Buletin Peternakan 49 (1): 349-357, February 2025

ISSTAP
Indonesian Society for Sustainable Tropical Animal Production

Bulletin of Animal Science

ISSN-0126-4400/E-ISSN-2407-876X Accredited: 36a/E/KPT/2016
http://buletinpeternakan.fapet.ugm.ac.id/

Doi: 10.21059/buletinpeternak.v%vi%i.100294

Potential of Goletrak Grass *(Borreria alata)* as Suplementation on Hay Multinutrient Waffle and Its Nutrition Value to Improve Growth Performance in Rabbit *(Oryctolagus cuniculus)*

Okti Widayati[1]*, Bangkit Lutfiaji Syaefullah[1], Gallusia Marhaeny Nur Isty[1], Hendra Nur Cahyo[2]

[1]Department of Animal Husbandry Extension and Animal Welfare, Politeknik Pembangunan Pertanian Manokwari, Manokwari 98312, West Papua, 98312.
[2]Institute of Animal and Aquacultural Sciences, Norwegian University of Life Sciences (NMBU), Aas, Norway.

Article history
Submitted: 30 September 2024
Accepted: 12 December 2024

* Corresponding author:
E-mail: widayatiokti@gmail.com

ABSTRACT

The aim of this study was to determine the effects of goletrak grass (*Borreria alata*) as suplementation in hay multinutrient waffle on the growth performance in rabbit (*Oryctolagus cuniculus*). The experiment was carried out in 2 stages consisting of hay multinutrient waffle (HMW) production and feeding application in rabbit. The HMW was produced in three formulations: H1 was used 5% *Boreria alata*; H2 10% *Boreria alata*; and H315% *Boreria alata*. Physical and chemical assessment of HMW were performed to evaluate the feed quality prior to feeding application. A total of 18 local rabbit males (*Oryctolagus cuniculus*) were assigned to 6 dietary treatments, 3 animals each, consisted: T01 = 100% benggala grass; T02 = 60% commercial pellet + 40% benggala grass; T1 = 60% commercial pellet + 40 % HMW; T2 = 40% commercial pellet + 60 % HMW; T3 = 20% commercial pellet + 80 % HMW; and T4 = 100 % HMW. The addition of goletrak grass (*Boreria alata*) had no significant effect (p>0.05) on physical propertiesincluding colours, texture, aroma, hardness, and durability index. However, significant effects (p<0.05) were observed on the chemical quality such as fat and nitrogen free extract. The effect of HMW feeding had significant effects (p<0.05) on feed conversion ratio (FCR), body weight gain and average daily gain (ADG), but it had no significant effect (p>0.05) on feed consumption. In conclusion, 15% inclusion of *Boreria alata* into HMW formulation, with 40% HMW in the diet, resulted in improved FCR, along with increased total weight gain and ADG. These findings suggest a beneficial impact of *Boreria alata* inclusion of performance and feed efficiency in rabbit.

Keywords: *Boreria alata, Goletrak grass, Hay multinutrient waffle, Rabbit*

Introduction

Rabbit farming is an option to be widely cultivated, because the price of rabbits is much cheaper compared to other livestocks such as goats, sheep, and cows. In addition, the feed does not compete with humans or with other livestock industries because rabbits have a high efficiency in the use of forage feed. Utilizing the potential of local feed supplies, rabbits' adaptability to diverse types of feed makes it easier to keep them in a variety of settings. Feed greatly aids animal growth; providing high-quality feed ensures healthy animal growth.

Climate is one of the factors that affect plant growth and production. Fluctuations in ENSO (*El Niño-Southern Oscillation*) in the Pacific Ocean are closely related to rainfall in Indonesia (Hendon, 2003; Aldrian and Susanto, 2003). ENSO conditions, either El Nino or La Nina, cause an increase or decrease in rainfall in Indonesia which has an impact on the longer or shorter dry season (Bell *et al*., 1999; Hendon, 2003; Tjasyono *et al*., 2010; As-syakur, 2010). The El Nino and La Nina phenomena affect the productivity and quality of plants (Irawan, 2006), including animal feed crops. On the other hand, a decrease in the amount of land for planting feed crops due to land conversion, a lack of attention from farmers to provide quality feed for their livestock, and a lack of information related to the importance of feed quality to livestock productivity also affect the availability of quality animal feed crops.

Borreria alata is an invasive weed found in oil palm fields that is a member of the *Rubiaceae* family (Motmainna *et al*., 2021). This plant is commonly found in tropical and subtropical regions of Asia, Europe, Africa, and America (To and Nguyen, 2016). Synonyms for *Borreria alata* include *Borreria latifoila*, *Borreria scaberrima Bold*, and *Spermacoce latifolia Aubl* (Conserva and Ferreira, 2012). The chemical composition of *Borreria alata* consists of 14,22% dry matter, 29,45% crude protein, 28,44% crude fiber, 2,16%

extract ether, 8,43% ash, and 48,52% total phenolic compound (Abbood *et al*., 2017). Previous research was conducted by Abbood *et al*. (2017) on the use of *Borreria alata* as a dietary supplement for chicken feed can improve meat quality. Another research conducted by Definiati *et al*. (2023) is about the use of coffee field weeds (*Boreria alata*) as a source of ruminant feed. According to previous study, their chemical composition and the abundance of *Borreria alata*, these weeds could be utilized as a source of forage for animal feed, especially in this study as rabbit feed.

