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EFFECT OF CASSAVA FLOUR RATIOS AS BINDER ON PHYSICAL PROPERTIES AND NUTRIENT CONTENT OF PELLETS MADE FROM CALLIANDRA (*CALLIANDRA CALOTHYRSUS*) AND LAMTORO *(LEUCAENA LEUCOCHEPALA*)

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Abstract
Feed in the form of pellets is one method of preserving feedstuffs that ensures a more reliable procurement and continuity of supply, thereby maintaining feed quality. This study aims to determine the effect of the level of cassava flour in pellets of calliandra and lamtoro mixture as a binder on physical properties and on the content of dry matter, organic matter, and crude protein. The study used an experimental method with a completely randomized design (CRD), with 4 treatments and 5 replications. The treatments consisted of P0 (100% mixture of calliandra and lamtoro + 0% cassava flour), P1 (90% mixture of calliandra and lamtoro + 10% cassava flour), P2 (80% mixture of calliandra and lamtoro + 20% cassava flour), and P3 (70% mixture of calliandra and lamtoro + 30% cassava flour). The study showed that the treatment had a significant effect ($P < 0.05$) on durability (87.40% to 77.88%) and crude protein (22.33% to 16.39%) but had no significant effect ($P > 0.05$) on specific gravity, pile density, pile compaction density, dry matter and organic matter content. It can be concluded that the P0 (100% mixture of calliandra and lamtoro) treatment produced the highest durability and crude protein values.
Keywords: pellets, cassava flour, binder, nutrients

PENGARUH PERBANDINGAN TEPUNG SINGKONG SEBAGAI BAHAN PEREKAT TERHADAP SIFAT FISIK DAN KANDUNGAN NUTRIEN PELET DARI KALIANDRA (CALLIANDRA CALOTHYRSUS) DAN LAMTORO (CALLIANDRA CALOTHYRSUS)

Abstrak
Pakan dalam bentuk pellet merupakan salah satu bentuk pengawetan bahan pakan yang lebih terjamin dari segi pengadaan dan kontinuitas penyediaannya untuk menjaga kualitas pakan. Penelitian ini bertujuan untuk mengetahui pengaruh level tepung singkong dalam pellet campuran kaliandra dan lamtoro sebagai bahan pengikat terhadap sifat fisik, kandungan bahan kering, bahan organik, dan protein kasar. Penelitian menggunakan metode eksperimen dengan rancangan acak lengkap (RAL) dengan 4 perlakuan dan 5 kali ulangan. Perlakuan tersebut terdiri dari P0 (100% campuran kaliandra dan lamtoro + 0% tepung singkong), P1 (90% campuran kaliandra dan lamtoro + 10% tepung singkong), P2 (80% campuran kaliandra dan lamtoro + 20% tepung singkong), dan P3 (70% campuran kaliandra dan lamtoro + 30% tepung singkong). Hasil penelitian menunjukkan bahwa perlakuan memberikan pengaruh nyata ($P<0,05$) terhadap nilai durabilitas, (87,40% hingga 77,88%) dan protein kasar (22,33% hingga 16,39%) serta tidak memberikan pengaruh nyata ($P>0,05$) terhadap berat jenis, kerapatan tumpukan, kerapatan pemadatan tumpukan, kandungan bahan kering dan bahan organik. Kesimpulan bahwa perlakuan P0 (campuran 100% kaliandra dan lamtoro) menghasilkan nilai durabilitas dan protein kasar tertinggi.
Kata kunci: pellet, tepung singkong, perekat, zat gizi

INTRODUCTION

Legumes is a protein source feed ingredient that can be utilized for ruminant feed. Their use is needed to meet nutrient adequacy, especially protein. Many types of legumes can be utilized as a protein source forage feed, including calliandra and lamtoro. Kaliandra and lamtoro have the advantages of easy availability, low price, high production, capable of supplying fermentable and by-pass protein, and can be used as alternative feed (Mardhiyetti et al., 2023; McSweeney et al., 2001; Pratama et al., 2022; Widharto et al., 2019). Calliandra contains 20.84% crude protein, 3.36% extract ether, 9.75% crude fiber, 58.22% non-nitrogen-free-extract (NNFE), and 7.83% ash (Susilawati & Khairani, 2017). Meanwhile, Lamtoro has a nutrient content of 27.89% crude protein, 28.73% extract ether, 13% crude fiber, 11.33% ash, and 33.12% non-nitrogen-free extract (NNFE) (Handayani, 2017).

