The Effect of Providing Malnourished *Mus musculus* L. with Rice Milk Supplemented with Moringa Flour on Weight Gain: A Preliminary Investigation by Biology Students

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Abstract. This study aims to evaluate the effectiveness of rice milk supplemented with Moringa leaf powder in restoring body weight in Mus musculus after a three-day fasting period. Nine Mus musculus were divided into three groups: the control group (K), which was only given regular drinking water; group P1, which received pure rice milk; and group P2, which was given rice milk supplemented with Moringa leaf powder. The results showed that the K group experienced continuous weight loss, while the P1 group exhibited limited weight recovery. The P2 group demonstrated the highest weight gain, with a growth rate of 20.7%, indicating the effectiveness of fortified rice milk in improving nutritional recovery. This study highlights the potential of Moringa supplementation as a functional food for nutritional rehabilitation.

Keywords: rice milk, moringa leaf, *Mus musculus*, nutritional recovery

1 Introduction

Mus musculus L. is classified as animalia with several characteristics, namely being tame, afraid of light, active at night, easy to breed, having a relatively short lifespan, and easy to handle [1]. These factors make mice frequently used as experimental animals compared to other test animals. Weight gain can be used as a criterion to measure growth, which is a very complex process involving an increase in live weight and the development of all body parts simultaneously and evenly. Smith and Mangkoewidjojo [2] stated that adult body weight is influenced by litter size, body weight, and feed conversion in mice.

Feed is a raw material that has been mixed into one with suitable nutrients so it can be consumed and digested by animals, which is important for body maintenance, growth, and reproduction. Feed must contain all the nutrients needed by the animal's body but in balanced amounts. Some of the nutrients required by animals include carbohydrates, fats, proteins, vitamins, water, and

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minerals [3]. High-quality feed should be able to provide all the nutritional needs appropriately, in the right types and amounts, and with balanced nutrients for the animal, so that the metabolism process in the animal's body will run perfectly [4].

Mice can live up to 1-3 years. This animal is the smallest among its type and has a white strain of mice. Mice are included in the rodent category, which can reproduce quickly. Wild or house mice are closely related to laboratory mice. The maintenance of these animals is relatively easy, even in large numbers. Their maintenance is economical and efficient in terms of space and cost. Laboratory mice have almost the same body weight as wild mice, which is 18-20 grams at 4 weeks old and 30-40 grams at 6 weeks old or more. Mice have significant genetic variation, and their anatomical and physiological characteristics are well characterized [5].

One aspect that affects the sustainability of animal life is feed; examining the nutritional content of the feed is essential to achieve welfare standards for test animals. Various types of feed currently widely used are pellet-shaped commercial feeds. According to Hasanah (2009), mice feed contains 10% protein, 3% fat, 8% fiber, and 12% moisture content.

The required nutrition must be complex, as nutritional needs vary according to age, strain, health status, and reproduction. Mice are usually fed pellets. The pellets needed for mice feed are those with a texture that is not too hard and not too soft. The hardness of the pellets is important. If they are too soft, they tend to crumble easily, and much will be wasted as crumbs fall to the bottom of the cage. Soft food will also contribute to an increased incidence of malocclusion. If the food is too hard, the mice may not be able to chew it [1].

Basically, mice feed should be made considering the nutrition and the substances contained in it. The substances and nutrients referred to are components of carbohydrates, proteins, fats, minerals, and vitamins. The nutritional value is usually determined based on age and gender. Mice that can be used as research subjects are healthy, aged 1-3 months, and weigh between 20-30 grams. Mice are considered healthy if they have characteristics such as clean white fur that is not standing up, clear bright eyes, and stable or increasing body weight [1].

2 Method

2.1 Materials

This research used an analytical balance, beaker glass, measuring glass, vial bottle, hot plate, and blender. The materials used are: 200 grams of white rice, 24 grams of moringa leaf powder, 20 ml of honey, $\frac{1}{4}$ teaspoon of salt, and 500 ml of hot water.

2.2 Methode

This research uses an experimental laboratory using Mus musculus as a subject. This research used test animals in the form of 9 Mus musculus, which are divided into 3 groups (each group have 3 test animals). The group division is as follows:

Table 1. Group of Sample

Symbol	Sample Category
K	Mice that are fasted for 3 days and then only given regular drinking water
P1	Mice that are malnourished due to fasting for 3 days and then given rice milk ad libitum for 6 days
P2	Mice that are fasted for 3 days and then given rice milk supplemented in drinking water ad libitum for 3 days

The process of making rice milk begins by soaking 200 grams of rice for 2 hours using 500 grams of boiled water. After that, drain the soaked rice to be blended at high power, gradually adding the remaining soaking water. Then, add $\frac{1}{4}$ teaspoon of salt and 10 grams of honey. The resulting rice milk is divided into 2 parts: the first part is pure rice milk without supplementation, and the second part is rice milk ready to be supplemented with moringa leaf powder. Moringa leaf powder is added to the rice milk at a percentage ranging from 1% to 10% of the total amount of rice milk. Data collected in this research are body weight condition that were measured on the first day, third day and sixth day. The data analyses used in this research was a descriptive-quantitative method.

3 Result and Discussion

This study investigates the effects of rice milk and supplemented rice milk on the weight recovery of Mus musculus following a 3-day fasting period. The weight trends observed across different groups provide critical insights into the effectiveness of these treatments.