Many researchers have conducted research aimed at improving feed quality with low-quality forage raw materials. Some of these solutions are the application of ammonia, silage (fermentation), and hay (preservation with reduced moisture content) (Kabeakan *et al*., 2020; Malalantang *et al*., 2023; Hasanah and Basriwijaya, 2023; Syaiful *et al*., 2020). One of the technologies selected is hay since it may change to a number of supporting circumstances. The first is that because most farmers rear their cattle on a large scale, they do not have dedicated acreage for cultivating forage. As a result, the cattle consume grass whose feed quality is not taken into account (Syaefullah *et al*., 2023). Second, in order to obtain high-quality feed, effective feed management is required because West Papua's harsh weather can result in insufficient feed availability. Third, additional feed for livestock, such as pellet feed and factory-made concentrates, has a very expensive price because there are no feed factories in West Papua, so the feed is imported from outside the island, which requires a large cost. Consequently, hay emerges as a cost-effective feed preservation alternative. The aim of this study was to determine the effects of goletrak grass (*Borreria alata*) as suplementation in hay multinutrient waffle on the growth performance in rabbit. In this study, researchers will make hay with ingredients from agricultural waste. Researchers will not only ensure feed availability during the dry season, but also enhance the growth of rabbit livestock by incorporating nutrients into the hay.

Materials and Methods

The research was conducted at Campus II Anday West Papua and the Pangkep State Polytechnic Laboratory in West Sulawesi from March to July 2024. The research was carried out in 2 stages consisting of the stage of making hay multinutrient waffle (HMW) and the stage of applying feed to rabbit.

Production and analysis Hay Multinutrient Waffle

The ingredients used to produce HMW include peanut straw, corn fooder, leucaena (*Leucaena leucocepala*), gliricidia (*Gliricidia sepium*), that was gathered from Teaching Farm (TEFA) Politeknik Pembangunan Pertanian Manokwari, Manokwari Regency, West Papua. The other inggredients were Oil Palm Empty Bunches (TKKS), sago pomace, goletrak grass (*Borreria alata*), and rabbit super minerals (Fortimax, Anugrah Jaya Satwa, Pasuruan) was gathered from Mokwam, Masni Distric, Manokwari Regency, West Papua.The production of HMW was based on the following feed formulation were H1 was formulated 5% *Boreria alata*, H2 10% *Boreria alata*, and H3 15% *Boreria alata*. We adjusted the composition of other ingredients to obtain a feed formulation with a crude protein content of about 16% (Table 1).

Table 1. Formulation and composition of hay multinutrient waffle (% DM)

Ingredients	**H1**	**H2**	**H3**
Peanut straw	30	29	26
Corn fooder	4.9	4.9	4.9
Oil Palm Empty Bunches	1	1	1
Sago pomace	5	5	5
Lamtoro (*Leucaena leucocepala*)	27	25	24
Gliricidia sepium	27	25	24
Boreria alata	5	10	15
Rabbit super minerals	0.1	0.1	0.1
Total	100	100	100
Nutrient composition			
Dry matter	62.17	62.62	64.93
Crude Protein	16.64	16.57	16.73
Crude Fiber	23.37	23.17	22.69
Crude Fat	5.36	5.20	5.12

Sources : Widayati *et al*., (2023); Wea *et al*., (2022); Dewanti, (2018); Praevia & Widayat, (2022); McDonald *et al*., (2011); Mucra *et al*., (2020); Eniolorunda (2011); Lestari *et al*., (2005); Widayanti (2008).

The HMW quality assessments included physical and chemical quality tests. Chemical quality included dry matter, ash, crude protein, crude fat, crude fiber, and nitrogen free extract. Physical quality included hardness level, durability index, and organoleptic (color, texture, and aroma) tests. The durability index was calculated using the following formula (Ismi *et al.,* 2017):

$$\text{Durability index (\%)} = \frac{W2}{W1} \times 100\%$$

Where W1 was hay weight after storage (g), and W2 was hay weight before storage (g). Organoleptic were an assessment of the color, texture, and aroma of hay. An organoleptic test was conducted with 20 moderately trained panelists to compare the color, texture, and aroma of hay (Fathia, 2016; Handayani *et al*., 2019). The organoleptic test assessment had a score of 1 to 4 for observing color, texture, and aroma quality (Table 2). The HMW formulations that have been selected based on physical and chemical quality were used to feed treatment for rabbit maintenance.

Table 2. Organoleptic test scoring

Indicators	Criteria	Score[1]
Colours	Bright brown	4
	Dark brown	3
	Dull Blackish brown	2
	Dull approaching gray	1
Texture	Very smooth	4
	Smooth	3
	Grainy	2
	Very rough	1
Aroma	Leaf Smell	4
	Less fishy	3
	Fishy	2
	Very fishy	1

[1]The lower the hay score, the lower the quality of the Hay Multinutrient Waffle

Feeding trial on rabbit

A total of 18 local rabbit male (*Oryctolagus cuniculus*) were used in the study for 28 d of rearing. Rabbits were assigned to 6 dietary treatments including; T01 = 100% benggala grass; T02 = 60% commercial pellet + 40% benggala grass; T1 = 60% commercial pellet + 40 % HMW; T2 = 40% commercial pellet + 60 % HMW; T3 = 20% commercial pellet + 80 % HMW; and T4 = 100 % HMW. Commercial pellet (Animax Rabbit, PT Superindo Jaya Makmur) contained 15% crude protein, 8% water content, 14% crude fiber, 14% ash, 2% crude fat, 0.8% Ca, and 2400 Kcal/kg of ME.

