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Coix lacryma-jobi L. Nutritional Value Concerning Nitrogen Fertilizer Doses

Taufan Purwokusumaning Daru, Mayang Sari and Hamdi Mayulu

Department of Animal Husbandry, Faculty of Agriculture, Mulawarman University, Samarinda, East Kalimantan, Indonesia

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Corresponding Author:
Hamdi Mayulu
Department of Animal Husbandry, Faculty of Agriculture, Mulawarman University, Samarinda, East Kalimantan, Indonesia
Email: hamdi.mayulu@unmul.ac.id

And

Taufan Purwokusumaning Daru
Department of Animal Husbandry, Faculty of Agriculture, Mulawarman University, Samarinda, East Kalimantan, Indonesia
Email: taufan@faperta.unmul.ac.id

Abstract: *Coix lacryma-jobi* L., as animal feed is considered a cereal plant from the Poaceae or Gramineae family. We aimed to determine the influence of different doses of Nitrogen (N) fertilizer on *Coix lacryma-jobi* L. It was conducted in the Lempake Village area; and the Chemical and biochemical laboratory of agricultural products and animal husbandry nutrition laboratory at Mulawarman University from March to September 2021. Data were collected using a randomized block design and five treatments as follows T_0 = control, T_1= 150 kg/ha, T_2= 300 kg/ha, T_3= 450 kg/ha, and T_4= 600 kg/ha with four replications. The results showed a significant effect on Dry Weight (DW) and Moisture Contents (MC) of *Coix lacryma-jobi* L., with no significant ($p<0.01$) effect on Dry Matter (DM) and Crude Fiber (CF). The application of different doses of N fertilizer led to a high Crude Protein (CP) and ash contents but failed to affect the crude fat and Nitrogen Free Extract (NFE). The best nutrient contents were observed at 600 kg/ha, with CF, CP, Ether Extract (EE), ash, and NFE at 24.34, 8.50, 1.49, 11.63, and 54.04%, respectively.

Keywords: *Coix lacryma-jobi* L., Nitrogen Fertilizer, Proximate

Introduction

Forage is the main feed for ruminant animals since it provides the necessary nutrients for maintenance, production, and reproduction (Mayulu, 2020). Therefore, the high productivity of the animal needs to be accompanied by an increase in the quality or quantity of the feed provided (Daru and Mayulu, 2020). *Coix lacryma-jobi* L. is a potential source of carbohydrates for ruminants and can be used for feed diversification. It is also known as delay, *Coix*, Job's tears, or jali (Devaraj *et al*., 2020; Juhaeti, 2015; Qosim *et al*., 2015). *Coix lacryma-jobi* L. is a whole-grain cereal that has been used as food and for medical purposes (Nurkolis *et al*., 2022). Furthermore, it originated in East Asia and Malaya and has spread widely across the world. There are two species: *C. lacryma-jobi* L. and C. aquatica Roxb found in China with C. aquatica being the oldest relative and the ancestor of C. l. var puellarum, C. l var. *lacryma-jobi*, as well as C. l. var. ma-yuen (Mayulu *et al*., 2020). *Coix lacryma-jobi* L. can resist pests and disease and easily adapts to several environmental conditions. It contains a high nutritional value with protein, water, energy, fat, carbohydrates, and vitamins such as B6, B12, and E of 11.0, 23.0 g, 324 kcal, 4.0, 61,0 g, 27.38, 3.67 and 164.26 mcg/100 g with antioxidant activity having DPPH IC_{50} value of 771.73 ppm (Qosim *et al*., 2015; Juhaeti *et al*., 2021; Tensiska *et al*., 2020).

