Effect of grain moisture on dehulling of *Nymphaea pubescens* seed

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Abstract. Grain *Nymphaea pubescens* has been widely consumed as traditional food such as snack bars and cake in South Kalimantan. The first experiment of this study focused on the difference in moisture content of *N. pubescens* seed after harvest to prevent seed decay and higher dehulling recovery. Dehulling was performed with a laboratory model seed polisher/dehulling apparatus. Dehulling experiments were carried out on samples exhibiting moisture contents ranging from 10% to 20.6%. Dehulling of *N. pubescens* seed was affected by moisture content. The optimum grain moisture for dehulling *N. pubescens* seed was 10% and 13.2%, respectively, with a higher amount of dehulled seed, resulting in dehulling efficiency of 48.6% and 45.6%, respectively, and lower levels of powder and broken seed. The dehulling efficiency decreased with an increased moisture content of *N. pubescens* seed.

Keywords: Dehulling, Moisture, *Nymphaea pubescens* seed.

1. Introduction

The increased population is accompanied by an increase in food sources of carbohydrates such as rice. *N. pubescens* can grow without human intervention in the wetland. *Nymphaea pubescens* seed contains carbohydrates up to 80%, protein 3.4-7% [1,2], which is potentially used as a food source in Indonesia. *Nymphaea pubescens* seed contains essential oil amino acids [3], and phytochemical components such as flavonoid, alkaloid, tannin, saponin, phenolic, and triterpenoid that have antibacterial activity [4] and antioxidant activity [5]. *Nymphaea pubescens* seed before used for making food must be dehulled using a paddy machine polisher. *Nymphaea pubescens* dehulled seed has been used by the people to make traditional food such as snack bars and cake in South Kalimantan, Indonesia.

*Nymphaea pubescens* seed consists of three layers macrosclereids, osteosclereids, and endosperm from outside to inside. The starch and phytochemical are distributed in the endosperm, while cellulose and lignin exist in macrosclereids. Traditionally, dehulling *Nymphaea pubescens* seed using paddy machine polisher and abrasive polisher manually. The dehulling *Nymphaea pubescens* seed results in poor quality due to the presence of an undehulled mixture with dehulled seed. Dehulling is important to obtain good quality and improve the meal which can be further utilized in functional food product development. During the dehulling process, a considerable amount of fiber and certain colors are removed, which would otherwise enter into the meal and diminish its quality. Dehulling is also advantageous for recovering cellulose and lignin-rich biomass for future use. The yield of dehulled seeds is influenced by the moisture content of the seed in general. As a result, this study will use a laboratory
small rice polisher to determine the moisture level of *Nymphaea pubescens* seed affecting dehulling parameters.

2. **Materials and Methods**

*Nymphaea pubescens* seed purchased from local people at Hulu Sungai Utara Regency, South Borneo Province, Indonesia. Local residents dried the treated seeds in the sun until they were completely dry, with a moisture content of 10-12 percent wb. The seeds were cleaned to remove stones and other debris.

2.1 **Dehulling of Nymphaea pubescens seed**

The dried *Nymphaea pubescens* seed samples were dehulled in a laboratory mini rice polisher electric. The *Nymphaea pubescens* seeds were placed in a tiny rice polisher that had previously been turned on. For a 10 g seed, the dehulling procedure took around 16-18 seconds. Dehulled seed, undehulled seed, powder, hull, and broken seed are all part of the dehulling fraction. The undehulled seed, powder, hull, and broken seed were manually separated from the dehulled seed. To determine dehulling efficiency and degree of dehulling, the entire dehulling fraction was weighed.

2.2 **Moisture conditioning of Nymphaea pubescens seed**

The initial moisture content of *Nymphaea pubescens* seed was determined by the hot air oven method at 105°C for the period until the constant weight [6]. The *Nymphaea pubescens* seed was conditioned for different moisture content levels (10, 13, 16, and 20% wb). The seeds were added distilled water and mixed to get more than the initial moisture content.

2.3 **Experimental procedure**

The experiments were carried out with a laboratory micro rice polisher electric at various moisture levels. The moisture level of the *Nymphaea pubescens* seed was conditioned to 10, 13, 16, and 20% wb. Before dehulling, the samples were allowed to equilibrate at room temperature (302°C), and their moisture contents were measured in triplicate, yielding average values of 10, 13.4, 16.8, and 20.6 percent, respectively.

2.4 **Statistical Analysis**

All trials were carried out in triplicate, and data obtained were subjected to an analysis of variance (ANOVA) and followed test using Least Significance Different to know for the effects of the different experimental factors on the properties measured. All statistical analyses were carried out using the statistical software Excel.

2.5 **Dehulling Data Analysis**

2.5.1 **Degree of dehulling (DD)**

The degree of dehulling calculated adopted from [7], based on the percentage of dehulled seeds to the initial weight of sample taken for dehulling. The degree of dehulling was defined using the following equation:

$$DD (\%) = \frac{W_1 - W_3}{W_1} \times 100$$  \hspace{0.5cm} (1)

2.5.2 **Dehulling efficiency (DE)**

Dehulling efficiency is an estimate of the efficiency of generating the main product, dehulled kernels, based on [7]. It was calculated using the following equation:

$$DE (\%) = \frac{W_1 - (W_3 + Wh + Wb)}{W_1} \times 100$$  \hspace{0.5cm} (2)
where \( W_1 \) is the initial weight of sample taken for dehulling (g), \( W_2 \) is the weight of dehulled seeds (g), \( W_3 \) is the weight of undehulled seeds (g), \( W_h \) is the weight of hulls (G), \( W_b \) is the weight of broken and powder (g).