Rabbits were kept in individual pen with a size of 50 × 60 cm. The pen was sanitized and fumigated 2 wk prior to the start of the experiment. Feed was given every morning and afternoon at 06.00 am and 06.00 pm, respectively. Animals had free access to drinking water the whole experiment. Daily feed intake was recorded from the start of feed treatment from d 1 to 28 d. Feed intake was calculated from the difference between the feed given and the rest of the feed, and the feed that has fallen. Feed intake sample was taken every morning and afternoon before feeding time. Feed intake per day was a total of morning feed intake and afternoon feed intake. Body weight was measured twice on days 1 and 28 on a digital scale (the "Camry" brand with a capacity of 5 kg with a precision of 1).

Statistical analysis

The data of hay chemical quality were subjected to analysis of variance from a one-way randomized design with the SPSS version 26 (Company invented the app, Country). The organoleptic data were analyzed using Kruskal Wallis. Significancy was stated if $p<0.05$, or tendency. The data of rabbit growth were analyzed using Covarian Analysis. Any significant differences among treatments were further tested using Duncan's Multiple Range Test for hay quality and Dunnet test for rabbit growth (Gomez and Gómez, 1976).

Results and Discussion

Physical quality of hay multinutrient waffle

The effects of the addition of goletrak grass (*Boreria alata*) on physical quality of hay multinutrient waffle is shown in Table 3. We observed that the inclusion of goletrak grass (*Boreria alata*) within the range of 5-15% in HMW formulation had no significant effect (P>0.05) on colours, texture, aroma, hardness, and durability index. Hay colour is determined from the ingredients that make up hay (Ratnani *et al*., 2009). In the current study, the colour of HMW between H1 (5% *Boreria alata*), H2 (10% *Boreria alata*) and H3 (15% *Boreria alata*) are visually similar because the ingredients that make up hay used in the hay composition are relatively the same (brownish-green colour). Color plays an important role in choosing a product. A good product color is one that is not much different from the original material (Utami *et al*., 2014). Hay that is well dried will cause a color that is still green. Plants that undergo a lot of changes are plants that are dried by drying in the sun and often have poor results. For the drying method of hay by drying in the sun, it takes 1-2 d, while with the artificial method (oven) the temperature used is 60°C for 24 h. Poor quality hay is the one that has a blackish-green color (Susila, 2015).

Table 3. Physical quality of hay multinutrient waffle

Treatment	H1	H2	H3	*p-value*
Colours[ns]	3.00±0.23	3.00±0.24	3.20±0.21	*0.54*
Texture[ns]	2.40±0.18	2.10±0.19	2.55±0.17	*0.14*
Aroma[ns]	3.85±0.08	3.50±0.14	3.40±0.19	*0.09*
Hardness (kg/m^3) [ns]	14.20±1.59	10.60±1.62	11.30±1.57	*0.15*
Durability index (%)[ns]	90.95±0.91	92.46±0.89	91.46±1.73	0.30

Description: H1 (5% *Boreria alata*), H2 (10% *Boreria alata*), and H3 (15% *Boreria alata*).

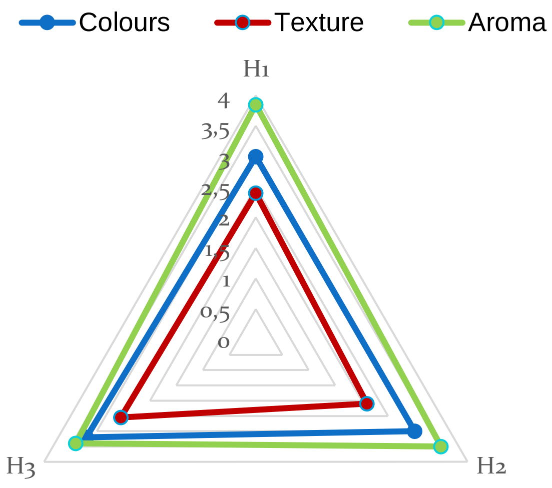

Figure 1. Spider web diagram of hay multinutrient waffle organoleptic assessment with formulation H1 (5% *Boreria alata*), H2 (10% *Boreria alata*), and H3 (15% *Boreria alata*)

The texture indicator between H1 (5% *Boreria alata*), H2 (10% *Boreria alata*) and H3 (15% *Boreria alata*) showed similar texture, which is rough. The process of making HMW is to cut into pieces that are slightly large and not uniform so that the texture of the resulting hay is rough. Wahyudi *et al*. (2020), stated that HMW which has a high density will provide a dense and hard texture so that it is easy to handle both storage and shocks during transportation and is expected to take longer in storage. The factors that cause the harshness of the hay texture are the presence or absence of adhesives, cavities in the hay, and the type of plant fiber (Aslamyah and Karim, 2012; Ismi *et al*., 2017). Meanwhile, Krisnan and Ginting (2009) reported that the compact texture of the feed can withstand the pressing process so that the bonds between the particles that make up the feed become very strong and the space between the particles of the material is not filled with air cavities.

