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Hematological and Clinical Effects of Jackfruit Leaf (Artocarpus heterophyllus) Extract in Javanese Thin-Tailed Sheep Infected with Haemonchus contortus

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Abstract

This study was conducted to evaluate the effect of jackfruit leaf extract on sheep in blood profile, and assessing clinical parameters.The experiment was carried out at the UGM Integrated Testing Laboratory, the Small Livestock Laboratory of the Agricultural Development Polytechnic. A Completely Randomized Design (CRD) was applied. The sample size was determined using the Federer formula: (n − 1)(t − 1) ≥ 15, where t represents the number of treatment groups and n represents the number of samples.A total of 25 female sheep were divided into five groups (five animals per group): P0 (0% dose, negative control), P1 (0.6% dose), P2 (1.2% dose), P3 (positive control treated with Albendazole), and P4 (healthy, worm-free sheep as an additional positive control).The results showed that jackfruit leaves contain total tannins of 235.6 mg/g, condensed tannins of 0.26 mg/g, saponins of 1.49 mg/g, and flavonoids of 1.53mg/g, indicating their potential as anthelmintic agents. Jackfruit leaf extract significantly increased weekly weight gain in thin-tailed sheep, significantly improved blood profile parameters, and had a significant effect on clinical indicators, including anemia status (FAMACHA© score) and dag score in sheep infected with *Haemonchus contortus*

Introduction

Indonesia's livestock sector faces growing pressure to become more competitive in the global industry. Among the various types of livestock raised in the country, including large ruminants such as beef cattle, dairy cattle, buffalo, and horses; small ruminants such as goats ans sheep, and non-ruminants such as pigs and poultry, each presents its set of challenges regarding productivity and competitiveness (Ekawasti et al., 2021). In sheep farming, success depends on combination of factors: careful selection of breeding stock, nutritious feed, proper housing, and effective disease management. Among the most persistent threats to sheep productivity is parasitic diseases, particularly gastrointestinal nematode infection.

Gastrointestinal worm infections take a serious toll on livestock health, causing weight loss, emaciation, anaemia, and stunted growth. Beyond their health impact, these infections carry significant economic consequences, including reduced productivity and mortality (Mravčáková et al., 2019). In Indonesia itself, losses due to gastrointestinal worms in goats and sheep are estimated at USD 4.7 millions. In contrast, haemonchosis (one of the most prevalent worm infections) was found 89.4% of goats across two provinces, with annual losses reaching approximately USD 1 million (Kate et al., 2016). Among the nematodes most frequently responsible for these problems in tropical small ruminants are *Haemonchus contortus*, *Trichostrongylus sp*., *Bunostomum sp*. and *Neamtodirus sp.* (Rocha et al., 2020). These parasites complete part of their life cycle inside the host's abomasum and small intestine, where adult females can produce 5,000–8,000 eggs per day (Sambodo et al., 2020) and consume up to 0.05 ml of blood per sheep daily (Ali et al., 2021). In sheep specifically, *Haemonchus contortus* infection can lead to hypoproteinemia, hypocalcemia, and hypophosphatemia, ultimately reducing carcass weight (Kate et al., 2022). Although anthelmintics drugs remain the primary control measure, their effectiveness is increasingly undermined by drug resistance (Jabar et al., 2022), prompting researchers to explore herbal

compounds as safer, low-toxicity alternatives to reduce worm infestations in livestock (Rahal et al., 2022).

One promising direction involves plants rich in tannins. Tannins have been reported to reduce worm burdens in livestock (Fereira *et al.*, 2016), with condensed tannins shown to bind to proteins in nematode cell walls, disrupting their integrity and killing the worms. Simultaneously, tannins bind plant proteins in the rumen, reducing microbial breakdown and increasing protein availability in the duodenum as an effect that strengthens the host's immune response against parasitic infection. Collectively, these properties make tannin-rich plants a compelling strategic alternative for nematode control in small ruminants (Pramu et al., 2025). In this context, jackfruit leaves (*Artocarpus heterophyllus*) have emerged as a candidate worth exploring, given their wide availability across Indonesia and their established pharmacological profile. Plant-based biological resources are used to help improve livestock growth.

Jackfruit leaves are known to possess antioxidant, antibacterial, anti-diarrheal and anti-tumor properties, and their nutrient content has shown benefits for improving livestock performance, particularly in goats, when used as primary feed. Their tannin content suggests significant potential as a natural anthelmintic agent. Therefore, this study aims to determine the effect of jackfruit leaf extract on the blood profile of Javanese thin-tailed sheep and to assess clinical parameters of thin-tailed sheep infected with gastrointestinal worms.

