotoevaporator; Cooled the flasks in a dryer and weighed them to within milligrams. The defatted sample can be used in determining crude fibre.
Protein analysis was done by Kjeldahl's method, which evaluated the total nitrogen content of the sample after it had been digested in sulphuric acid with a mercury or selenium catalyst. To milligram precision, weighed out 1 g of sample and placed in the Kjeldahl flask; Added 10 g potassium sulphate, 0.7 g mercuric oxide and 20 ml concentrated sulphuric acid; Placed the flask tilted at an angle in the digester, brought to boiling point and retain until the solution is clear; Continued to heat 30 minutes more. If foam was too abundant, added a little paraffin wax; Left to cool, gradually adding approximately 90 ml distilled, de-ionized water. When cold added 25 ml sodium sulphate solution and stir; Added one glass bead and 80 ml of 40% sodium hydroxide solution, keeping the flask tilted. Two layers will form; Quickly connected the flask to the distillation unit, heat and collect 50 ml of distillate containing ammonia in 50 ml of indicator solution; At the end of distillation, removed the receptor flask, rinsed the end of the condenser and titrated the solution with the standard chlorhydric acid solution.

Carbohydrate content was measured by Clegg-anthrone method. The steps were: Weighed out 1.0 g of dry or 2.5 g of wet sample to within 0.001 g containing approximately 60 to 300 mg of total available carbohydrates; Transferred quantitatively to a stoppered 100 ml graduated cylinder; Added 10 ml water and stirred with glass rod to disperse the sample; Added 13 ml of the perchloric acid solution. Stired constantly with glass rod for 20 min; Rinsed rod with distilled water and brought volume to 100 ml. Mixed and filtered into a 250 ml volumetric flask; Rinsed the graduated cylinder with distilled water and add this to the volumetric flask; Calibrated the flask with distilled water and shake; Diluted 10 ml of the extract to 100 ml with distilled water. Used a pipette to transfer 1 ml of diluted filtrate to a test-tube; Using a pipette took two 1 mg samples of distilled water for duplicate blanks and put each one in a test-tube; Took two 1 ml duplicate blanks using the dilute glucose solution; Quickly added freshly prepared anthrone reagent to all the tubes; Caped the tubes and mixed vigorously; Placed in a water-bath and heat for 12 minutes; Cooled rapidly to room temperature; Transferred the solution to 1 cm spectrophometer cells. The green colour was stable for only 2 hours; Read the absorption rate at 630 nm against the blank.

Figure 1. The schematic overview of the fluidized bed drying equipment from Djaeni et al. with modification [12].
3. Experimental Result

3.1. Moisture content and Head Rice Yield

Results showed that compared to conventional drying without zeolite in same duration of drying, the adsorption dryer was more superior in term of head rice yield as well as product quality improvement. The air temperature had effect both on moisture content and head rice yield (table 1). At higher temperature, the relative humidity of air is low. Air also has more sensible heat that can be used for evaporating water [12]. The higher temperature, the higher drying rate, the lower moisture content but the lower product quality.

| Treatment       | Temperature (°C) | Time (min.) | Moisture Content (%) | Head Rice Yield (%) |
|-----------------|------------------|-------------|----------------------|---------------------|
| with zeolite    | 40               | 0           | 23                   |                     |
|                 |                  | 15          | 19.5                 |                     |
|                 |                  | 30          | 15.2                 |                     |
|                 |                  | 45          | 14.6                 |                     |
|                 |                  | 60          | 13.8                 | 64.7                |
|                 | 60               | 0           | 23                   |                     |
|                 |                  | 15          | 19.2                 |                     |
|                 |                  | 30          | 14.6                 |                     |
|                 |                  | 45          | 13                   |                     |
|                 |                  | 60          | 13                   | 64                  |
| without zeolite | 40               | 0           | 23                   |                     |
|                 |                  | 15          | 20.4                 |                     |
|                 |                  | 30          | 16.5                 |                     |
|                 |                  | 45          | 15.6                 |                     |
|                 |                  | 60          | 15.5                 | 62.4                |
|                 | 60               | 0           | 23                   |                     |
|                 |                  | 15          | 20.1                 |                     |
|                 |                  | 30          | 16.2                 |                     |
|                 |                  | 45          | 15.3                 |                     |
|                 |                  | 60          | 15                   | 60.5                |

In paddy drying without zeolite experiments, generally, the moisture content was higher and head rice yield was lower than paddy drying with zeolite experiments (table 1). It was caused zeolite adsorbs water from the air dryer during drying process [12]. Hence, the humidity of air can be kept low and driving force of drying is higher.

HRY was important indices in judging the quality milled rice in Indonesia; however, in some countries, HRY was frequently used as important quality in assessing milled rice quality. According to SNI 6128:2015, Indonesia had two classes (premium class and medium classes) of national head rice yield standard by regulatory body. In premium class, head rice yield must be 95% of total milled rice. Medium class divided into three grades: 78%, 73%, and 60% minimum requirement of head rice yield. The head rice yield of dried paddy with and without zeolite in this experiment results had qualified the last grade (3rd grade of medium class) of SNI paddy quality 6128:2015 (min. 60%). This grade represented medium-low quality of paddy that can be found in Indonesia market (also included in Bulog Indonesia paddy stock).

Proximate was observed from each sample at 60 minutes of drying process because they had the most propotional moisture content which is suitable for milling. The proximate analysis results...
showed that there were no much differences in ash, fat, protein, and carbohydrates content that contain in samples (table 2).

Table 2. Proximate analysis result.

| Sample          | Ash Content (%)db | Fat Content (%)db | Protein Content (%)db | Carbohydrates Content (%)db |
|-----------------|-------------------|-------------------|-----------------------|-----------------------------|
| Zeolite 40°C    | 11.18             | 0.73              | 6.73                  | 66.83                       |
| Zeolite 60°C    | 11.10             | 0.73              | 6.73                  | 66.86                       |
| Non-zeolite 40°C| 11.24             | 0.71              | 6.75                  | 66.80                       |
| Non-zeolite 60°C| 11.32             | 0.70              | 6.76                  | 66.32                       |

*the presence of water was ignored for the purposes of the calculation

4. Conclusion
Results showed that zeolite can improve driving force for drying as indicated in lower moisture content in same temperature and duration of drying operation. The head rice yield of dried paddy with and without zeolite in this experiment results had qualified the last grade of standard by regulatory body. The proximate analyzed result showed there were no much differences in ash, fat, protein, and carbohydrates content that contained in samples.

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