The aroma of HMW for H1 (5% *Boreria alata*) , H2 (10% *Boreria alata*) and H3 (15% *Boreria alata*) have a rather musty aroma. Aroma is one of the physical quality testers of feed that can be used as a guideline in determining the quality of feed products before and after storage (Miftahudin, 2015; Solihin *et al*., 2015). Hay with good quality has a fresh aroma that resembles hay raw materials without a musty or pungent smell (Seto, 2019). Unwanted aroma changes can be caused by disruptive microorganisms that produce unpleasant odors. Microorganisms that play a role include bacteria and fungi (Zuhra, 2006).

In addition to being determined not only from the organoleptic test, the physical quality of the HMW can also be observed from its durability index and hardness level. The results showed that the quality of hay multinutrient waffle with various compositions for rabbit feed had no real effect on its hardness level and durability index (Table 3). The hardness can be affected by differences in formulation, pressing process, uneven distribution of materials during printing and conditioning process (Miasari, 2004). The compaction process during printing or hay multinutrient waffle also affects the decrease in volume and increase in density (Verma *et al*., 1996). High density values are more advantageous in storage because they do not require a lot of storage space (Ratnani *et al*., 2009). The low level of hardness or hay multinutrient waffle has a consistency that is easily brittle, which affects the shape and storage process. Meanwhile, in hay multinutrient waffles with high density (too dense) can make it difficult for livestock to eat them (Jayusmar *et al*., 2002).

Durability index were carried out to determine whether the hay multinutrient waffle produced can withstand impact, shock, friction and drops during the storage and distribution process. A good hay is one that is dense, strong and not easily brittle. In this study, H2 had the highest durability index (92.46±0.89%) because H2 had a low weight loss during 8 wk of storage. McEllhiney (1994) stated that the factors affecting durability are the characteristics of raw materials, texture, and water, as well as the stability of material characteristics and particle size. Tight waffles have a high durability index and will be resistant to friction and impact so that the higher the durability index of the waffle, the easier it will be in the handling process during storage or transportation (Munasik *et al*., 2013).

Chemical quality of hay multinutrient waffle

The effect of the addition of goletrak grass (*Boreria alata*) on chemical quality of hay multinutrient waffle is shown in Table 4. In our study, inclusion of *Boreria alata* had significant effect ($p<0.05$) on fat and nitrogen free extract, but it had no significant effect ($p>0.05$) on dry matter, ash, fiber, and protein content. The standard chemical content in making hay for rabbit feed includes minimum water content of 15-20% or a dry matter content of 80% (Subekti, 2009), ash content of less than 15% (Fadhilah *et al*., 2022), fat content ranging from 3-5%, fiber content ranging from 12-16% (Lebas, 1983), and protein content from 14-18% (Aritonang *et al*., 2004). Based on the content of dry ingredients, ash, fat, fiber and protein (Table 4), the manufacture of hay multinutrient waffle has met the hay standards for rabbit feed. Excessive moisture content will shorten the shelf life of hay. Dry materials mostly consist of organic matter which includes protein, fat, crude fiber and nitrogen free extract, all of which are able to produce energy that is beneficial to the livestock (Parakkasi, 1995). The difference in crude fat content in H1, H2 and H3 was suspected to be due to the difference in formulation in peanut straw, lamtoro and gamal which have a high crude fat content. Peanut straw, lamtoro and gamal contain fat of 2.20%, 11.68%, and 4.43% (Rayani *et al*., 2021; Sona *et al*., 2023; Sulastri, 1984), respectively.

Table 4. Chemical composition (% of DM, unless otherwise stated) of hay multinutrient waffle (HMW) with different level of *Boreria alata* inclusion

Item (%)	H1	H2	H3	*p-value*
Dry matter (% of fresh matter)	84.52±0.86	82.63±0.87	82.42±0.35	*0.14*
Ash	6.71±0.63	6.32±0.01	5.25±0.91	*0.29*
Crude Fat	7.73±0.26^{b}	7.24±0.24^{b}	5.21±0.47^{a}	*0.01*
Crude Fiber	15.92±0.42	15.75±0.14	16.86±0.64	*0.22*
Crude Protein	19.60±1.17	18.11±0.48	17.49±0.23	*0.17*
Nitrogen Free Extract	50.04±1.77^{a}	52.59±0.57^{ab}	55.21±1.11^{b}	*0.05*

^{a,b} Different letters in the same rows indicates significant ($p<0.05$)
Description: H1 (5% *Boreria alata*), H2 (10% *Boreria alata*), and H3 (15% *Boreria alata*)

Table 5. Dietary formulation and chemical composition of treatment diet

	Treatment					
Ingredients (%)	T01	T02	T1	T2	T3	T4
Pellet Animax	0	60	60	40	20	0
Benggala grass (*Panicum maximum cv. Jacq*)	100	40	0	0	0	0
Hay Multinutrient Waffle (HMW)	0	0	40	60	80	100
Total	100	100	100	100	100	100
Nutrient composition (%)						
Dry matter	20	60.80	85.77	84.66	83.54	82.43
Ash	3.10	9.64	10.50	8.75	7.00	5.25
Crude Fat	0.50	1.40	3.28	3.93	4.57	5.21
Crude Fiber	6.10	10.84	15.14	15.72	16.29	16.86
Crude Protein	2.60	10.64	16.60	16.89	17.19	17.49