Materials And Methods

Materials

The research was conducted at the UGM Integrated Testing Laboratory and the Small Livestock and Animal Health Laboratory of the Yogyakarta Magelang Agricultural Development Polytechnic.The research materials include the equipment and materials used during the study. The equipment used was as follows: a camera, 3 ml syringe, microscope slide, cover slip, mortar, dropper pipette, water bath, microscope, stopwatch, counter, oven, Erlenmeyer flask, electronic balance, surgical scissors, and pipette. The materials used consisted of jackfruit leaf extract, adult *Haemonchus contortus* worms, distilled water, 0.62% NaCl, anthelmintics, 10% ethanol, 10% formalin, and female javanese thin-tailed sheep (Widiarso et al., 2024)

Methods

This study employed a completely randomised design (CRD). The sample size was determined using Federer's formula, namely $(n - 1)(t - 1) \geq 15$, where t represents the number of treatment groups and n represents the number of samples in each group (Jonghae et al., 2024) In this study, 25 female javanese thin tailed sheep were used and divided into five groups, each comprising five sheep as replicates. The groups comprised: a negative control (P0) with a 0% dose, treatment 1 (P1) with a 0.6% dose, treatment 2 (P2) with a 1.2% dose, treatment 3 (P3) as a positive control using Albendazole, and treatment 4 (P4)

as a positive control consisting of healthy, worm-free ewes. The experimental animals used were female sheep aged 6–8 months with a body weight ranging from 13–18 kg, sourced from livestock herds in Magelang Regency. Feed was provided at 10% of body weight, consisting of forage such as gliricidia, gamal leaves, turi leaves, and pasture grass, as well as supplementary feed in the form of tofu pulp or rice bran. The sheep were housed individually in battery-style pens, with pen temperatures matching room temperature. Before the treatment began, the animals underwent an adaptation period of one week

Preparation of 1% jackfruit leaf extract

The jackfruit leaf crude drug is prepared by cutting or chopping the leaves until they are finer or smaller in size. The chopped material is then weighed to the desired concentration, namely 1 gram. Next, the chopped jackfruit leaves are placed in a beaker and 100 mL of distilled water is added. The beaker containing this mixture is then heated in an oven at 90°C for 15 minutes. Once the heating process is complete, the liquid remaining in the beaker is removed and filtered to obtain a 1% jackfruit leaf extract. (Sambodo et al., 2018).

Collection of adult worms

Adult worms were obtained directly from the abomasum of naturally infected sheep slaughtered at the Slaughterhouse. The section of the abomasum bordering the rumen and duodenum was excised and tied off with string. The contents of the abomasum were carefully removed and visible parasites were collected in a container containing Phosphate Buffered Saline (PBS) or 0.62% NaCl (Kumar et al., 2020).

Cultivation of infective larvae (L3)

According to Muda et al. (2021), to obtain first-stage larvae (L1), the Baermann technique was used, employing a 6-inch diameter glass funnel positioned upright. The tip of the funnel is connected to a rubber tube; the lower third of the tube is clamped, and a collection container is placed beneath it. Ten grams of faeces containing worm eggs are wrapped in two layers of gauze and suspended at the centre of the funnel's opening. Next, the funnel is filled with water at 25°C until the entire sample is submerged. After standing for 24 hours, the clamp on the tube is released and several millilitres of fluid from the lower part of the tube are collected into the container. The fluid is left to stand for 30 minutes, then poured into a Petri dish and transferred to a microscope slide for observation under a microscope. The next step is to leave the sample at room temperature for 5 days. On the 6th day, the sides of the container are rinsed with 10 ml of distilled water to collect the larvae. Observation is carried out using a stereo microscope to identify eggs that have developed into third-stage larvae (L3) by adding a drop of Lugol's iodine solution, after which the infective larvae (L3) are collected.

Fecal egg count reduction test

In the initial stage prior to treatment, faecal samples were collected from all sheep to determine the presence or absence of worm infestation via microscopic examination. Once it was confirmed that there was no worm infestation, all groups were infected with 5,000 infective larvae (L3) orally each week for 3 weeks. In the fourth week, the EPG was counted using the McMaster method. Subsequently, from treatment 2 through to treatment 4, jackfruit leaf extract was administered daily for 2 weeks. After 4 weeks, faecal samples were collected from each treatment group to test for the presence or absence of nematode infestation in the sample animals or to calculate the EPG value for each treatment using the formula:

$$\text{FECR (\%)} = \frac{\text{EPG before treatment} - \text{EPG after treatment}}{\text{EPG before treatment}} \times 100$$

Clinical examination

This examination includes body weight measurement, examination of the conjunctiva, and the Dag Score. Body weight measurements were taken on day 0, day 7, day 14, and day 21. Observation of the colour of the conjunctiva is carried out on all livestock based on three colour categories: red (no anaemia), pale (anaemia), and white severe anaemia (Florina et al., 2023).

Research variables

The variables studied were: in vivo parameters including weekly weight gain and blood profiles; and clinical examinations including: degree of anaemia (Famacha©) and Dag score.