However, leguminous production has several challenges, such as not being durable, and if stored for a long time, it can reduce the physical quality and nutrient content of the legumes (Akakpo et al., 2020). Feed preservation needs a feed that can be stored for a long period while maintaining its physical properties and nutrient content. One feed preservation technique is to process feed into pellets. Pellets are feed that is molded using a pellet molding machine (die) so that it is cylindrical with different diameters, lengths, and degrees of hardness (Susilawati, 2017).

Leguminous pellets are known as “green concentrates,” a nutrient-dense, high-protein, and energy-dense feed whose raw material is derived from leguminous forage (Tarigan et al., 2018). The forage used comes from the leaves and young stems of legumes, which have high protein (Castro-Montoya & Dickhoefer, 2020). The concentrate can be derived from a single forage of a single leguminous species or multiple leguminous mixtures derived from different leguminous plant species. The advantages of green concentrate compared to conventional concentrates are that it is cheaper than conventional concentrates and is not an imported feed ingredient (Muneer et al., 2021). The mixture of calliandra and lamtoro can be used as a protein supplement feed.

Pelletizing requires a binder to make it strong, not brittle, and well-formed. One of the feed ingredients that can be used as a binder is cassava flour, which contains high starch. Nutrient content of cassava flour derived from white cassava (sticky rice) is 2.3% crude protein, 0.72% extract eter, 2.93% crude fiber, 92.25% dry matter, 97.36% organic matter, and 87,73% non-nitrogen-free extract (NNFE) (Prasetyo et al., 2019). Starch, when heated with water, will undergo gelatinization, which serves as an adhesive, thus affecting the strength of the pellets. Gelatinized starch and denatured protein during the heating process in a pelletizing machine will increase the strength of the pellets. The pelletizing machine will increase the strong adhesion that prevents the pellets from being easily damaged (Abdollahi et al., 2013). Based on the research of Harahap et al. (2023), adding 10% tapioca flour adhesive produces the best physical quality of a sago pulp and indigofera leaves mix pellets, in terms of moisture content, specific gravity, pile density, pile compaction density, and impact resistance. Based on Aprillina's (2023) research, the use of adhesive derived from cassava (*onggok*) at a rate of up to 30% yields the highest dry matter of 95.08%, which is not significantly different from organic matter. However, in terms of crude protein degradability, the highest value is achieved with the use of onggok at 0%. Therefore, it can be hypothesized that the addition of 10% cassava flour in mixed pellets of calliandra and lamtoro affects their physical quality and nutrient content.

MATERIALS AND METHODS

Ekperimental Design

The research was conducted at the Laboratory of Poultry and Non Ruminant Nutrition, Faculty of Animal Husbandry, Padjadjaran University, Sumedang. Calliandra and lamtoro were obtained from Ujung Jaya subdistrict in Sumedang and cassava was made from cassava purchased from Cileunyi market and farmers from Jatiroke area, Sumedang. The materials were dried for 3-5 days and after drying, the calliandara, lamtoro and cassava were ground into flour using a disk mill with a size of 30 mesh. The nutrient content of the research materials can be seen in Table 1. 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). This study uses a Completely Randomized Design (CRD).

Treatments consisted of : P0 = 100% mixture of calliandra and lamtoro + 0% cassava flour; P1 = 90% mixture of calliandra and lamtoro + 10% cassava flour; P2 = 80% mixture of calliandra and lamtoro + 20% cassava flour and P3 = 70% mixture of calliandra and lamtoro + 30% cassava flour. Information on the nutrient content of each treatment can be seen in Table 2.

Table 1. Nutrient Content of Research Materials

Feed Ingredients	Nutrient Content						
	Water*	Ash	EE	Crude Protein	Crude Fiber	NNFE	TDN
	-----------------------------% ---------------------------------						
Dried Cassava	56.40	4.94	1.52	2.30	3.51	87.73	78.15
Calliandra	56.50	9.89	5.33	26.93	17.36	40.48	71.25
Lamtoro	69.77	7.04	4.68	26.11	19.75	42.42	70.02

Source: Ayuningsih, et al., (2022) (Unpublished)
* Results of laboratory analysis of ruminant nutrition and animal feed chemistry Faculty of Animal Husbandry, Padjadjaran University (2024)