The content of nitrogen free extract (NFE) in H1 (5% *Boreria alata*) , H2 (10% *Boreria alata*) and H3 (15% *Boreria alata*) has significant differences. The crude fiber on H1 (5% *Boreria alata*) , H2 (10% *Boreria alata*) and H3 (15% *Boreria alata*) was different, so it caused the differences of NFE. Hartadi *et al*. (2005), stated that a decrease in crude fiber from a feed ingredient will increase its NFE content. The NFE content in feed ingredients is highly dependent on other components such as crude protein, crude fiber, crude fat and ash. Nitrogen free extract is a soluble carbohydrate including monosaccharides, disaccharides and polysaccharides that are easily soluble in acid and alkaline solutions and have high digestibility (Anggorodi, 2005). Cherney (2000), stated that NFE is composed of sugars, organic acids, pectin, hemicellulose and lignin that are soluble in alkali. The quality standard of rabbit feed was water max 12% content, max 14% ash, min 15% crude protein, min 2% crude fat, and min 14% crude fiber (SNI 8510, 2018). Based on the results of physical and chemical quality assessment, the best hay multinutrient waffle formulation was obtained, namely H3. This formulation was further used for feed treatment in rabbit rearing. Formulations are selected based on those that are closed to the SNI rabbit feed standard. The quality standard of rabbit feed was water max 12% content, max 14% ash, min 15% crude protein, min 2% crude fat, and min 14% crude fiber (SNI 8510, 2018).

Effect of hay multinutrient waffle feed on the productivity of rabbit

The effect of hay multinutrient waffle feeding on rabbit productivity is shown in Table 6. The effect of hay multinutrient waffle feeding had significant effect ($p<0.05$) on FCR, body weight gain and average daily gain (ADG), but it had no significant effect ($p>0.05$) on feed intake. Feed consumption had no significant results, which showed that the feed treatment given had relatively similar palatability. Feed consumption is the ability in which livestock are able to consume the feed that is available. According to Rizqiani (2015) several factors that affects the level of feed consumption in rabbits include palatability, taste, nutrient concentration, feed shape, and the weight of the livestock itself.

Table 6. Feed consumption, FCR, body weight gain and average daily gain (ADG) of rabbit fed hay multinutrient waffle (HMW)

Treatment	Feed Consumption (g/28d)^{ns}	FCR	Body Weight Gain (g)	Average Daily Gain (ADG) (g)
T01	1954.16±51.20	8.77±0.61^{a}	226.67±23.13^{b}	8.09±0.83^{b}
T02	1852.77±61.06	8.02±0.45^{a}	232.00±8.96^{b}	8.28±0.32^{b}
T1	1846.24±64.60	5.15±0.32^{a}	360.00±16.46^{d}	12.85±0.59^{c}
T2	1772.09±62.31	5.53±0.36^{a}	325.33±32.63^{cd}	11.61±1.16^{c}
T3	1690.27±61.14	9.33±2.03^{a}	280.66±34.76^{bc}	10.02±1.57^{b}
T4	1520.65±34.58	25.27±3.02^{b}	62.33±7.26^{a}	2.22±0.26^{a}
p-value	0.69	<0.01	<0.01	<0.01

^{a,b,c,d} Different letters in the same column indicates highly significant (p<0.01)

Description: T01 (100% benggala grass), T02 (60% commercial pellet + 40% benggala grass), T1 (60% commercial pellet + 40 % HMW), T2 (40% commercial pellet + 60 % HMW) T3 (20% commercial pellet + 80 % HMW), and T4 (100 % HMW)

The results of data analysis showed that the T1 (60% commercial pellet + 40% hay), had the smallest FCR value of 5.15±0.32, the highest body weight of 360.00±16.46 g, and ADG of 12.85±0.59 g/d. Inversely, T4 with 100% HMW had the highest FCR value, the lowest body weight, and ADG. In the current study, we found that the application of HMW was more efficient when the feed was mixed with commercial pellets, with the percentage of hay multinutrient waffle range from 40 to 60%. The combination of feeding treatments makes an ADG of around 11.61 to 12.85 g/d for local rabbit. The lower the feed conversion value, the better the feed efficiency value for rabbit growth (Aritonang *et al*., 2003). The feed conversion ratio is influenced by feed quality, livestock's ability to convert feed into meat, environment, live weight, physical shape, and feed balance (Tarmanto, 2009). In addition, the level of rabbit feed consumption and body weight gain also affect the value of FCR (Nurkholis *et al*., 2021). In the early fattening stage, young, rapidly growing animals have a far more small FCR than those that are close to slaughter weight. Maertens (2009) stated that rabbits aged 30-37 d with a body weight of about 740-1050 g have an FCR value of 1.91 and weight gain of 44 g/d. Meanwhile, according to Sarwono (2010), the daily body weight gain of rabbits has an ideal standard of 9-17 g/d. Nevertheless, FCR value can be affected by other factors such as nutrition. In addition, Qurniawan (2016) stated that the factors affecting body weight gain include sex of the animal, feed consumption, seeds and feed quality. Body weight gain is closely related to feed intake, if feed consumption is disturbed, it will interfere with growth (Uzer *et al*., 2013).