Data analysis

The data collected were analysed using ANOVA, followed by Duncan's Multiple Range Test (Jonghae et al., 2024).

Ethical Approval

This research ethic approved by commision ethic of animal science and veterinary on Polytechnique of Agriculture Development Yogyakarta Magelang with number : 327/ LB.040/I.9.1/01/2026

Results

1. Phytochemical content of jackfruit leaves with potential as anthelmintics

Jackfruit leaves have potential as anthelmintics due to their content of total tannins, condensed tannins, saponins and flavonoids, as shown in Table 1 below.

Table 1. Phytochemical composition of jackfruit leaves

Composition	Result
Total Tannin	235,6 mg/gram
Tannin terkondensasi	0,26 gram/kg
Saponin	1,49%b/b
Flavonoid	1,53 5b/b

Source: Results of analysis by the Integrated Research and Testing Laboratory at UGM, Yogyakarta

Table 1 shows the results of the phytochemical analysis, indicating that the high total tannin and condensed tannin content in jackfruit leaves suggests their potential as anthelmintics. This is consistent with the findings of Kumar *et al.,* (2020), who reported that a tannin content of at least 5% or 50 mg/gram confers anthelmintic properties.

2. The effect of jackfruit leaf extract (A. heterophyllus) on the blood profile of sheep after two weeks of treatment

Jackfruit leaf extract at various doses had a significant effect on white blood cell count, red blood cell count, haemoglobin level, and HCT ($P<0.05$) in the negative control group compared with groups P1, P2, P3 and P4 (Table 2).

Table 2. Blood profile of sheep after 2 weeks of treatment with jackfruit leaf extract (*Artocarpus heterophyllus*)

Blood Profile	Negative control (P0)	Jackfruit leaf extract 0,6 mg/mL (P1)	jackfruit leaf extract 1,2 mg/mL (P2)	Positive Control (P3)	Positive control(P4)
WBC ($x10^9$µl)	8,44±0,65[a]	12,98±1,94[a]	9,43±6,94[a]	15,30±4,97[a]	16,83±6,16[a]
RBC($x 10^6$)	8,75±0,49[a]	14,12±0,17[b]	14,61±0,75[b]	13,94±1,39[b]	14,75±0,58[b]
Hb (gr/dl)	9,81±0,16[a]	12,80±0,92[b]	13,03±0,32[b]	13,27±0,94[b]	13,67±0,35[b]
HCT(%)	32,09±0,73[a]	38,61±0,49[b]	37,29±2,04[b]	36,83±4,07[b]	36,74±1,54[b]

[a,b,c] Means in the same row with different superscript differ significantly ($P<0.05$)

3. The effect of jackfruit leaf extract on weekly weight gain in Javanese Thin-tailed sheep

Jackfruit leaf extract for two consecutive weeks increased the weekly weight gain in thin-tailed sheep (Table 3).

Table 3. Effect of jackfruit leaf extract administration on weekly weight gain in javanese thin-tailed sheep

Consentrationmg/mL)	Average weekly gain (gram)
P0	772,50± 33,41[a]
P1	940,00± 36,45[c]
P2	1245,75± 98,20[b]
P3	1244,50± 126,29[b]
P4	1105,00± 124,93[b]

[a, b, c:] Means in the same column with different superscript differ significantly (P<0.05)

The results of the ANOVA analysis in Table 3 and Figure 1 show that there is a significant difference (P<0.05) in the weekly weight gain of thin-tailed sheep between the control group and the groups treated with jackfruit leaf extract (P1, P2, P3, and P4). When compared withthe positive control (P3), it was also found that there was no significant difference (P > 0.05) between P2 and P3. This implies that jackfruit leaf extract possesses anthelmintic efficacy against *Haemonchus contortus* equivalent to that of chemical anthelmintics (Albendazole), meaning jackfruit leaf anthelmintics could serve as an alternative to chemical anthelmintics.

4. The effect of jackfruit leaf extract (A. heterophyllus) on the severity of anaemia after two weeks of treatment

Jackfruit leaf extract *A. heterophyllus* for two weeks was able to reduce the severity of anaemia in the conjunctiva of the eye as assessed using the FAMACHA® test.

Table 4. Effect of jackfruit leaf extract *Artocarpus heterophyllus* on the severity of anaemia in sheep after 2 weeks of treatment

Concentration (mg/ml)	Degree of anemia Week 0	Degree of anemia Week 2
P0	4,20 ±0,45[a]	4,60 ±0,55[a]
P1	4,20±0,45[a]	3,20 ±0,45[b]
P2	3,6±0,55[a]	2,6±0,55[c]
P3	4,40 ±0,55[a]	2,6±0,89[c]
P4	4,50±0,55	3,20±0,55[b]

Note: 1–5 (1 best; 5 worst). Means in the same column with different superscript differ significantly (P<0.05)

After two weeks of treatment, Jackfruit leaf extract reduced the severity of anemia on the conjunctiva of the eye as assessed through the FAMACHA® test (Table 4).