Table 2. Nutrient Content of Mixed Pellet Ingredients

Treatments	Nutrient Content						
	Water	Ash	EE	Crude Protein	Crude Fiber	NNFE	TDN
	-----------------------------% ---------------------------------						
P0	63.14	8.47	5.01	26.52	18.56	41.45	70.64
P1	57.69	8.11	4.66	24.10	17.05	46.08	71.39
P2	52.24	7.76	4.31	21.68	15.55	50.71	72.89
P3	46.80	7.41	3.96	19.25	14.04	55.33	72.89

Source: Calculations based on Table 1 and research treatments
EE = ether extract; NNFE = Non nitrogen free extract; TDN = Total digestible nutrient
P0= (100% mixture of calliandra and lamtoro + 0% cassava flour),
P1= (90% mixture of calliandra and lamtoro + 10% cassava flour),
P2= (80% mixture of calliandra and lamtoro + 20% cassava flour),
P3= (70% mixture of calliandra and lamtoro + 30% cassava flour).

Table 3. Effect of treatment on physical properties and nutrient content of pellets

Parameters	Treatments			
	P0	P1	P2	P3
Specific gravity (g/cm^3)	1.20^a	1.24^a	1.21^a	1.25^a
Pile density (g/cm^3)	0.68^b	0.66^a	0.68^b	0.67^a
Pile compaction density (g/cm^3)	0.71^a	0.70^a	0.71^a	0.71^a
Durability (%)	87.40^a	84.36^b	80.96^c	77.88^d
Dry matter (%)	94.86^a	94.44^a	94.59^a	94.23^a
Organic matter (%)	87.36^a	89.57^a	88.33^a	88.60^a
Crude protein (%)	22.33^d	19.55^c	17.69^b	16.39^a

Note: Different letters in the significance column indicate significantly different ($P < 0.05$)

Pelletizing procedure

Pellets of mixed calliandra and lamtoro were made using a Kisuba brand pellet machine type KL120 with a mold length of 1.5-2 centimeters and a diameter of 0.5 centimeters in diameter. The particle size of calliandra, lamtoro, and cassava flour was 0.60 millimeters each. The pellet materials was manually mixed until homogeneous. The procedure for making pellets followed the procedure outlined by Royani & Herawati (2020), where the forage is dried first, then ground into flour. The forage flour then mixed with adhesive flour until homogeneous and processed in a pellet molding machine. Aprillina (2023) suggests that 20 % water is required in pellet molding mechine for every treatment.

Measurement of physical properties and nutrient content of pellets

Measurement of specific gravity, pile density and pile compaction density followed the procedure of Nugraha et al. (2022) while durability using the Pfost tumbling method followed the procedure of Susilawati et al. (2012). Measurement of dry matter, organic matter and crude protein followed the procedure of AOAC (2005).

Experimental design and statistical analysis

This study consisted of four treatments with five replications, so that there were a total of 20 experimental units. The research treatments were as follows:

P0 = 100% pellets of mixed calliandra and lamtoro + 0% dried cassava
P1 = 90% pellets of calliandra and lamtoro mixture + 10% dried cassava
P2 = 80% pellets of calliandra and lamtoro mixture + 20% dried cassava
P3 = pellets of 70% calliandra and lamtoro mixture + 30% dried cassava

The study used a completely randomized design (CRD). The mathematical model used is as follows:

$$Yij = \mu + \alpha_i + \varepsilon_{ij}$$

Where:

Yij : observed response due to *i*-th treatment and *j*-th replication.
μ : general mean.
αi : effect of *i*-th treatment.
Ɛij : effect of error from *i*-th treatment and *j*-th replication

Duncan's multiple range test is performed if there is a difference in influence between treatments. The treatment was said to have a significant effect if $P < 0.05$. Duncan's Multiple Range Test was used to determine the real difference between treatments. Statistical significance between treatments was said to be significantly different if $P < 0.05$.

RESULTS AND DISCUSSION

From the research results, the use of cassava flour as an adhesive in each treatment resulted in a value of 1.20 - 1.25 g/cm^3 on specific gravity, pile density resulted in a value of 0.68 - 0.67 g/cm^3, pile compaction density of 0.71 g/cm^3 and durability of 87.40 - 77.88% while for the nutrient content of pellets, the results obtained for each treatment were dry matter 94.86 - 94.23%, organic matter 87.36 - 88.60% and crude protein 22.33 - 16.39%. The effect of cassava flour in the mixture of pellets made from calliandra and lamtoro had a significant effect ($P < 0.05$) on durability and crude protein but no effect ($P > 0.05$) on specific gravity, pile density, pile compaction density, dry matter and organic matter. The research data can be seen in Table 3.