Conclusion

In conclusion, supplementation with *Boreria alata* at 15% in HMW was considered optimal based on assessment of physical and chemical quality. This formulation, with approximately 40% HMW inclusion in the total diet, resulted in the lowest FCR and yielded the highest total weight gain and ADG.

Conflict of interest

The authors have no conflict of interest to declare. All authors have seen and agree with the contents of the manuscript.

Funding statement

This research was supported by DIPA Research Grants in 2024, Politeknik Pembangunan Pertanian Manokwari, Agricultural Ministry.

Acknowledgement

Thank you to the DIPA Research Grants in 2024, Politeknik Pembangunan Pertanian Manokwari, Agricultural Ministry for providing research funding so that this research can be carried out well.

Author’s contribution

The authors confirm contribution to the paper as follows: study conception and design: O. W., B. L. S.; data collection: O. W., B. L. S and G.M.N.I.; analysis and interpretation of results: O. W., B. L. S., G.M.N.I., and H.N.C.; draft manuscript preparation: O. W., B. L. S., G.M.N.I., and H.N.C. All authors reviewed the results and approved the final version of the manuscript.

Ethics approval

There are no human subjects in this article and informed consent is not applicable.

References

Abbood, A. A., A. B. Kassim, H. S. Jawad, Y. A. Manap, and A. Q. Sazili. 2017. Effects of feeding the herb *Borreria latifolia* on the meat quality of village chickens in Malaysia. Poultr. Sci. 96(6) :1767-1782.

Aldrian, E., and R. D. Susanto. 2003. Identification of three dominant rainfall regions within Indonesia and their relationship to sea surface temperature. Int. J. Climatol. 23(12) : 1435-1452.

Anggorodi, R. 2005. Ilmu makanan ternak umum. Gadjah Mada University Press,Yogyakarta.

Aritonang, D., M. A. Harahap, and Y. C. Raharjo. 2004. Pengaruh penambahan biovet dalam ransum dengan berbagai kandungan protein-energi terhadap pertumbuhan anak kelinci rex. Trop. Anim. Sci. J. 27(2) : 69–76.

Aritonang, D., N. A. T. Roefiah, T. Pasaribu, and Y.C. Raharjo. 2003. Laju pertumbuhan kelinci rex , satin dan persilangannya yang diberi luctosym dalam sistem pemeliharaan intensif. Jitv. 8(3) : 164–169.

Aslamyah, S., and M.Y. Karim. 2012. Uji organoleptik, fisik, dan kimiawi pakan buatan untuk ikan bandeng yang disubstitusi dengan tepung cacing tanah (*Lumbricus sp*.). Jurnal Akuakultur Indones. 11(2) : 124–131.

As-syakur, A. R. 2010. Pola spasial pengaruh kejadian la nina terhadap curah hujan di Indonesia tahun 1998/1999; observasi menggunakan data TRMM multisatellite precipitation analysis (TMPA) 3B43. Prosiding Pertemuan Ilmiah Tahunan MAPIN XVII Bandung.

Bell, G. D., M.S. Halpert, C.F. Ropelewski, V.E. Kousky, A.V. Douglas, R.C. Schnell, and M.E. Gelman. 1999. Climate assessment for 1998. Bull. Am. Meteorol. Soc. 80(5) :S1-S48.Cherney, D. J. R. 2000. Characterrization of forage by chemical analysis. CABI Publishing, Wollingford.

Conserva, L. M., and J.J.C. Ferreira. 2012. Borreria and spermacoce species (rubiaceae): a review of their ethnomedicinal properties, chemical constituents, and biological activities. Pharmacogn. Rev. 6(11) : 46.

Definiati, N., A. Sahputra and N. Setyowati. 2023. Weed availability as a ruminant forage source on coffee farmers' land in Kandang Village, Indonesia. Int. J. Agric. Life Sci. *2*(7) : 166-173.

Eniolorunda, O. O. 2011. Evaluation of biscuit waste meal and *Leucaena leucocephala* leaf hay as sources of protein and energy for fattening “yankassa” rams. Afr. J. Food. Sci. 5(2) : 57-62.

Fadhilah, I. N., V. Octaviani, and N. Kurniasih. 2022. Nilai nutrisi (analisis proksimat) ampas kelapa terfermentasi sebagai pakan kelinci. Gunung Djati Conference Series. 77 : 83–88.

Fathia, N. 2016. Uji sifat fisik dan mekanik pakan ikan buatan dengan perekat tepung tapioka. *Skripsi*. Fakultas Pertanian, Universitas Lampung, Bandar Lampung.

Gomez, K.A.. 1976. Statistical procedures for agricultural research. Lohn Wiley and Sons, Los Banos.

Handayani, I. S., B. I. M.Tampubolon, A. Subrata and R. I. Pujaningsih. 2019. Evaluasi organoleptik multinutrien blok yang dibuat dengan menggunakan metode dingin pada perbedaan aras molases. J. Ilmu Nutrisi Teknol. Pakan. 17(3): 64-68.

Hartadi, H., R. Soedomo and T. D. Allen. 2005. Tabel komposisi pakan untuk Indonesia. Edisi ke-3. Gadjah Mada University Press, Yogyakarta.

Hasanah, H. and K.M.Z. Basriwijaya. 2023. Pengetahuan dan sikap peternak sapi potong terhadap teknologi pengolahan limbah pertanian sebagai pakan ternak. JCI. 2(11) : 4411-4416.

