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Research Article

Physical and Nutritional Characteristics of Indigofera, Gamal, and Cassava-Based Pellets for Sustainable Livestock Feed

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Abstract | The main challenge in the development of livestock is the availability of sustainable quality feed, especially protein sources. Reliance on imported feed-based commercial feeds such as soybean meal and fishmeal not only increases production costs, but also threatens national feed security. The use of local forage Indigofera, Gamal and Cassava in pellet formulations is a solution for the feed dependency. These pellets show inexpensive economic potential compared to factory feed. This is because most of the raw materials are in the form of local leguminosa that can be cultivated by farmers themselves, thereby reducing production costs. In addition to the low cost of production, these pellets have 17-21% crude protein, which is enough for ruminant livestock to grow and produce. This study aims to examine the effect of variations in the proportions of Indigofera, Gamal, and Cassava on the physical properties and nutritional content of pellets. The research was conducted with an experimental method using a completely randomized design (CRD) with a total of 20 experimental units (4 treatments and 5 replicates). Treatments are a balances of P0 (50% Indigofera + 50% Gamal+ 0% Cassava Flour), P1 (45% Indigofera + 45% Gamal + 10% Cassava Flour), P2 (40% Indigofera + 40% Gamal + 20% Cassava Flour), P3 (35% Indigofera + 35% Gamal + 30% Cassava Flour). Indigofera and gamal mixed pellets with gaplek flour adhesive material are made using a Kisuba brand pellet machine type KL 120 with a mold length of 1.5 cm and a diameter of 0.4 cm, a mold temperature of 70-80 °C, an output of 90-120 kg/hour, and a rotation of 1450 rpm. The length of the resulting pellets is 1-1.5 cm. Based on the analysis of the findings, the difference in the proportions of Indigofera, Gamal, and Cassava on pellet quality had a very real effect ($p<0.01$) on organic matter, ash, crude protein, organic matter free nitrogen and durability. However, it does not affect the water content, dry matter, bulk density, compaction density, and pellet specific gravity. The differing proportions of Indigofera, Gamal, and Cassava significantly influenced ($p<0.01$) the nutritional content and physical properties of the pellets. Pellets in the proportion of Indigofera, Gamal, and Cassava have a durability of 92.6-95.48%, dry matter content ranges from 96.02–96.75%, organic matter is 91.49–93.39%, crude protein is between 17.71–21.65%, ash is 2.63-5.26%, and organic matter without nitrogen (N-free organic matter) is between 69.84–75.67%.

Keywords | Pellets, Durability, Nutrients, Local Feed, Gamal, Indigofera

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INTRODUCTION

The livestock sector in Indonesia has a strategic role in providing food of animal origin and driving the economy of rural communities. One of the main challenges in the development of livestock is the availability of sustainable quality feed, especially protein sources. Dependence on imported materials such as soybean meal and fishmeal not only increases production costs, but also threatens national feed security (Makkar, 2016). Therefore, innovation in the use of local leguminosa forage resources is needed as an alternative to high-quality and environmentally friendly feed ingredients.

West Java is a producer of various forage products, including grasses and leguminoses such as *Indigofera zollingeriana* (Indigofera), *Gliricidia sepium* (Gamal), and *Manihot esculenta* (Cassava). Indigofera and Gamal are leguminosa sources of protein, while Cassava is a source of energy. The natural source of protein in ruminant livestock can be pellets sourced from these three ingredients, because it has the potential if used as a feed material. Cassava leaves and waste have a lot of nutrient content and high nutrient availability in rural areas, especially West Java. Meanwhile, Indigofera and Gamal are leguminosa plants with high crude protein and can grow on marginal land. The manufacture of local forage-based leguminosa pellets aims to improve the efficiency of the chain, and supports the principle of sustainable feed based on the utilization of local resources, the reduction of agricultural waste, and the strengthening of the economy of small farms (Rao *et al*., 2015). Density, hardness and strength are physical properties in pellet making. Fiber, crude protein and energy are nutrient content that are important parameters in assessing the quality and feasibility of technology application (Li *et al*., 2022).