Effect of Binder Level on Specific Gravity of Mixed Pellets Kaliandra and Lamtoro

Specific gravity is a parameter used to measure the mass of pellets per unit volume. The specific gravity of the pellet is usually measured by measuring the weight of the pellet in a fixed volume. Typically, pellets are placed in a measuring cup which contains water, and then stirred until the air between the pellet particles disappears. The overall specific gravity value resulting from this research ranges from 1.14 - 1.32 g/cm^3. This value is not much different from the specific gravity of the substitute soybean meal with fermented *Indigofera zollingeriana*, namely 1.07 - 1.33 g/cm^3 (Febriyanti et al., 2019). The higher the specific gravity, the heavier the materials that can be accommodated in a container. Based on the results of Duncan's test, the adhesive level of the calliandra and lamtoro mixture pellets had no effect ($P > 0.05$) on the specific gravity of the pellets for each treatment. This is thought to be due to the ingredients in the ration additions having relatively the same particle size so that has implications regarding the difference in specific gravity produced.

Effect of Binder Level on Pellet Pile Density A mixture of Kaliandra and Lamtoro

Pile density is one of the influencing factors volume of space for storage. The pile density is to calculate the weight of the material to the volume of space without going through a compaction process. Pile density can determine density and become an automatic dosing factor feed. The overall value of the pile density resulting from this study ranged from 0.65 - 0.69 g/cm^3. These results are similar to those obtained by Harahap et al. (2020), who researched the differences in the composition of ration formulations by adding various levels of molasses, namely 0.41 g/cm^3, and similar to those obtained by Jaelani et al. (2016) on the effect of stacking and shelf life of pelleted feed, which resulted in a pile density ranging from 0.64 – 0.66 g/cm^3.

Based on the results of Duncan's test, the adhesive level of the calliandra and lamtoro mixture pellets had no effect ($P > 0.05$) on the density of the pellet pile for each treatment. This is thought to be because the specific gravity affects the pile density value. The pile density value is closely related to the specific gravity, where the higher the specific gravity, the higher the density of the pile and vice versa (Yatno, 2011). Pile density is a physical property that plays an important role in calculating the volume of space required for a material with a certain specific gravity, such as when filling mixers, elevators and silos. The treatments of P0 and P2 reached the highest specific gravity and required less space.

Effect of Binder Level on Compaction Density of Kaliandra and Lamtoro Mixed Pellet Piles

Pile compaction density is the ratio of the weight of the material to the volume of space it occupies after a compaction process, such as shaking. The pile compaction density value is greater than the pile density value because of the shaking that causes compaction, so that the volume per milliliter of material is smaller (Jaelani, 2016). The overall value of pile compaction density resulting from this research ranges from 0.69 – 0.73 g/cm^3. The results of this research are higher than the research of Harahap et al (2020) on differences in the composition of ration formulations, which added various levels of molasses, namely 0.44 g/cm^3. The results of Duncan's test show that the binder level of the calliandra and lamtoro mixture pellets had no significant effect ($P > 0.05$) on compaction density pile of pellets for each treatment. The pile compaction density value in this study shows a greater value than the pile density value due to compaction. Pile compaction density is influenced by pile density. This is in accordance with the statement of Royani and Herawati (2020) that pile compaction density and pile density of ration pellets are positively correlated, the higher the pile density value, the higher the pile compaction density and vice versa. Pile compaction density is useful for determining the capacity and accuracy of filling storage areas. The higher the stack compaction density value, the smaller the volume of space occupied and vice versa.

Effect of Binder Level on Durability of Kaliandra and Lamtoro Mixtured Pellets

Pellet durability is a parameter that indicates the resistance of pellet particles to physical treatment, such as friction, pressure, or shock. The value of pellet durability is usually expressed as a percentage of the number of intact feed pellets after physical treatment. The durability test uses a tumbling box machine with a speed of 50 rpm for 10 minutes. The overall durability values generated from this study ranged from 76.60% - 92.20%. The results of this study were lower when compared to the research of Harahap et al. (2020) on the addition of kepok banana peel flour in rations stored for different times, namely 96.65% - 98.05%. Based on the results of Duncan's test., there were differences for each treatment, meaning that the different levels of calliandra and lamtoro mixed pellet adhesives significantly ($P < 0.05$) affected the durability of pellets for each treatment.