Hendon, H. H. 2003. Indonesian rainfall variability: impacts of ENSO and local air–sea interaction. J. Clim. 16(11) : 1775-1790.

Irawan, B. 2006. Fenomena anomali iklim El Nino dan La Nina: kecenderungan jangka panjang dan pengaruhnya terhadap produksi pangan. In Forum Penelitian Agro Ekonomi. 24(1) : 28-45.

Ismi, R. S., R.I. Pujaningsih and S. Sumarsih. 2017. Pengaruh penambahan level molasses terhadap kualitas fisik dan organoleptik pellet pakan kambing periode penggemukan. JITP. 5(3) : 58-63.

Jayusmar, E., Trisyulianti and J. Jachja. 2002. Pengaruh suhu dan tekanan pengempaan terhadap sifat fisik wafer ransum dari limbah pertanian sumber serat dan leguminose untuk ternak ruminansia. Trop. Anim. Sci. J. 24(3) : 76–82.

Kabeakan, N. T. M. B., M. Alqamari and M. Yusuf. 2020. Pemanfaatan teknologi fermentasi pakan komplet berbasis hijauan pakan untuk ternak kambing. JPM. 2(2) : 196-203.

Krisnan, R., and S. P. Ginting. 2009. Penggunaan solid ex-decanter sebagai binder pembuatan pakan komplit berbentuk pellet: evaluasi fisik pakan komplit berbentuk pellet. Semnas TPV. 480–486.

Lebas, F. 1983. Small scale rabbit production and managenent system. World Animal Review (46). Roma.

Lestari, C. M. S., H. I. Wahyuni and L. Susandari. 2005. Budidaya kelinci menggunakan pakan limbah industri pertanian dan bahan pakan inkonvensional. Lokakarya Nasional dan Peluang Pengembangan Usaha Agribisnis Kelinci. 55-60.

Maertens, L. 2009. Possibilities to reduce the feed conversion in rabbit production. Giornate in Coniglicoltura ASIC. 2-3.

Malalantang, S. S., M. M. Telleng, W. B. Kaunang, M. R. Waani and S. Sane. 2023. Silase sebagai salah satu solusi mengatasi kekurangan hijauan pakan di desa Kasuratan Kecamatan Remboken Kabupaten Minahasa. In Prosiding SNPPVP. 4(1) : 429-433.

McDonald, P., R. A. Edwards, J. F. D. Greenhalgh, C. A. Morgan, L. A. Sinclair and R. G. Wilkinson. 2011. Animal nutrition (7th ed.). Pearson, UK.

McEllhiney, R. R. 1994. Feed manufacturing technology IV. American Feed Industry Assocition, Arlington.

Miasari, R. 2004. Pemanfaatan tandan kosong kelapa sawit sebagai bahan baku wafer ransum komplit pakan domba. *Skripsi*.

Miftahudin. 2015. Pengaruh masa simpan terhadap kualitas fisik dan kadar air pada wafer limbah pertanian berbasis wortel. JIPT. 3(3) : 121-126.

Motmainna, M., A. S. Juraimi, M. K. Uddin, N. B. Asib, A. M. Islam and M. Hasan. 2021. Bioherbicidal properties of *Parthenium hysterophorus*, *Cleome rutidosperma* and *Borreria alata* extracts on selected crop and weed species. Agronomy. 11(4) : 643.

Mucra, D. A., T. Adelina, A. E. Harahap, I. Mirdhayati, L. Perianita and Halimatussa'diyah. 2020. Kualitas nutrisi dan frkasi serat wafer ransum komplot subtitusi dedak jagung dengan level persentase ampas sagu yang berbeda. Jurnal Peternakan. 17(1) : 49-55.

Munasik, M., C.I. Sutrisno, S. Anwar and C. H. Prayitni. 2013. Physical characteristics of pressed complete fedd for dairy cattle. Int J Eng. 4 *:* 61–65.

Nurkholis, M., U. Kalsum and O. R. Puspitarini. 2021. Pengaruh penambahan campuran *Nitrobacte*r Sp dan *Lactobacillus fermentum* terenkapsulasi terhadap konsumsi pakan, pertambahan bobot badan, dan konversi akan pada kelinci. Bulmater. 15(2) : 20–30.

Parakkasi, A. 1995. Ilmu makanan ternak ruminansia. Penerbit Universitas Indonesia, Jakarta.

Praevia, M. F. And W. Widayat. 2022. Analisis pemanfaatan limbah tandan kosong kelapa sawit sebagai cofiring pada PLTU Batubara. Jurnal EBT. *3*(1) : 28-37.

Qurniawan, A. 2016. Kualitas daging dan performa ayam broiler di kandang terbuka pada ketinggian tempat pemeliharaan yang berbeda di Kabupaten Takalar Sulawesi Selatan. Program Pascasarjana, Institut Pertanian Bogor. *(Tesis).*

Ratnani, Y., S. Basymeleh and L. Herawati. 2009. Pengaruh jenis hijauan pakan dan lama penyimpanan terhadap sifat fisik wafer. JIIIP. 12(4).

Rayani, T. F., Y. Resti and R. K. Dewi. 2021. Kuantitas dan kualitas fodder jagung, padi dan kacang hijau dengan waktu panen yang berbeda menggunakan smart hydroponic fodder. JINTP. 19(2) : 36–41.