The potential of local leguminoses such as Indigofera, Gamal and Cassava as feed ingredients has been previously researched. Crude protein content above 25%, low lignin levels and high digestibility are traits that Indigofera possesses, as a source of protein for ruminants (Gunun *et al*., 2023). Gamal, a leguminosa with high crude protein content (20–23%), is easy to grow in the tropics and suitable as a feed ingredient for sustainable farming systems (Sánchez *et al*., 2006). Another alternative energy source is Cassava, but the processing process is needed to be safe for livestock because the cyanide acid content decreases. The combination of these ingredients will have advantages in terms of stability and nutrient content that will meet the needs of ruminant livestock. The stability of pellets is greatly influenced by the content of lignin and crude fibers, the higher the crude fiber content, the more brittle the pellets tend to be brittle (Li *et al*., 2022). This is emphasized by others who show that the pelletization process can increase feed density, reduce losses during transportation, and improve the efficiency of consumption by livestock (Rao *et al*., 2015). Crude fiber, especially high lignin, can not only affect the quality of pellets, but can also interfere with fermentability in the rumen.

Further research showed that the combination of Cassava and Gliricidia resulted in pellets with high physical value (durability and density), particularly when a 5% starch binder was added (Dada *et al*., 2020). The results of another study compared various natural binders for Indigofera-based pellets, and found that tapioca provides comparable results to commercial binders in terms of pellet stability. The shape of feed (mesh, pellets, wafers) also affects nutrient content and physical density, where pellets and wafers produce better density and protein values than mash (Wan *et al*., 2021). In Indonesia, it is shown that the combination of Cassava flour and Gamal is able to increase the daily weight gain of Ongole cattle as well as the income of farmers (CSIRO, 2021). Other studies prove that chemical properties will affect physical properties, differences in nutrient content will have different physical properties. So this will determine the properties of the pellets produced.

From all these findings, it can be seen that the combination of Indigofera, Gamal, and Cassava is able to effectively meet the nutritional needs of livestock, but can also be processed into high-quality pellets that support a sustainable feed system. However, there is still no information that combines these three ingredients. The novelty of this research is to provide information on the combination of Indigofera, Gamal, and Cassava used as pellets. This study was conducted to determine the optimal proportion of these ingredients in pellet formulations that balance physical quality and nutrient content, especially in the context of the utilization of local forage resources in Indonesia.

This study aims to examine the influence of variations in the proportions of Indigofera, Gamal, and Cassava on the physical properties and nutritional content of pellets as a form of sustainable feed strategy based on local forage. The benefit of this research is that it is a recommendation for the use of Local Feed ingredients, especially leguminosa that is efficient, affordable and abundant in availability that will support environmentally friendly farming. The selection of Indigofera, Gamal and Cassava was based on the availability at the research location, namely Sumedang Regency.

MATERIALS AND METHODS

Experimental design

This research was carried out using an experimental method using a Complete Random Design (CRD) consisting of

4 types of treatments and each treatment was repeated 5 times so that 20 experimental units were obtained. Treatments are a balances of P0 (50% Indigofera + 50% Gamal+ 0% Cassava Flour), P1 (45% Indigofera + 45% Gamal + 10% Cassava Flour), P2 (40% Indigofera + 40% Gamal + 20% Cassava Flour), P3 (35% Indigofera + 35% Gamal + 30% Cassava Flour). Information on the nutrient content of each treatment can be seen in Table 2.

Table 1: Nutritional content of ingredients based on dry matter.

Ingredients*	Dry matter (%)	Ash (%)	EE (%)	Crude protein (%)	Crude fiber (%)	NNFE (%)	TDN (%)
Cassava flour	94.85	4.94	1.52	2.30	3.51	87.73	78.15
Indigofera	94.88	8.44	7.75	30.48	19.47	33.86	73.62
Gamal	93.36	7.70	4.68	23.98	19.45	42.79	70.35

Description: *Laboratory Analysis Results of Ruminant Nutrition and Animal Feed Chemistry, Faculty of Animal Science Universitas Padjadjaran.