The results of the ANOVA analysis in Table 4 and Figure 2 revealed that there is a significant difference (P<0.05) on the severity of anaemia of thin-tailed sheep between the control group and the groups treated with jackfruit leaf extract (P1, P2, P3, and P4).

5. The effect of jackfruit leaf extract (A. heterophyllus) on the Dag score after two weeks of treatment

Two weeks after administration of jackfruit leaf extract (*A. heterophyllus*), a change in the severity of anaemia was observed, which typically becomes apparent when the *Haemonchus contortus* burden is significantly reduced.

Table 5. Effect of jackfruit leaf extract (*A. heterophyllus*) on the Dag score of thin-tailed sheep after 2 weeks of treatment

Two weeks after administration of jackfruit leaf extract (*A. heterophyllus*), a change in the severity of anaemia was observed, which typically becomes apparent when the *Haemonchus contortus* burden is significantly reduced (Table 5).

Concentration (mg/ml)	Dag score Week 0	Dag score week 2	Decrease dag score
P0	2,40 ±0,55[a]	3,00 ±0,00[a]	-0,60[a]
P1	2,40±0,55[a]	1,60 ±0,55[b]	0,80[b]
P2	2,20±0,45[a]	1,4±0,55[c]	0,80[b]
P3	2,60 ±0,55[a]	1,2±0,45[c]	1,4[c]
P4	2,40±0,55	1,40±0,55[b]	1[c]

Note: 0–4 (0 best; 4 worst). Means in the same column with different superscript differ significantly (P<0.05)

The results of the ANOVA analysis in Table 5 and Figure 3 revealed that there is a significant difference (P<0.05) on the dag score of thin-tailed sheep between the control group and the groups treated with jackfruit leaf extract (P1, P2, P3, and P4).

The results of the ANOVA analysis in Table 5, Figure 1, and figure 4 revealed that there is a significant difference (P<0.05). The dag score typically uses a 0 **to 5 visual scale:**

Score 0-1 indicated that Clean breech, with little to no faecal soiling. **Score 2 or 3:** showed that Moderate faecal accumulation around the crutch and tail. **Score 4 or 5 revealed that h**eavy accumulation, with dags covering the tail, under the crutch, and running down the legs.(Pickering et al., 2013)

Discussion

1. Phytochemical content of jackfruit leaves with potential as anthelmintics

The phytochemical profile of jackfruit leaves supports their use as a natural anthelmintics. Sreeja Devi *et al.* (2021) reported that anthelmintic agents can inhibit nematode larval development, reduce adult worm populations, impair reproductive capacity, and decrease egg output in feces. The condensed tannin content of 0.26 grams/kg places jackfruit leaves in the “low” category, defined as the content of 2.5–10.0 grams/kg. Meanwhile, it is defined as detected if the content is between 0.2–2.5 g/kg, and as moderate between 10.0–50.0 g/kg (Kumar *et al.,* 2020). While this level is relatively low, it remains biologically significant. Condensed tannins at levels below 50 mg/kg body weight in feed have been shown to exert anthelmintic effects by binding to nematode cell walls, thereby inactivating and killing the parasites (Sahu *et al.,* 2025). Amarowicz *et al*. (2024) further noted that excessively high condensed tannin levels, exceeding 55 grams/kg dry matter, can reduce feed intake and digestibility, suggesting that the levels found in the jackfruit leaves can reduce daily weight gain in goats

2. The effect of jackfruit leaf extract (A. heterophyllus) on the blood profile of sheep after two weeks of treatment

The blood profile results indicate that jackfruit leaves can restore hematological parameters to within normal reference ranges. According to Aziz *et al.* (2022), the blood profiles of the control group (Group A) and the infected group (Group B) on day 18 post-infection showed PCV values of at 31.5% and 15.34%, respectively. By day 28 post-infection, Group A recorded 30.75% and Group B 10.32%, reflecting a progressive decline in total red blood cells (RBC), hematocrit (PCV), and hemoglobin (Hb) in the infected groups.

The normal hemoglobin level for female goats/sheep is 9 to 15 g/dl (Widiarso *et al*., 2024), and the normalization of hemoglobin across all treatment doses reflects the extract's anthelmintic action. It aligns with Widiarso *et al*. (2024), who reported that jackfruit leaf extract at a dose of 0.18 mg/ml increased Hb from 6.67 to 11 g/dl, and restored Hb levels to normal (169.67 vs 8.77) at a dose of 0.12 and at a dose of 0.18 (211.33 vs 8.77).