The P0 treatment, or the pellets of the calliandra and lamtoro mixture without the addition of adhesive, showed the highest durability results. This result was thought to be due to the high protein content in the calliandra and lamtoro pellets, which allows the pellets to form even without cassava. The gelatinized starch and denatured protein during the heating process in the pellet machine will increase the durability of the pellets, making strong attachment that makes the pellets not easily damaged (Abdollahi et al., 2013). The content of protein and crude fiber in the material is a supporting factor for the high durability value. This is in accordance with the statement of Krisnan and Ginting (2009) that the physical quality of feed pellets such as durability is influenced by the chemical composition of the ingredients, namely fat, starch, protein, and fiber. However, the average value of the durability of all treatments can be said to be optimum as the opinion of Dozier et al. (2010) that the optimum quality of pellets has an index of impact resistance > 80%. impact resistance index > 80%.

Effect of Treatment on Dry Matter Content

One of the determinants of the quality of pelleted feed is the dry matter content of the pellets. Dry matter is the component in animal feed that remains after all water or moisture has been removed. Dry matter includes everything other than water, such as protein, fiber, fat, vitamins, and minerals. The range of dry matter content of pellets from caliandra and lamtoro mixtures in this study was 94.23% - 94.86%. Based on the results of Duncan's test, it is known that treatment has no significant effect ($P > 0.05$) on dry matter content. This is thought to occur because all research objects received the same treatment after being made into pellets, namely drying in the sun for the same length of time. Drying with direct sunlight is the most economical and easiest drying process. Aprillina (2023) argues that the dry matter content that has no significant effect is caused by the dry matter of the pellet constituent material itself, which is the same. This statement is supported by Kayaode et al (2020), who state that the same pellet constituent material causes the same dry matter content. In this study, all treatments consisted of the same material content, comprising calliandra, lamtoro, and dried cassava.

The proximate analysis results showed a high dry matter content of the pellets. This result was because the pelleting process involves the pressing (compaction) of materials, accompanied by heating when molding pellets. Ilmiawan (2015) stated that good pellets are characterized by dry matter content ranging from 88 - 86%. The moisture content of the pellets is also influenced by the drying process, where, when drying is carried out, the water component contained in the pellets evaporates due to heat from sunlight. The dry matter content of the pellets in this study is in accordance with SNI 8675:2018 concerning biomass pellets for energy with a maximum value of moisture content of 10%. Based on the dry matter value obtained from the proximate analysis, it can be concluded that the moisture content of the mixed pellets in this study is less than 10%. This is in accordance with the opinion of Wajizah (2014) that the lower the moisture content, the higher the dry matter content in the pellets.

The dry matter content in this study was higher compared to the dry matter content of Indigofera zollingeriana pellets mixed with cassava waste, which reached up to 30% in Aprillina's (2023) study, where the dry matter content ranged from 92.57% to 96.55%. Hidyatullah (2022) reported that calliandra twig pellets had a dry matter content ranging from 89.89% to 90.84%; this dry matter content was still lower than that of the pellets in this study. Dry matter content similar to this research was found in Yunita et al., (2022) with a dry matter content of 94.73% - 94.98% in *Indigofera zollingeriana* pellets mixed with sago flour. A high dry matter value can increase the storage capacity of feed to be more efficient. This is in accordance with the statement of Susilawati et al. (2012), which states that making forage pellets with a dry matter content of almost 100% will save forage storage space at least up to five times because fresh grass contains around 80% water. The process of making pellets needs to pay attention to several factors, including temperature and water content, because this will affect the quality of the ration produced, namely changes in structure, texture, digestibility, and anti-inflammatory content. nutrition (Wuri, 2015). The moisture content of feed ingredients can be determined after the feed ingredients are heated in an oven at 105ºC for 24 hours. Dry ingredients are calculated based on the difference between 100% minus the percentage of water content of a feed ingredient that is heated until its size remains constant.