Rizqiani, A. 2015. Performa kelinci potong jantan lokal peranakan new zealand white yang diberi pakan silase atau pelet ransum komplit. Departemen Ilmu Nutrisi Dan Teknologi Pakan, Fakultas Peternakan. Institut Pertanian Bogor.

Sarwono, B. 2010. Kelinci potong dan hias. Agro Media Pustaka, Jakarta.

Seto, R. 2019. Memanfaatkan hay untuk pakan ternak ruminansia. In Infovet.

SNI 8510.2018. Pakan kelinci pemeliharaan atau dewasa. Badan Standarisasi Nasional, Jakarta.

Solihin, Muhtarudin, and R. Sutrisno. 2015. Pengaruh lama penyimpanan terhadap kadar air kualitas fisik dan sebaran jamur wafer limbah sayuran dan umbi-umbian. JITP. 3(2) : 48–54.

Sona, K., G. Oematan, T. O. D. Dato and M. Mullik. 2023. Pengaruh level campuran daun lamtoro (*Leucaena leucocephala*) dan daun kelor (*Moringa oleifera*) terhadap berat, ukuran dan kandungan nutrisi maggot lalat tentara hitam (*Hermetia illucens*). Anim. Agric. 1(1) : 1–12.

Subekti, E. 2009. Ketahanan *Pakan Ternak Indonesia*. JIIP. 5(2) : 63–71.

Sulastri, S. 1984. Pengaruh tingkat pemberian tepung daun gamal dalam ransum terhadap komponen tubuh dan karkas ayam pedaging. In *Karya Ilmiah*. Fakultas Peternakan. Institut Pertanian Bogor. Bogor.

Susila, T. G. O. 2015. Pengawetan dan penyimpanan hijauan pakan ternak. Universitas Udayana.

Syaefullah, B. L., N. P. V. T. Timur, S. C. Labatar and E. E. Bachtiar. 2023. Cattle disease studies via geographical information system in Bowi Subur Village, Masni District, Manokwari Regency, West Papua Province. JIIP. 33(1) : 549-555.

Syaiful, F. L., D. T. Diva and M. Hafizoh. 2020. Penerapan teknologi amoniasi jerami sebagai pakan alternatif sapi potong di Kenagarian Sungai Kunyit, Solok Selatan. JHI*. 3*(1) : 88-95.

Tarmanto, E. 2009. Performan produksi kelinci new zealand white jantan dengan bagasse fermentasi sebagai salah satu komponen ransumnya. *Skripsi*. Fakultas Pertanian, Universitas Negeri Sebelas Maret, Surakarta.

Tjasyono, B., A. Lubis, I. Juaeni and S. W. Harijono. 2010. Dampak variasi temperatur Samudera Pasifik dan Hindia Ekuatorial terhadap curah hujan di Indonesia. JSD. 5(2): 1-12.

To, L. C., T. N. K. Pham and P. K. P. Nguyen. 2016. One new compound from *Borreria alata* (Aubl.) DC (Rubiaceae) in Vietnam. Science and Technology Development Journal. 19(1) : 19-25.

Utami, K. B., L. E. Radiati and P. Surjowardojo. 2014. Kajian kualitas susu sapi perah PFH (studi kasus pada anggota Koperasi Agro Niaga di Kecamatan Jabung Kabupaten Malang). JJIP. 24(2) : 58–66.

Uzer, F., N. Iriyanti and Roesdiyanto. 2013. Penggunaan pakan fungsional dalam ransum terhadap konsumsi pakan dan pertambahan bobot badan ayam broiler. J. Ilmiah Peternakan. 1 (1) : 282–288.

Verma, A. K., U. R. Mehra, R.S. Dass and H. Singh. 1996. Nutrient utilization of Murrah buffalos (*Bubalus bubalis*) from compressed complete feed block. Anim Feed Sci Technol. 59 : 255–263.

Wahyudi, S. A., N. Sultan and S. Kasim. 2020. Kualitas fisik dan nutrisi wafer ransum komplit kelinci dengan penambahan tepung cacing tanah (*Lumbricus rubellus*) pada lama penyimpanan yang berbeda.

Wea, R., R. Y. K. Mangngi, Y. Y. Bay, B. Badewi, A. Semang, B. B. Koten and I. G. K. O. Wirawan. 2022. Kandungan nutrien, fraksi serat dan nutrient value fermentasi jerami kacang tanah (*Arachys hypogaea*) pada level nira lontar (*Borassus flabellifer*) yang berbeda. Livest. Anim. Res. 20(3) : 275-283.

Widayanti, A. 2008. Efek pemotongan dan pemupukan terhadap produksi dan kualitas *Borreria alata* (Aubl.) sebagai hijauan makanan ternak kualitas tinggi. *Skripsi*. IPB University.

Widayati, O., B. L. Syaefullah, S. Sritiasni, N. Zurahmah, A. Aswandi, and I. Irma. 2023. Evaluation of the growth and yield of organic corn fodder under various watering times and concentrations of rabbit urine fertilizers. Bull. Anim. Sci. 47(4) : 261-266.

Zuhra, C. F. 2006. Cita rasa (flavour). Fakultas Matematika dan Ilmu Pengetahuan Alam. *Skripsi*. Universitas Sumatra Utara. Medan.