Coix lacryma-jobi L. requires supporting nutrients that can be obtained from fertilization to achieve high productivity. Fertilizer application is mainly aimed at improving soil fertility by providing necessary nutrients to the plant. The principle of fertilization involves using the right type with the appropriate doses, methods, and timing to increase plant growth and yield (Buamool and Phakamas, 2018). It needs to be adapted to land conditions and site-specific technologies to optimal natural resources' use and become effective and efficient (Irawan *et al*., 2015). Nitrogen (N) is a vital nutrient that has a significant role in increasing plant growth (Huber and Thompson, 2007). The application of N fertilizer is essential, for soil with low organic matter to maintain sufficient nutrients for the plant's productivity (Murcitro and Hasanudin, 2006). Nitrogen plays an important role in supporting leaf growth such as increasing the protein level of the plant, wide-leaf size with a greener color associated with the formation of chlorophyll pigments, and improving the overall quality (Leghari *et al*., 2016;

Sadjadi *et al*., 2017). We aimed in the t current study to examine the effect of N fertilizer application with different doses on *C. lacryma-jobi* L.

Materials and Methods

Duration and Location of the Study

This study was carried out from March to September 2021 in Lempake Village, North Samarinda Sub-district, Samarinda City. The analysis was performed at the Chemical and Biochemical Laboratory of Agricultural Products and Animal Husbandry Nutrition Laboratory, Faculty of Agriculture.

Materials and Equipment

In this study, the materials used were (a) *C. lacryma-jobi* L. and (b) The analysis such as $CuSO_4$, $NaSO_4$, H_2SO_4, and NaOH. The equipment adopted in the proximate analysis includes an electric oven, analytic balance, porcelain dish, tongs, kiln, filter paper, tweezers, measuring cup, desiccator, gloves, soxhlet, biuret, destruction flask, Buchner funnel, beaker, distillation flask, vacuum pump, electric heater, and fume hood.

Data Collection Method

Data were collected using the following formula approach (Suleman *et al.*, 2019).

Moisture Contents (MC)

$$MC(\%) = \frac{A + B - C}{B} \times 100\% \quad (1)$$

Remark:
A = Porcelain dish's weight
B = Sample weight and
C = Porcelain dish and sample weight

Dry Matter (DM)

$$DM = 100\% - MC \quad (2)$$

Crude Fiber (CF)

$$CF(\%) = \frac{W_2 - W_3}{W_1} \times 100\% \quad (3)$$

Remark:
W_1 = Initial weight (g)
W_2 = Post oven weight (g) and
W_3 = Post-kiln weight (g)

Crude Protein (CP)

$$CP(\%) = \frac{V \times N \times 0.014 \times 6.25 \times P}{\text{weight sample (mg)}} \times 100\% \quad (4)$$

Remark:
V = Sample titration volume
N = Normality of HCL or H_2SO_4 and
P = Dilution factor 100/5

Ether Extract (EE)

$$EE(\%) = \frac{W_1 - W_2}{W} \times 100\% \quad (5)$$

Remark:
W = Initial weight (g),
W_1 = Pre-extraction weight (g) and
W_2 = Post-extraction weight (g)

Ash

$$\text{Ash}(\%) = \frac{W_1 - W_2}{W} \times 100\% \quad (6)$$

Remark:
W = Initial weight (g)
W_1 = Crucible + incinerated sample (g) and
W_2 = Empty dish weight (g)

Nitrogen Free Extract (NFE)

$$NFE(\%) = 100\% - (\%CP + \%CF + \%EE + \%\text{Ash} \quad (7)$$

Data Analysis

This study used a randomized design with five treatments including T_0 = control, T_1 = 150 kg/ha, T_2 = 300 kg/ha, T_3= 450 kg/ha, and T_4= 600 kg/ha with four replications. Data were analyzed using the Analysis of Variance (ANOVA) method. When there was a significant difference, it was followed by Duncan Multiple Range Test (DMRT) at a 95% confidence level.

Results and Discussion

Dry Weight

Dry weight is considered the constant weight of feed ingredients after passing through drying. It shows the nutritional status and is an indicator that determines whether a plant's growth is satisfactory. Furthermore, DW is closely related to nutrient availability in soil (Sitorus *et al*., 2014). Table 1 shows the DW result of *C. lacryma-jobi* L. which was given N fertilizer with different doses.