Blood loss caused by *Haemonchus contortus* infection is the primary driver of anemia in sheep, with adult worms capable of consuming up to 0.05 ml of blood per worm per day (Flay *et al.,* 2022). Blood loss of 5–50 mL per day can produce clinical signs such as pale mucous membranes and anorexia. In the jackfruit leaf extract treatment at a dose of 0.6%, hemoglobin levels increased from 9.81 to 12.80. The normal red blood cell count in sheep is 8–12 ($\times 10^{12}$/L), and treatment with jackfruit leaf extract normalized red blood cell counts to 13–14 ($\times 10^{12}$/L). This blood loss leads to a corresponding decrease in red blood cell count, PCV, and hemoglobin levels (Widiarso et al., 2024). The ability of jackfruit leaf extract to normalize these parameters suggests that its tannin content effectively reduces worm burden, thereby limiting blood loss and supporting hematological recovery.

The effect of the extract on white blood cell counts is also noteworthy. The white blood cell count in sheep is 4–12 $\times 10^{9}$/L (Widiarso *et al.,* 2024), and counts in both the negative control and treatment groups fell within this range. Treatment with jackfruit leaf extract resulted in increased white blood cell counts after two weeks (Widiarso *et al.,* 2018), reaching 12.93 $\times 10^{9}$/L (P1), 9.43 $\times 10^{9}$/L (P2), and 15.30 $\times 10^{9}$/L (P3). According to Aziz *et al*. (2022), goats infected with *H. contortus* showed lower white blood cell counts than uninfected ones, while treatment led to significant increases in lymphocytes, monocytes, neutrophils, and eosinophils, all of which are closely associated with the host's immune defense mechanisms. The normalization of white blood cell counts in the treated groups is therefore consistent with reduced parasitic load and an improved immune response.

Regarding hematocrit, the normal range in sheep is 26–40%. All treatment groups receiving jackfruit leaf extract showed significant differences ($P<0.05$) compared with the negative control and fell within the normal range, with the PVC value in P0 recording the lowest at 32.08%. In comparison, the other treatment groups ranged from 36.74% to 38.61%. It indicates that the tannin component in jackfruit leaf extract is capable of killing *Haemonchus contortus* worms by preventing nematode worm larvae development, reducing adult worm populations, and impairing reproductive capacity (Sambodo *et al.,*

2020). Pramu *et al.* (2025) also noted that tannins reduce protein-binding complexes, forming bonds strong enough to resist cellular digestion, which underlies their classification as antinutrients with anthelmintic potential.

3. The effect of jackfruit leaf extract on the clinical effects of Javanese thin-tailed sheep

The ANOVA results in Table 3 show a significant difference ($P<0.05$) in weekly weight gain between the control group and the treated groups. No significant difference ($P > 0.05$) was found between P2 and the positive control (P3), indicating that jackfruit leaf extract possesses anthelmintic efficacy against *Haemonchus contortus* worms equivalent to that of Albendazole. The significant increase in weekly weight gain in treated groups can be attributed to a reduction in fecal worm egg output from 4,680 to 200 at a dose of 1.2 %, accompanied by a decrease in adult worm burden in the digestive tract. As anemia was progressively reduced over a two-week treatment period, nutrient circulation and absorption improved, contributing to weight recovery. It aligns with Flay *et al.* (2022), who found that caged sheep experiencing blood and plasma protein loss due to parasitic infection show stunted weight gain. These findings suggest that jackfruit leaf extract may serve as a viable natural alternative to chemical anthelmintics.

4. The effect of jackfruit leaf extract (A. heterophyllus) on the severity of anemia

The reduction in FAMACHA scores following treatment reflects a decrease in hemorrhagic anemia, hypoproteinaemia, and edema caused by L4-stage larvae and adult *H. contortus* worms. Two weeks after administration of jackfruit leaf extract *(A. heterophyllus*), a change in the severity of anemia typically becomes apparent when the *Haemonchus contortus* burden is significantly reduced. A 2–5% increase in PCV is expected by the second week, with clinical signs of anemia (e.g., pale mucous membranes) beginning to improve. As worm burden decreased, erythrocyte regeneration improved due to reduced blood loss, supported by tannins' role in enhancing protein utilization efficiency and promoting erythropoiesis, thereby improving hematological status (Florina *et al.,* 2023). As an ovicidal therapy, jackfruit leaf extract reduces the population of newly hatched larvae, leading to gradual improvements in PCV rather than immediate ones. The most significant clinical improvements are typically observed in the third to fourth weeks of treatment (Sahu *et al.,* 2025), suggesting that a longer observation period may yield even more pronounced results.

5. The effect of jackfruit leaf extract (A. heterophyllus) on the Dag score

While *Haemonchuscontortus* does not cause severe diarrhea as *Trichostrongylus* or *Cooperia* do, parasitic stress combined with feed factors can lead to mild fecal soiling. The reduction in the Dag Score to 0–1 (drier, cleaner) following a two-week treatment, along with improved solid/compact fecal consistency and feed intake, reflects more efficient intestinal function as parasite burden declined. Moderate tannin doses have also been shown to stabilize the rumen microbiota, thereby reducing excessive fermentation that can trigger mild diarrhea (Kumar *et al.,* 2020). Collectively, the improvements

in the Dag score align with the broader recovery observed across all clinical and hematological parameters in this study.