Table 2: Nutritional content of pellets based on calculations.

Treatment*	Dry matter (%)	Ash (%)	EE (%)	Crude protein (%)	Crude fiber (%)	NNFE (%)	TDN (%)
P0	94.12	8.07	6.92	27.23	19.46	38.33	71.99
P1	94.19	7.76	6.38	24.74	17.87	43.27	72.60
P2	94.27	7.44	5.84	22.24	16.27	48.21	73.22
P3	94.34	7.13	5.30	19.75	14.68	53.15	73.83

Description: P0 (50% Indigofera + 50% Gamal + 0% Cassava Flour), P1 (45% Indigofera + 45% Gamal + 10% Cassava Flour), P2 (40% Indigofera + 40% Gamal + 20% Cassava Flour), P3 (35% Indigofera + 35% Gamal + 30% Cassava Flour).

Pellet making procedure

The pellets used were mixture of Indigofera and Gamal with a balance of 1:1. Pellet making uses binders in the form of gaplek with several levels of delivery, namely 0%, 10%, 20% and 30%. The materials used in making pellets, namely Indigofera leaves, Gamal leaves, and Cassava are obtained from farmers in Sumedang Regency, West Java Province, Indonesia. Indigofera, Gamal, and Cassava are dried and then ground using a hammer mill until they become flour with a size of 30 mesh.

Indigofera and Gamal mixed pellets with Cassava adhesive are made using a Kisuba brand pellet machine of the KL 120 type with a mold length of 1.5 cm and a diameter of 0.4 cm, a mold temperature of 70-80 °C, an output of 90-120 kg/hour, and a machine rotation of 1450 rpm. The process of making these pellets is without the addition of water. The length of the pellets produced is 1-1.5 cm. The pellets formed are then dried in the sun to reduce moisture content and lower the temperature due to the pelletizing process. Next, the samples are tested for chemical and physical properties by first drying the sample in a 60 °C oven for 48 hours.

Measurement of physical properties and nutrient content of pellets

The analysis of the physical quality of pellets was carried out at the Laboratory of Poultry and Non-Ruminant Nutrition, Faculty of Animal Husbandry, Universitas Padjadjaran. Nutrient content analysis was carried out at the Ruminant Nutrition Nutrition and Animal Feed Chemistry Laboratory, Faculty of Animal Husbandry, Universitas Padjadjaran, Sumedang Regency, West Java Province. Measurement of specific density, bulk density and compaction bulk density follows the procedure of Nugraha *et al.* (2022). Specific Gravity (g/mL) = Weight of material (g)/ Difference in the volume of change of aquades (mL). Bulk density (kg/m^3) = Material weight (kg)/ Volume (m^3). Compaction bulk density (kg/m^3) = Weight of compacted material (kg)/ Volume (m3). While durability using the Pfost tumbling method follows the procedure of Susilawati *et al.* (2012). Pellet Durability Index (PDI)= (Weight of pellet after rotating (g)/ Weight of pellets before rotating (g)) x 100%. Dry material measurement with an oven with a temperature of 60°C for 48 hours. Organic matter is obtained by reducing dry matter with ash, and crude protein by Kjeldahl's method following the AOAC (2005) procedure.

Statistical analysis

The research data was analyzed by analysis of variance (ANOVA) to determine the effect of treatment on parameters. If the results have a real effect, the Duncan Test is continued to find out the difference in treatment and Regression to find out the pattern of the relationship between the level of treatment and the parameters. The analysis was carried out using SPSS 21 software.

RESULTS AND DISCUSSION

Nutrient content

The results of the study on the difference in the proportion of Indigofera, Gamal and Cassava to pellet nutrient quality are presented in Table 3. Based on statistical analysis, treatment had a very significant effect ($p<0.01$) on organic matter, ash, crude protein, and organic matter without nitrogen. However, it does not affect the water content and dry matter of the pellets. Organic matter and organic matter free nitrogen increase with the higher the level of Cassava flour. The content of ash and crude protein decreases with the higher the level of Cassava flour.