The results showed that the application of different N doses significantly ($p<0.05$) affects the DW contents. The DMRT test result indicated that T_1 had a significant ($p<0.05$) difference with T_0, T_2, T_3, and T_4. Moreover, the average DW of *Coix lacryma-jobi* L. contained in T_0, T_2, T_3, and T_4 were significantly different.

Table 1: DW of *Coix lacryma-jobi* L.

	Treatment				
	T_0	T_1	T_2	T_3	T_4
Group	----------g m^{-2}----------				
1	21.42	83.63	40.89	33.91	52.55
2	44.04	37.22	37.51	16.34	19.66
3	31.15	73.74	36.45	32.61	41.59
4	47.54	87.58	18.61	29.39	36.95
Total	144.15	282.18	133.46	112.25	150.75
Average	37.69^a	36.04^a	70.55^b	33.36^a	28.06^a
SD	12.03	22.96	10.02	8.04	13.69

Remark: 1. T_0 = control, T_1 = fertilizer doses 150 kg/ha, T_2 = fertilizer doses 300 kg/ha, T_3 = fertilizer doses 450 kg/ha and T_4 = fertilizer doses 600 kg/ha
2. SD= Standard Deviation
3. Different superscript shows a significant difference ($p<0.05$)

Table 2: Moisture content of *Coix lacryma-jobi* L.

	Treatment				
	T_0	T_1	T_2	T_3	T_4
Group	----------%				
1	10.74	10.79	11.59	12.72	13.98
2	11.72	12.41	11.52	12.87	12.40
3	11.64	10.87	12.74	11.82	13.27
4	10.72	11.31	11.40	12.93	12.02
Total	44.81	45.38	47.24	50.33	51.68
Average	11.20^a	11.35^a	11.81^{ab}	12.58^b	12.92^b
SD	0.550	0.750	0.620	0.520	0.880

Remark: 1. T_0 = control, T_1 = fertilizer doses 150 kg/ha, T_2 = fertilizer doses 300 kg/ha, T_3 = fertilizer doses 450 kg/ha and T_4 = fertilizer doses 600 kg/ha
2. SD= Standard Deviation
3. Different superscript shows a significant difference ($p<0.05$)

The application of N fertilizer in T_1 (150 kg/ha) produced the highest yield on the DW. Furthermore, the dose at T_2, T_3, and T_4 was believed to exceed the optimum limit of plants in nutrient absorption. The application of N fertilizer significantly affects the MC of *C. lacryma-jobi* L. This dose influences the production of elephant grass's DW (Mangiring *et al*., 2017). Furthermore, the application of N fertilizer with the right dose significantly affects the DW of the plant. This is because organic NPK fertilizer which is given at the right dose can improve soil fertility and make it easier for roots to absorb water. Therefore, this increases plant metabolism, which affects DW (Marlina *et al*., 2015).

Moisture Contents

Moisture Content is the amount of water contained in the feed ingredient. Table 2 shows the MC result of *C. lacryma-jobi* L. which was given N fertilizer with different doses.

The results showed that the application of N fertilizer at different doses significantly ($p<0.05$) affects the MC of *C. lacryma-jobi* L. with $p<0.05$. Furthermore, the DMRT test indicated that T_4 and T_3 are positively different from T_1 and T_0. The average MC also showed an insignificant difference for T_2. In this study, the application of T_4 produced the highest. As cutting time increases, the moisture and DM of the feed ingredient also increase. However, when the forage-cutting age is younger, MC is higher (Aulia, 2017). The increase in MC of a feed ingredient tends to reduce the percentage of the nutrient, specifically DM (Aulia, 2017).

The high MC in the young plant is related to the presence of active cells that carry out the process of cell division and tissue formation (Aulia, 2017). In the leaf cells, moisture is necessary as a substrate or reactant for several biochemical reactions such as photosynthesis and it also acts as a nutrient solvent to transport the nutrients into the leaves (Keraf and Mulyanti, 2017). MC of old plants tends to decrease while there is an increase in DM. This is because, in the old plant, there is a thickening of the cell walls (Aulia, 2017).