Conclusion

Jackfruit leaves contain 235.6 mg/g of total tannins, 0.26 g/kg of condensed tannins, 1.49% (w/w) of saponins, and 1.53% (w/w) of flavonoids, confirming their potential as anthelmintic agents. Jackfruit leaf extract had a significant effect ($P<0.05$) on blood profile parameters, namely red blood cell count, hemoglobin (Hb) level, and hematocrit (HCT), in thin-tailed sheep infected with *Haemonchus contortus* in vivo. It also significantly improved clinical parameters, including weekly weight gain, anemia severity (FAMACHA©), and the Dag score. These findings suggest that jackfruit leaf extract at a 1.2% dose possesses anthelmintic efficacy equivalent to that of Albendazole and may serve as a viable natural alternative to chemical anthelmintics.

Declarations

Data availability. The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ethical approval. This study was approved by the Animal Ethics Committee (CEUA) of the Polytechnique of Agriculture Development Yogyakarta-Magelang under protocol number 327/ LB.040/I.9.1/01/2026

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Conflict of Interest. The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper."

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Figures

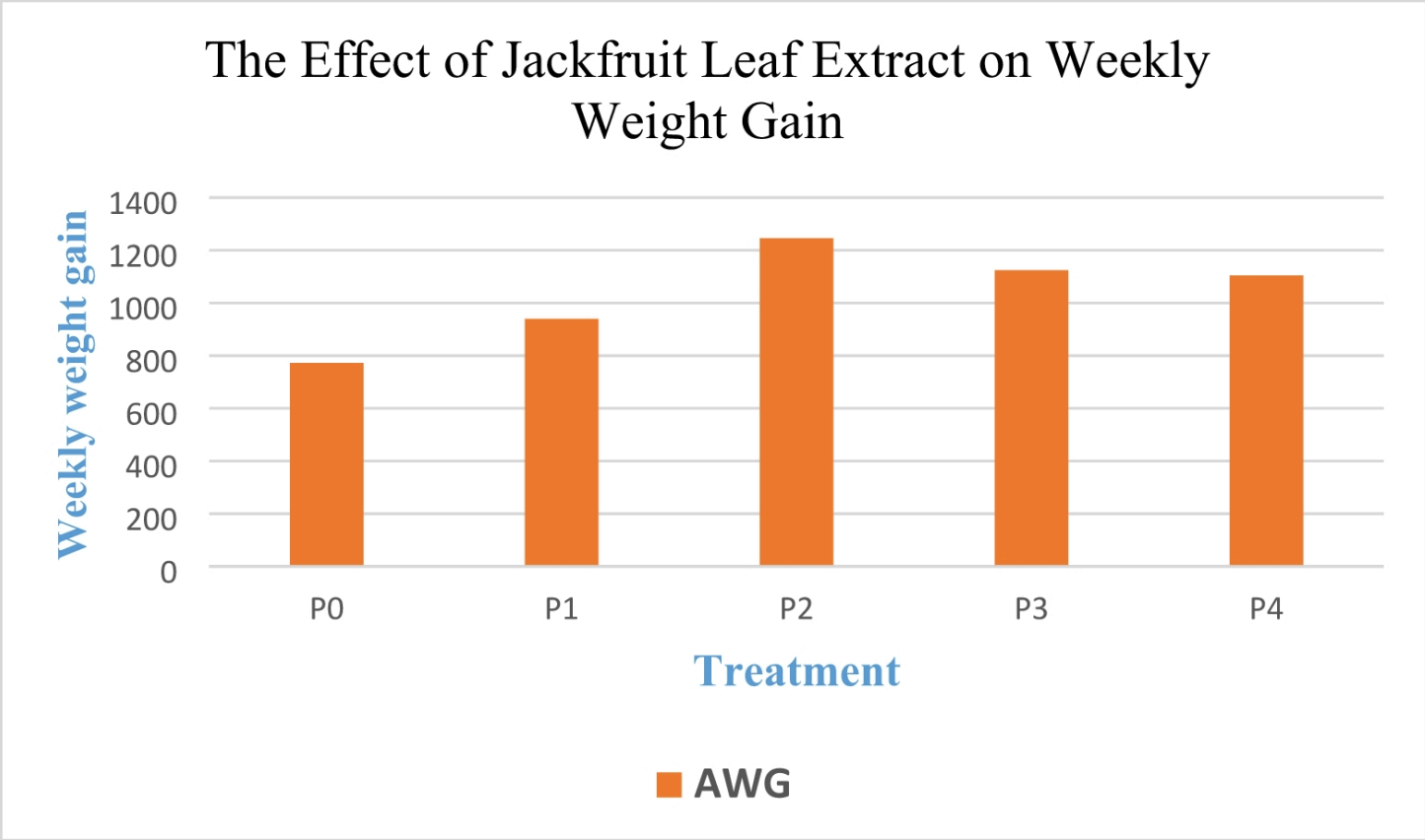


Figure 1

The effect of jackfruit leaf extract on weekly weight gain

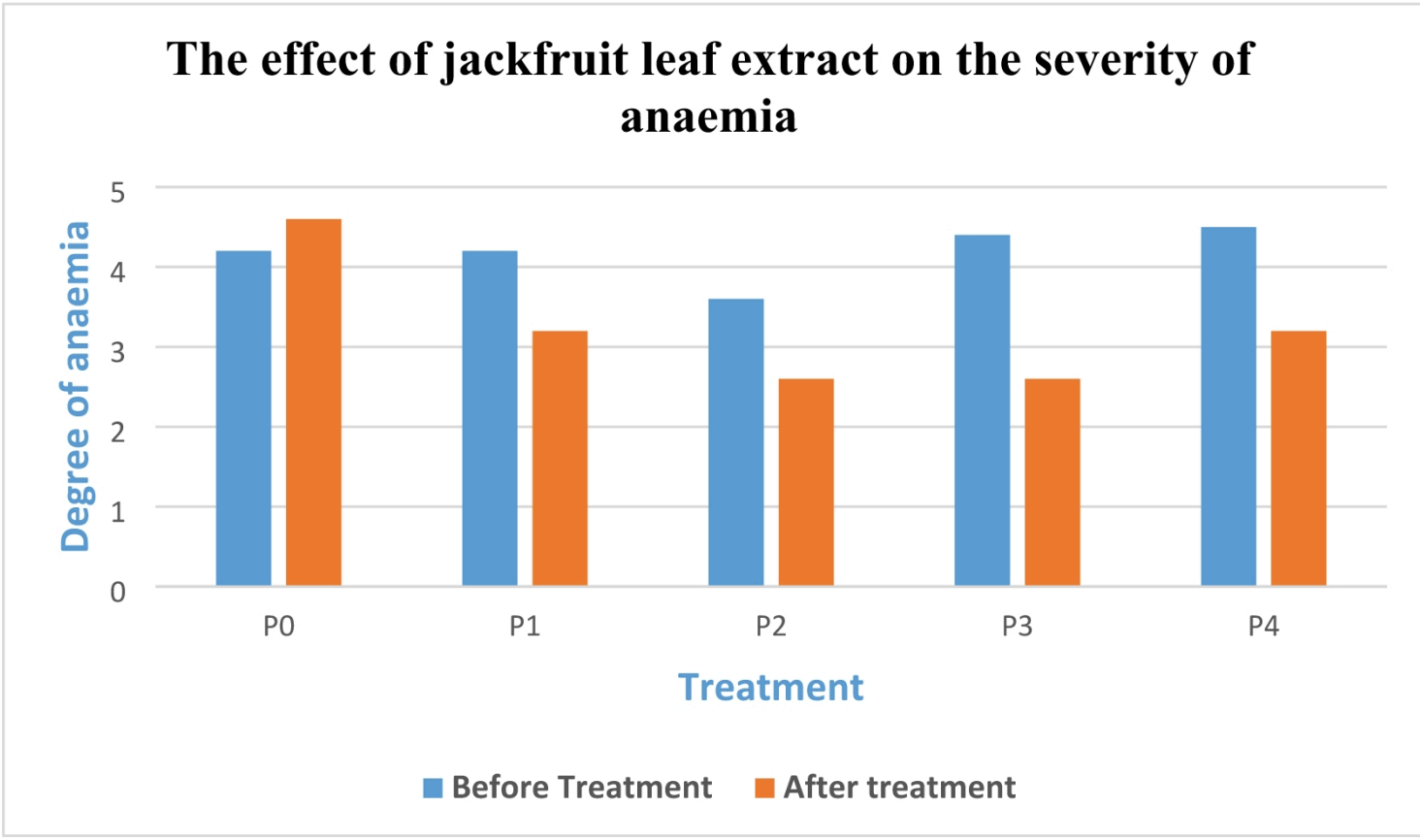


Figure 2

Effect of jackfruit leaf extract *Artocarpus heterophyllus* on the severity of anaemia in sheep after 2 weeks of treatment