Effect of Treatment on Organic Material Content

Organic materials include carbohydrates, proteins, fats, vitamins, and other organic compounds. Organic materials are all materials that can be burned into carbon dioxide, water, and ash under certain conditions in laboratories. The organic matter content is an important indicator of feed quality because it reflects the amount of nutrients that can be utilized by livestock.

The range of organic matter content of the pellet mixture of calliandra and lamtoro in this study was 87.36% - 89.57%. From the results of the Duncan test, the treatment did not significantly affect ($P > 0.05$) their organic materials due to the same organic ingredients that make up the pellets themselves. This is in line with research by Aprillina (2023), which stated that the treatment had no real effect on the organic material content. Dry materials are closely related to organic materials. In this research, feed pellets based on corncob contain complete organic ingredients that have a value comparable to dry ingredients, with organic ingredients ranging from 51.50% to 61.98% and dry ingredients ranging from 54.89% to 63.97%. This is similar to the results of the analysis in this study which contained organic matter and dry matter contents that did not differ too much numerically. Similar results were also found in research by Badewi and Hadisutanto (2020), who reported the dry matter and organic matter content of gamal-based complete feed, which had an organic matter content ranging from 78.17% - 82.09% and dry matter ranging from 93.25% - 94.93%.

The results of proximate analysis show that the average organic material content was not too different numerically. Yunita et al., (2022) stated that the organic material content of pellets is greatly influenced by the ash content of the pellet making material. Low ash content in the pellet material will make the organic material content of the pellets high, and vice versa if the ash content is high, the organic material content of the pellets will be lower because ash is not included in the organic material components. The constituent components of organic materials include crude fiber, protein, fat, carbohydrates, and NNFE. The cassava flour in this study serves as the adhesive for the mixed pellets. The organic matter content of the pellets that was not affected by the addition of cassava meal cassava flour is basically an energy/carbohydrate source feed that will be utilized by rumen microbes in ruminants. High organic matter indicates high digestibility of feed ingredients. The digestibility of organic matter is an indicator of the ease with which feed is degraded by rumen microbes (Almaeda et al., 2022).

Effect of Treatment on Crude Protein Content

Crude protein is the total protein content of feed, which is a key nutrient for growth, reproduction, and maintenance of animal health. Ensuring adequate crude protein levels in feed is crucial to support various physiological functions in livestock (Dumadi et al., 2021). Protein is an essential nutrient required for growth, tissue repair, milk production, and reproduction. The range of crude protein content of calliandra and lamtoro mixed pellets in this study was 16.39% - 22.33%. Based on Duncan's test, the addition of various cassava balances to the mixture of calliandra and lamtoro pellets had a significant effect ($P < 0.05$) on crude protein content. The protein content value of P3 is the lowest, with a crude protein content of 16.39% and P0 is the highest, with a crude protein content of 22.33% (Table 3). Crude protein content of calliandra and lamtoro leaves based on Table 1, shows a fairly high crude protein content with each value of 26.93% - 26.11%. Contrary to the two types of legumes used as the main ingredient of pellets, cassava flour has a relatively low crude protein content of 2.30%. This is because cassava flour is a type of tuber that is a source of carbohydrates so it has a high starch content.

Cassava flour in this study acts as a binder that can increase the shelf life of feed and additional sources of energy and carbohydrates. Carbohydrates and energy are needed by rumen microbes for digestion in ruminants. Based on the results obtained, the higher the use of cassava flour in making calliandra and lamtoro mix pellets, the lower the crude protein content. This is in line with the opinion of Herawati and Royani (2019) that the higher the cassava flour given, the lower the crude protein produced. Apart from the use of cassava flour, the decrease in crude protein content of mixed pellets is because the pelleting process involves a heating process that causes protein denaturation. Maier and Watkins (1999) stated that starch gelatinization and protein denaturation have been widely accepted as thermomechanical interactions that can improve pellet quality. Based on this statement, protein denaturation that occurs can improve the physical quality of pellets even though the crude protein content decreases. Another advantage of using cassava flour as an adhesive is that it is a source of easily digestible carbohydrates and energy for rumen microbes.

CONCLUSIONS

The addition of cassava flour in pellets of mixed calliandra and lamtoro has a significant effect on durability and crude protein but had no significant effect on specific gravity, pile density, pile compaction density, dry matter and organic matter content. The Pellet legumes without cassava gave the highest values for durability and crude protein at 87.40% and 22.33%. Therefore, this forage does not require cassava flour as a binder in making pellets.

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