Dry Matter

Dry Matter refers to the total material in feed without moisture and is used to determine nutrient levels in rations (Mayulu *et al*., 2021; Seymour *et al*., 2019). Table 3 shows the DM levels of *C. lacryma-jobi* L. Under different doses of N fertilizer.

Table 3: Dry matter of *Coix lacryma-jobi* L.

Group	Treatment				
	T_0	T_1	T_2	T_3	T_4
	%				
1	15.580	12.120	13.630	13.650	10.720
2	10.340	14.890	12.910	11.880	14.290
3	13.840	11.400	13.880	11.810	10.870
4	13.580	14.300	14.890	13.060	14.780
Total	53.350	52.720	55.310	50.410	50.660
Average	13.340	13.180	13.830	12.600	12.670
SD	2.180	1.680	0.820	0.910	2.170

Remark: 1. T_0 = control, T_1 = fertilizer doses 150 kg/ha, T_2 = fertilizer doses 300 kg/ha, T_3 = fertilizer doses 450 kg/ha and T_4 = fertilizer doses 600 kg/ha
2. SD= Standard Deviation

Table 4: Crude fiber content of *Coix lacryma-jobi* L.

Group	Treatment				
	T_0	T_1	T_2	T_3	T_4
	%				
1	26.9700	25.4600	24.4400	24.960	27.370
2	27.7700	27.1200	25.3500	23.520	23.080
3	27.6400	23.8700	25.8400	25.560	23.890
4	26.4600	26.9500	24.5600	25.020	23.020
Total	108.8300	103.4000	100.1900	99.070	97.350
Average	27.2100	25.8500	25.0500	24.770	24.340
SD	0.6100	1.5200	0.6600	0.870	2.060

Remark: 1. T_0 = control, T_1 = fertilizer doses 150 kg/ha, T_2 = fertilizer doses 300 kg/ha, T_3 = fertilizer doses 450 kg/ha and T_4 = fertilizer doses 600 kg/ha
2. SD= Standard Deviation

The application of T_2 with N fertilizer produced the highest DM. However, the application of N fertilizer insignificantly influences DM. This is because DM contained in the grass changed with the plant age. As a plant becomes older, it contains less moisture and a higher proportion of cell walls compared to cell content, leading to an increase in DM (Seseray and Santoso, 2013).

As the plant grows older and the fertilizer level increases, it produces more DM, organic matter, and CP. Dry Matter production also increases with the plant age at cutting (Dumadi *et al*., 2021). In mature plants, the photosynthesis activity not only supports growth but also stores food services, resulting in higher DM content and production (Keraf and Mulyanti, 2017).

Crude Fiber

Crude Fiber is an organic substance that is insoluble in H_2SO_4 and 1.5 N NaOH since it is cooked successively for 30 min. The level of CF in the feed can affect its digestibility (Asyari, 2017). Table 4 shows the CF content of *C. lacryma-jobi* L. Under N fertilizer with different doses.

The application of T_0 produced the highest CF contents. The result showed that the application of N fertilizer insignificantly affects MC. Furthermore, CF is determined by the type of plant, size, age, and other factors. Crude Fiber content tends to increase with plant age (Fitriana *et al*., 2017; Dumadi *et al.*, 2021).

The plant that receives high levels of N tends to have optimum growth, resulting in higher protein and lower CF. Crude Fiber is composed of insoluble polysaccharides such as cellulose and hemicellulose, as well as lignin. Although non-ruminants cannot digest CF, it serves as a source of rumen microbial energy and stomach-filling material for ruminants (Salim *et al*., 2015).

Crude Protein

Protein is a complex organic compound with a high molecular weight. Meanwhile, CP is produced and generated from N × 6.25 with the assumption that the average protein contains 16% N. Figure 1 shows CP levels of *Coix lacryma-jobi* L. at different doses of N fertilizer.