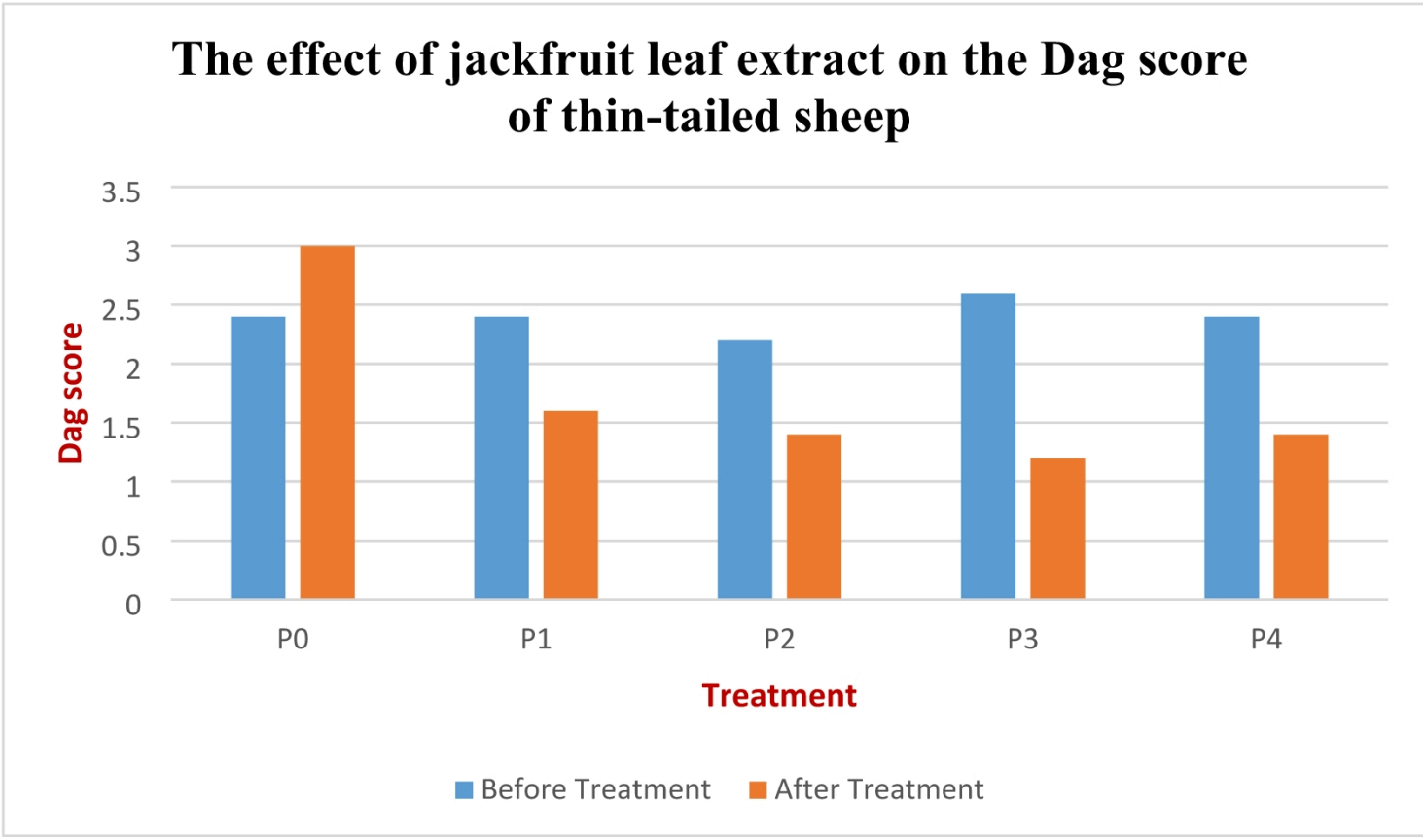


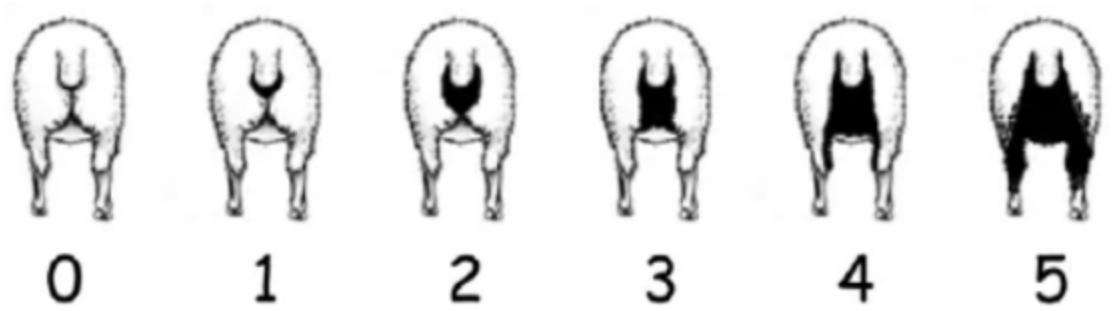
Figure 3

The effect of jackfruit leaf extract on the dag score of thin tailed sheep



Figure 4

Dag score sheep



Scoring system for dag score (0 = no dags, 5 = complete dags over the tail, under the crutch and down the legs), courtesy of Sheep Improvement Limited (www.sil.co.nz).

Figure 5

Legend not included with this version