Dry matter between 96.02–96.75%, organic matter between 91.49–93.39%, crude protein between 17.71–21.65%,

Table 3: The effect of treatment of the proportions of Indigofera, Gamal, and Cassava on the nutrient content of pellets.

Parameters	P0	P1	P2	P3	P-value
Dry matter (%)	96.75±1.13	96.72±0.17	96.4±0.46	96.02±0.34	0.274
Water content (%)	3.25±1.13	3.28±0.17	3.6±0.46	3.98±0.34	0.274
Organic matter (%)	91.49±0.2[a]	91.89±0.14[b]	92.88±0.18[c]	93.39±0.18[d]	0.001
Ash (%)	5.26±1.27[b]	4.83±0.31[b]	3.51±0.5[a]	2.63±0.29[a]	0.001
Crude protein (%)	21.65±0.47[c]	21.3±0.58[c]	19.41±0.69[b]	17.71±0.95[a]	0.001
Organic matter free nitrogen (%)	69.84±0.53[a]	70.59±0.53[a]	73.48±0.74[b]	75.67±0.97[c]	0.001

Description: P0 (50% Indigofera + 50% Gamal + 0% Cassava Flour), P1 (45% Indigofera + 45% Gamal + 10% Cassava Flour), P2 (40% Indigofera + 40% Gamal + 20% Cassava Flour), P3 (35% Indigofera + 35% Gamal + 30% Cassava Flour). Different superscripts show very real differences (p<0.01).

ash 2.63–5.26%, and N-free organic matter between 69.84–75.67% of the pellets produced in this study showed high nutrient composition. When compared to previous studies, these results show significant advances in the nutritional quality of local forage-based pellets. This high nutrient content is compared to the data on the nutritional requirements for sheep for growth which requires 14-16% crude protein (NRC, 2007).

The proportion of raw materials such as Indigofera, Gamal, and Cassava in pellet formulations significantly affects the nutrient content. The implication of these results is that the use of Cassava in Gamal and Indigofera pellets should be limited to prevent a decrease in nutrient content, especially crude protein. This decrease in crude protein will disrupt the balance of nutrients needed by livestock, especially in growth and production phases such as lactation and pregnancy that require high protein intake. So that the formulation of rations with the addition of singkoing must be adjusted to the nutritional needs of livestock so as not to reduce livestock productivity.

When compared to other studies, the crude protein value of pellets (17.71-21.65%). These results are in line with previous studies that reported that crude protein content tends to decrease in the pellet manufacturing process, (Netto *et al*., 2019). When compared to the protein content of Gamal and Indigofera, Gamal has a crude protein of around 20-30% (Sofyan *et al*., 2020) and 18-24% (Dada *et al*., 2020). Meanwhile, Indigofera has a crude protein content of 20-28% (Bawala *et al*., 2021) and above 25% (Gunun *et al*., 2023). The crude protein content of pellets produced in this study is still in the normal range as a feed material for protein sources.

Although Gamal has crude protein and is high in essential minerals such as calcium and phosphorus, it has anti-nutrient tannins and gliricidin that can reduce palatability if given in high amounts (Dada *et al*., 2020). Tannins are anti-nutrient compounds found in gamal, have a varied impact on livestock health depending on the concentration, species of livestock and duration of consumption. Low to moderate concentrations of tannins will provide benefits of reducing worms (anthelmintic effect) and increasing the efficiency of protein use by inhibiting protein degradation from rumen microbes (Min *et al*., 2003). But if consumed in the long term and in high amounts, it will reduce palatability, inhibit nutrient absorption, decrease protein digestibility and cause metabolic disorders (Makar, 2003). Trials in sheep showed that the tannins in Gamal had an anthelmintic effect, but at high concentrations it could reduce the intake and digestibility of the ration (Hoste *et al*., 2006) and in sheep fed rations containing Gamal led to a decrease in consumption and weight gain compared to control sheep (Kaitho *et al*., 1997).