The application of T_4 produced the highest CP. The application of different doses significantly ($p<0.05$) affects the average ash content of *Coix lacryma-jobi* L. The protein content increased with the addition of N doses. This is because the acceleration of vegetative growth such as more leaves indicates an increase in forage quality (Wulandari *et al.*, 2021).

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The provision of high N aims to trigger the development of plant leaves as it acts as a nutrient that forms amino acids and proteins (Wulandari *et al*., 2021). Furthermore, the CP content of the plant highly depends on N availability in the soil. This showed that N plays an important role in the development of a plant's chlorophyll and protein. The higher N content in the soil increases the CP of the forage because it is used for protein synthesis (Rahmawati *et al.*, 2019).

Ether Extract

Crude fat or ether extract including lipids and non-fatty substances is an organic matter that dissolves in fat solvents composed of ether, petroleum ether, and petroleum benzene. Also, it is a mixture of several compounds that dissolve in fat solvents. Figure 2 shows the EE level of *C. lacryma-jobi* L. Under different doses of N fertilizer.

The application of T0 produced the highest crude fat content of 1.66%. The application of this fertilizer at different doses failed to affect the EE contents of *C. lacryma-jobi* L. However, the sufficient availability of N in the soil can produce maximum leaves green granules, and fat. This is because the plant's fat content is closely related to the leaves' green granules. The fertility level of a plant through the assimilation process of photosynthesis and minerals is needed in metabolic reactions to the crude fat produced (Wulandari *et al*., 2021).

Ether Extract content can be affected by several factors, such as the planting distance. This is because the crude fat of a plant is inversely proportional to its moisture. As the plant becomes older, the moisture content decreases but its crude fat increase. This showed that plant age can affect its MC and DM. A young plant has active cells that carry out the process of cell division and tissue formation, while an older plant thickens cell walls, resulting in higher DM and lower MC (Fahmi *et al*., 2010).

Ash

Ash is a substance that is created when a material is burned completely at a temperature of 500-600°C. During this process, all organic compounds are converted into gases such as CO2, H2O, and others, while the remaining solid substance is known as ash. Figure 3 shows the ash level of *C. lacryma-jobi* L. under different doses of N fertilizer.

The application of T_4 produced the highest ash content. The application of this fertilizer brings about different ash content of *C. lacryma-jobi* L. Furthermore, ash is significantly ($p<0.05$) related to climate conditions during the vegetative phase and pod filling. Herdiawan *et al.* (2014) explained that trimming frequency affects the mineral concentration contained in the plant.

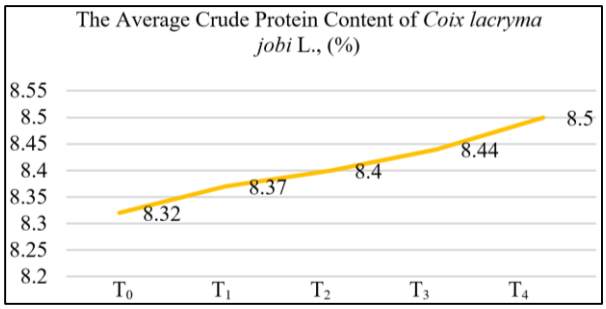

Fig. 1: Crude protein content of *Coix lacryma-jobi* L

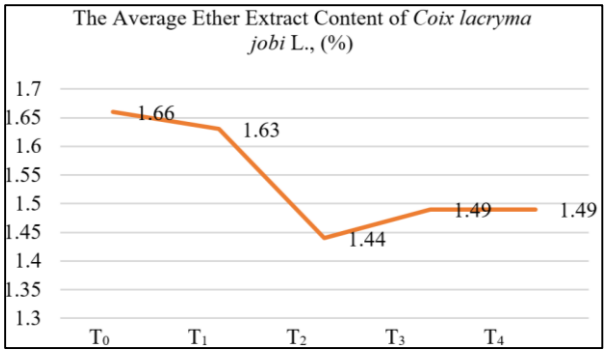

Fig. 2: Ether extract level of *Coix lacryma-jobi* L.