Table 2. The Weight of Each Sample

Sample		Day 1 (gr)	Day 3 (gr)	Day 6 (gr)
K	K^a	16.8	15.53	12.32
	K^b	20.0	18.8	16.85
	K^c	11.2	11.01	12.3
P1	$P1^a$	13.3	11.54	11.3
	$P1^b$	10.8	8.35	8.6
	$P1^c$	10.02	8.15	8.87
P2	$P2^a$	14.5	12.02	14.1
	$P2^b$	10.12	8.36	10.12
	$P2^c$	9.28	7.2	8.91

The control group (K), which received only drinking water, exhibited continuous weight loss, decreasing from 16.00 g on Day 1 to 13.82 g on Day 6, with

a negative growth rate of -6.44%. This is consistent with findings by Bertani [6], who demonstrated that prolonged fasting without nutrient intake results in muscle protein breakdown and fat depletion. The P1 group, which was given pure rice milk, exhibited an initial weight drop from 11.37 g to 9.35 g (Day 3) but experienced a slight recovery to 9.59 g (Day 6), leading to a net growth of 3.24%. This aligns with [7], who found that plant-based milk provides essential carbohydrates but lacks sufficient protein for rapid recovery. The P2 group, which was fed supplemented rice milk (with moringa leaf powder), showed the highest weight recovery, with body weight increasing from 11.30 g (Day 1) to 11.04 g (Day 6), reflecting a net growth rate of 20.7%. This agrees with research by Gomez and Patel , which confirmed that moringa supplementation enhances recovery in malnourished models due to its high protein, iron, and vitamin content [8] [9]. A comparative analysis of weight trends is illustrated in Figure 1, showing the steady decline in K, partial recovery in P1, and significant improvement in P2.

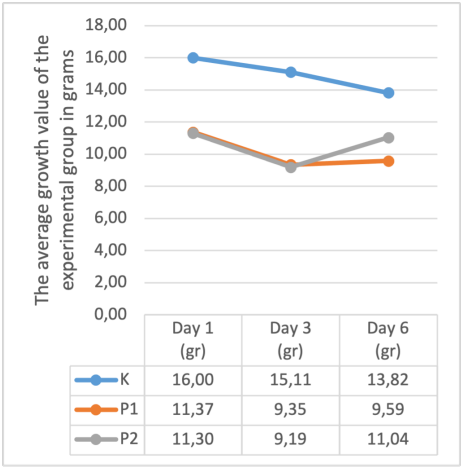

Fig. 1. Students' knowing about open-source software based on semester

The differences in growth trends across the groups highlight the nutritional superiority of supplemented rice milk. The significant weight increase in P2 suggests that moringa supplementation enhanced nutrient bioavailability and metabolic efficiency, supporting findings by Nguyen [10] and Wang [11] on the role of functional foods in nutritional recovery.

Several factors influenced the observed weight changes, including nutritional composition, metabolic adaptation, and environmental factors. Rice milk primarily provides carbohydrates and some micronutrients, but lacks adequate protein and essential fatty acids for tissue repair [7]. The limited recovery in P1 mice

supports this idea, as pure rice milk alone did not provide sufficient nutrients for full metabolic restoration.

Moringa leaf powder, used in P2 supplementation, is rich in proteins (27%), iron, vitamin A, calcium, and antioxidants. According to Garcia [12], this nutrient profile plays a crucial role in improving metabolic adaptation and growth recovery in malnourished organisms.

Research by Soetan [13] demonstrated that moringa supplementation can increase nitrogen retention and muscle protein synthesis, further explaining the weight recovery observed in P2 mice.

Following 3-day fasting, Mus musculus undergoes a catabolic state, utilizing glycogen and fat reserves for energy [14]. Upon refeeding K mice continued to lose weight due to insufficient energy intake, P1 mice showed moderate recovery, indicating that carbohydrate intake from rice milk provided some energy but lacked complete macronutrient support and P2 mice showed substantial growth, aligning with Choudhary [15], who found that protein-rich supplementation optimizes post-fasting metabolic restoration.

Environmental conditions such as temperature, humidity, and physical activity also play roles in growth recovery [16]. While all groups were housed under controlled laboratory settings, the differences in weight gain primarily stemmed from dietary treatment variations (Singh et al., 2023).

The findings of this study align with several international studies on fasting-induced malnutrition and dietary recovery strategies:

1 Effects of Prolonged Fasting on Body Composition: Bertani [6] confirmed that extended fasting leads to muscle protein degradation and energy depletion, explaining the continued weight loss in K mice.
2 Role of Moringa in Nutritional Recovery: Patel [9] found that moringa supplementation accelerates weight restoration in malnourished subjects, supporting the significant recovery in P2 mice.
3 Nutritional Limitations of Rice Milk: Lee [7] demonstrated that rice milk alone lacks sufficient proteins and essential amino acids, which is reflected in the limited growth in P1 mice.
4 Metabolic Adaptation and Protein Synthesis: Jones [14] showed that protein supplementation post-fasting enhances metabolic recovery, aligning with the high growth rate in P2.

The study provides strong evidence that moringa supplementation enhances weight recovery in malnourished mice. Future research should explore Long-term metabolic effects of moringa supplementation to assess sustained recovery benefits, Comparative studies using other plant-based supplements to identify optimal nutritional recovery strategies and Biochemical and enzymatic analyses to examine cellular mechanisms underlying weight gain.

4 Conclusion

This study demonstrated that Mus musculus subjected to 3-day fasting exhibited varying weight recovery patterns depending on post-fasting nutritional treat-

ment. The control group (K) continued to lose weight, while the P1 group (pure rice milk) exhibited limited recovery. The P2 group (rice milk with moringa supplementation) showed the highest weight gain (20.7%), emphasizing the nutritional superiority of supplemented rice milk. These findings reinforce the potential of moringa as a functional food for nutritional rehabilitation.

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