3. Results

*Nymphaea pubescens* seeds (figure 1a) and yield comparative dehulling of *Nymphaea pubescens* seed is presented in figure 1b–e, ANOVA for dehulling parameters *Nymphaea pubescens* seed (Table 1) and comparative dehulling fractions are presented in table 2, and comparative dehulling efficiency and degree of dehulling on the different moisture content of *Nymphaea pubescens* seed are presented in Figure 2.

![Figure 1](image1)

**Figure 1.** Yield comparative dehulling of different moisture content

a. *Nymphaea pubescens* seed; b. 10%; c. 13.2%; d. 16.8%; e. 20.6%.

| Source          | Degrees of Freedom | Mean Square | F-value | F-crit |
|-----------------|--------------------|-------------|---------|--------|
| Dehulled seed   | 3                  | 520.74      | 102.24* | 4.07   |
| Powder          | 3                  | 24.21       | 17.08*  | 4.07   |
| Broken          | 3                  | 74          | 21.81*  | 4.07   |
| Hull            | 3                  | 20.89       | 93.79*  | 4.07   |
| Undehulled seed | 3                  | 229.1       | 57.3*   | 4.07   |

* Significant at F-value > F-crit (P≤0.05)

*Table 1.* ANOVA for dehulling parameters *Nymphaea pubescens* seed at different moisture contents

| Moisture content (%) | Dehulled seed (%) | Powder (%) | Broken seed (%) | Undehulled seed (%) |
|----------------------|-------------------|------------|-----------------|---------------------|
| 10                   | 48.6\(^a\)        | 6.7\(^a\)  | 9.4\(^b\)       | 13.6\(^a\)          |
| 13.2                 | 45.6\(^a\)        | 7.4\(^a\)  | 8.8\(^a\)       | 19.4\(^c\)          | 18.7\(^b\)          |
| 16.8                 | 30.3\(^b\)        | 7.9\(^a\)  | 14.3\(^b\)      | 15.5\(^b\)          | 32.2\(^c\)          |
| 20.6                 | 20.6\(^a\)        | 12.9\(^b\) | 19.4\(^c\)      | 17.9\(^b\)          | 29.1\(^c\)          |

Mean values following different letters in the same column for each moisture content are significantly different (P < 0.01) on the application of the Least Significant Different (LSD) test
4. Discussion

*Nymphaea pubescens* seeds are small and light with a weighing of 1.2 mg with the color of the seeds is brownish-green (Figure 1a). Yield comparative dehulling of *Nymphaea pubescens* seed is presented in figure 1b–e and comparative dehulling parameters are presented in table 2. Results indicate that different moisture was significantly (P≤0.05) affected in all dehulling parameters i.e. dehulled seed, powder, broken seed, hull, and undehulled seed. The moisture content of *Nymphaea pubescens* seed was in the range of 10 to 20.6 %, It is observed from Table 2 that the optimum dehulled seed is 48.6% at 10% moisture content followed by 45.6% dehulled seed at 13.2% moisture content. The dehulled seed decreased significantly with increasing moisture content higher than 13.2% of *Nymphaea pubescens* seed. Results showed that the moisture content at 10% is not significantly different with 13.2% treatment to dehulling parameters i.e dehulled seed, powder, and broken seed (Table 2), but significantly different for dehulling parameters hull and undehulled seed according to LSD test (P<0.01). These treatments result in high dehulled seed, decrease powder, and broken seed. At 10% and 13.2% moisture content, the best results of different moisture dehulling parameters were obtained, while greater moisture content was not suitable. Lower dehulled seed and greater powder and broken seed were the results of the increased moisture. This might be because the seed became softer, more difficult to separate from the hull and kernel, and more readily broken as the moisture level increased. These findings are consistent with dehulling of flaxseed, which has a lower moisture content that is favorable for dehulling [8], but paddy and sorghum have higher moisture contents that are favorable for dehulling at 10-14 percent [9] and 14.3 percent [10], respectively, to obtain the best-dehulled seed.

The greatest degree of dehulling (86.4%) and dehulling efficiency (48.6%) were reported at a moisture level of 10%. (Figure 2). However, according to the statistical test, the moisture content of 10% and 13.2% are not statistically different at the 1% level of probability. When the moisture content exceeds 13.2 percent, the degree of dehulling and dehulling efficiency reduces dramatically. As a result, at 20.6 percent moisture content, varied circumstances enhanced the degree of dehulling while decreasing dehulling efficiency. Because of the 20.6 percent moisture content, there is more powder and broken seed in this condition. Although the seeds have been dehulled, they produce powder and shattered seeds. The increased moisture content may make the material softer and easier to break.
5. Conclusion
The moisture content has an important role in dehulling of *Nymphaea pubescens* seed. The lower moisture content at 10% and 13.2% were the best condition to get optimum dehulled seed, lower powder, and broken seed.

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