The content of dry matter and organic matter in Cassava is around 86-90% and 88-92% organic, respectively, so that the pellets in this study have a higher dry matter content of 96.02–96.75%, and a higher organic matter content of 91.49-93.39%. This shows that the pellet manufacturing process successfully reduces moisture levels and improves organic stability (Parmar *et al*., 2017). The content of pellet ash (2.63-5.26%) is also still in the good range (2-6%), the ash content of leguminosa leaves is around 3-7% (Bain *et al*., 2024). The relationship between increasing or decreasing the nutrient content of pellets due to treating the different proportions of Indigofera, Gamal, and Cassava is presented in Figure 1.

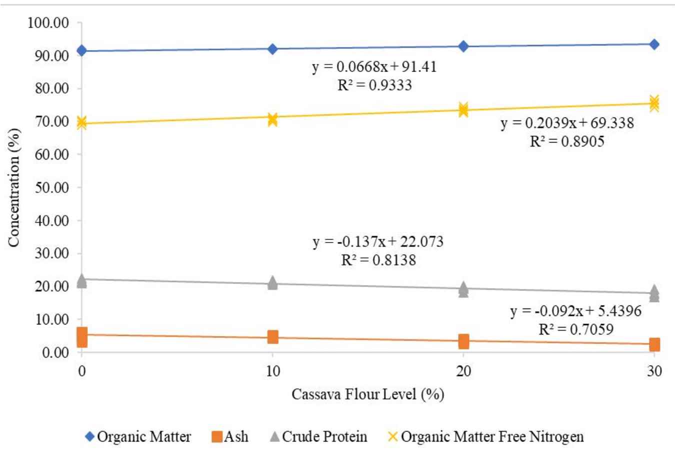

Figure 1: Graph of the relationship of the proportion of Indigofera, Gamal, and Cassava to the nutrient content of pellets.

Table 4: The effect of the treatment of the proportions of Indigofera, Gamal, and Cassava on the content of the physical properties of pellets.

Parameters	P0	P1	P2	P3	P-value
Bulk density (kg/m^3)	420.11±17.34	398.69±20.87	401.39±17.46	410.12±9.2	0.215
Compaction density (kg/m^3)	443.52±17.94	426.91±18.6	429.21±16.5	441.07±10.26	0.300
Specific gravity (g/cm^3)	1.18±0.03	1.21±0.05	1.2±0.03	1.18±0.04	0.475
Durability (%)	95.48±0.88^c	94.04±0.61^b	92.6±1.5^a	94.04±0.62^b	0.003

Description: P0 (50% Indigofera + 50% Gamal + 0% Cassava Flour), P1 (45% Indigofera + 45% Gamal + 10% Cassava Flour), P2 (40% Indigofera + 40% Gamal + 20% Cassava Flour), P3 (35% Indigofera + 35% Gamal + 30% Cassava Flour). Different superscripts show very real differences (p<0.01).

Figure 1 shows a very strong relationship between organic matter and organic matter free nitrogen which increases along with the increase in Cassava flour levels which is shown with a R^2 value of 89.06% for organic matter free nitrogen and 93.33% for organic matter. The strong relationship between ash content and crude protein decreased along with the increase in Cassava flour levels which was shown by the R^2 value of 81.38% for crude protein and 70.59% for ash.

The decrease in the crude protein content of pellets is caused by the dilution effect of the increased proportion of Cassava. This effect occurs because Cassava, especially its tubers, contains a very low crude protein of 1-3% based on dry matter when compared to Gamal and Indigofera. When the proportion of Cassava increases in the formula, the composition of the leguminosa Indigofera and Gamal decreases proportionally. As a result, the total crude protein content in the mixture will decrease even if the dry ingredients remain high (Prastio *et al*., 2022).

Physical properties

In addition to affecting the nutrient content, the difference in the proportions of Indigofera, Gamal, and Cassava affects physical properties. The results of the study are presented in Table 4. Based on the analysis of the variance, the difference in the proportion of Indigofera, Gamal, and Cassava to the quality of pellets did not affect the bulk density, compaction density, and specific gravity. Although P1 has lower bulk density and compaction density values based on the Duncan test, this is because the measurement data has a high diversity (based on the standard deviation value). However, it is very significant (p<0.01) that it affects the durability of pellets. Based on the Duncan Test, the durability of P0 is higher than other treatments (P1, P2, and P3), meaning that even without Cassava flour mixed Indigofera and Gamal has excellent pellet strength. The findings of this study are that pellets in the proportion of Indigofera, Gamal, and Cassava have high durability with a range of 92.6-95.48% (Figure 2).