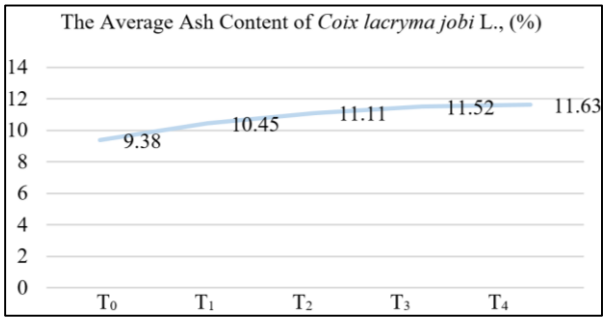

Fig. 3: The ash level of *Coix lacryma-jobi* L.

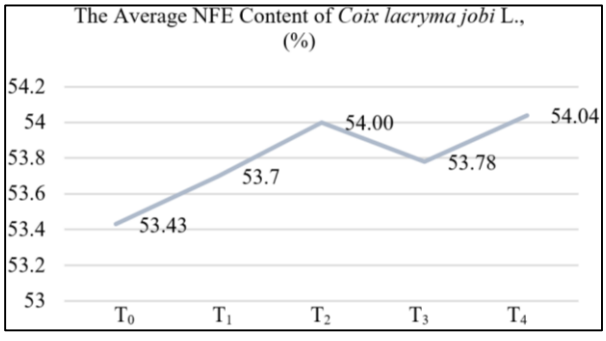

Fig. 4: Nitrogen free extract level of *Coix lacryma-jobi* L.

The high ash content in the young plant is caused by the presence of more active cells in comparison to old ones, which tend to have more dead and damaged cells. As a result, nutrients absorbed by the roots are transported to young leaves, leading to an increase in ash content. The ash content does not increase in older leaves as they experience cell death. This is because nutrients absorbed by the roots cannot be transported efficiently to the leaves (Fachrudin *et al*., 2012).

Nitrogen Free Extract (NFE)

Nitrogen free extract is obtained by reducing the DM with all components such as moisture, CF, CP, EE, and ash. Figure 4 shows the NFE level of *C. lacryma-jobi* L. under different doses of N fertilizer.

The T4 treatment resulted in the highest NFE. The application of N at different doses failed to affect the average NFE content of *C. lacryma-jobi* L. Furthermore, the NFE content changes as it ages, with young plants tending to have lower NFE. A higher portion of non-structural carbohydrates inside the plant's cell corresponds to a lower proportion of CF, which consists of structural carbohydrates (Muwakhid and Ali, 2019).

Conclusion

The application of N fertilizer at different doses (zero, 150, 300, 450, and 600 kg/ha) significantly affects DW and MC. However, it failed to positively influence DM and crude fat of *C. lacryma-jobi* L. Increasing doses of N fertilizer were found to increase CP and ash but failed to affect the crude fat and NFE. The application of N at 600 kg/ha resulted in the highest nutrient content including CF, CP, EE, Ash, and NFE.

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Author's Contributions

Taufan Purwokusumaning Daru: Assisted in the experimental design, sample analysis, data verification, justification, statistical data analysis, review, and funded contribution.

Mayang Sari: Assisted in the experimental land preparation, planted gardens, experimental land control, sample preparation, and sample collecting, as well as a tabulation of sample data.

Hamdi Mayulu: Creation of the idea, written, conceptualization of methodology, experimental design, research reporting, an article written, reviewed, and edited, as well as funded.

Ethics

This manuscript is original and contains research results that have never been published. Corresponding authors confirm that all authors have read, agree to the manuscript, and there are no ethical issues or conflicts that occurred after the manuscript was published.

Declaration of Competing Interest

The authors have no competing financial interests or personal relationships that tend to affect the work reported in this manuscript.

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