The durability of the pellets produced in this study is 92.6-95.48%. This value shows that the quality of the pellets is good and has met the quality standards (>90%) for animal feed. When compared to other studies, the pellet durability was 94.95% in Indigofera leaf pellets without the addition of binders (Bain *et al*., 2024), and slightly lower than other studies that resulted in the durability of Indigofera and leucaena pellets of 98.83-99.36% (Handoko *et al*., 2013). The durability of the pellets produced by this study is much higher when compared to pellets made from pure Cassava flour with a durability value of 84.44% (Oduntan and Koya, 2015).

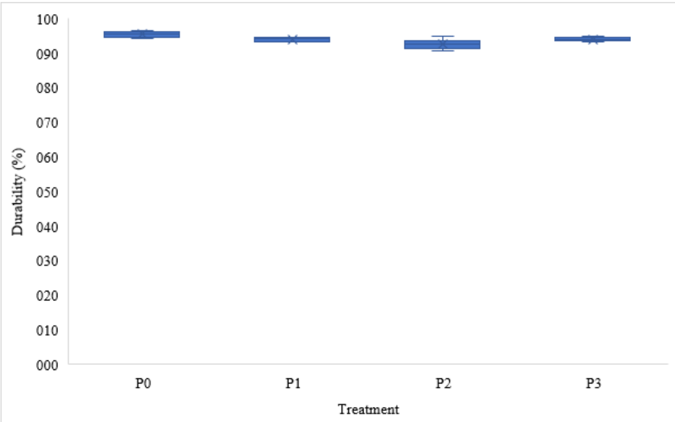

Figure 2: Graph of the relationship between the proportion of Indigofera Gamal and Cassava treatment to the nutrient content of pellets.

Description: P0 (50% Indigofera + 50% Gamal + 0% Cassava Flour), P1 (45% Indigofera + 45% Gamal + 10% Cassava Flour), P2 (40% Indigofera + 40% Gamal + 20% Cassava Flour), P3 (35% Indigofera + 35% Gamal + 30% Cassava Flour).

This is due to mechanical processes that may occur due to the interaction factors between water distribution and gelatinization of starch. For starch to be effective as a binder, optimal gelatinization conditions are needed, usually at a temperature of 60-70 °C with sufficient humidity. If the moisture content of the mixture is low, then the starch will not gelatinize completely, so it does not form strong bonds between particles. In addition, uneven water distribution due to inhomogeneous materials will also inhibit the formation of thermoplastic bonds (Thomas *et al*., 1996; Briggs *et al*., 1999). In this study, there was no addition of water in the pellet making process, so the effect of Cassava flour was not optimal.

Another explanation that supports this result is that it is suspected that proteins that undergo denaturation during the heating process in the pellet machine will increase the strong adhesion so that the pellets do not break down easily (Abdollahi *et al*., 2013). In addition to the denaturation of proteins this result because the low crude fiber content in leguminosa leaves allows the material particles to fuse better, dense and indestructible pellets are produced in this process. The formation of solid pellets is aided by the pressure and heat mechanisms in the machine, even without binding agents such as starch (Thomas *et al*., 1996).

Quality pellets, produced from the balance between protein from forage and flour from Cassava are important. So that the needs and palatability of pellets for ruminant livestock can be met. High crude fibers in Indigofera and high Gamal can produce pellets that are less compact, brittle and easily destroyed (Harahap *et al*., 2024). These properties can be enhanced through the starch gelatinization mechanism which can improve the cohesion between particles during the pellet making process if Cassava is added (Bain *et al*., 2024).

So, it can be concluded that the physical strength and stability of pellets can be improved due to the high protein content in the material, without the addition of binders such as Cassava. The density, hardness, and stability of the pellet shape are affected by the starch in the Cassava which becomes a natural binder that will improve the physical properties of the pellets (Parmar *et al*., 2017; Bain *et al*., 2024).

CONTRADICTIONS AND RECOMMENDATIONS

The higher durability of P0 (without Cassava) contradicts the hypothesis that Cassava starch improves binding. This hypothesis is based on the natural properties of starch as a binder (binder), which when gelatinized can help hold the feed material particles together into a denser and stronger shape. In theory, Cassava starch that has gelatinized will absorb water, expand and form a thick tissue, harden after drying, increase cohesion between particles so that the durability of pellets should increase (Bui *et al*., 2018; Chisenga *et al*., 2019). However, the results showed that P0 without Cassava had a higher durability than the treatment of adding Cassava (P1, P2, and P3).

This is due to the absence of the gelatinization process of the added Cassava due to the lack of water content in the ingredients. Cassava does not become a binder but instead becomes a filler that weakens the physical structure of the pellet. Gelatinization is the process of changing the crystalline structure of starch into an easily digestible amorphous form, occurring when starch is heated with sufficient water content. Cassava starch gelatinizes at a temperature of around 60-70°C (Ratnayake and Jackson, 2006; Briggs *et al*., 1999). However, without enough water, this process does not take place optimally. The texture of the pellets becomes brittle because the binding of feed particles from gelatinization to a solid form does not occur (Garcia *et al*., 2016). This is the limitation of the Cassava gelatinization process without enough water.

Practical recommendations

The effect of feed ingredients in the form of pellets of this treatment further decreases the nutrient content, especially crude protein, with an increase in the content of Cassava, because there is a decrease in the proportion of Indigofera and Gamal. Excessive increase in Cassava (>30%) has been proven to reduce crude protein content which will negatively impact the balance of the ration, especially for livestock that require high protein. It is therefore recommended that the rate of addition of Cassava in the pellet formula does not exceed 30%. At this level, pellets still show good durability, the cost of raw materials is relatively cheap compared to commercial, and the nutrient content, especially crude protein, is still within a decent range to support livestock production.

The results of this study prove that leguminosa pellets made from a mixture of Indigofera, Gamal and Cassava in different proportions can be used as a natural source of protein for ruminant livestock. Leguminosa pellets provide a natural source of protein as well as support the efficient use of agricultural by-products, contributing to the sustainability of farming.

CONCLUSION

The different proportions of Indigofera, Gamal, and Cassava greatly influence ($p<0.01$) the nutritional content and physical properties of the pellets produced. Pellets in the proportion of Indigofera, Gamal, and Cassava have a durability of 92.6-95.48%, dry matter content ranges from 96.02–96.75%, organic matter is 91.49–93.39%, crude protein is between 17.71–21.65%, ash is 2.63-5.26%, and organic matter without nitrogen (N-free organic matter) is between 69.84–75.67%. The inclusion rate of Cassava >30% will reduce the crude protein content, so it will interfere with the fulfillment of livestock needs when pellets are used to complement the provision of grass as the main feed.

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NOVELTY STATEMENT

These results suggest that local leguminosa formulations can provide adequate physical quality and nutrients and can support the sustainability and efficiency of local resource-based feed production. The high protein content in the feed ingredients of Indigofera dam Gamal will affect the physical strength and stability of the pellets, even without the addition of starch-containing binders such as Cassava.

AUTHOR'S CONTRIBUTION

Urip Rosani: designing research, analyzing data, interpreting results and drafting manuscripts. Budi Ayuningsih: designing the research, receiving research funding, and approving the final manuscript. Iin Susilawati, Iman Hernaman and Nyimas Popi Indriani: interpreting the results and approving the final manuscript. Geiska Nabillah Rosma Putri and Amallia Restu Imanda collected and analyzed the data. Regasa Begna: designing research and approving the final manuscript

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Data availability statement

All data supporting the findings of this study are available within the paper.

Conflict of interest

The authors have declared no conflict of interest.

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