Research Article

Substitution of Soybean Meal with Fermented Kapok Seeds and its Effect on the Growth Performance and Nutrient Digestibility of Sheep Raised in Stall with Palm Leaf and Galvanized Iron Roofs

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Abstract | Fermented kapok seeds (FKS) are rich in various nutrients, so they can be used as animal protein feed to replace soybean meal (SBM) in animal feed. This study aimed to study the effect of substituting soybean meal with fermented kapok seeds on the growth performance and digestibility of sheep reared in stalls with either palm leaf roofs or galvanized iron roofs. This study used a 2 x 5 split plot pattern randomized block design and was replicated three times. Livestock was grouped based on body weight. The main plots are two types of stable roofs (palm leaf roof and galvanized iron roof). The subplots were five levels of soybean meal being substituted with fermented kapok seeds, namely: R1: 100% Soybean Meal, R2: 75% Soybean Meal + 25% Fermented Kapok Seeds, R3: 50% Soybean Meal + 50% Fermented Kapok Seeds, 25% Fermented Kapok Seed Soybean + 75% Fermented Kapok Seeds and R5: 100% Fermented Kapok Seeds. The results showed that the stall roof showed a significant difference ($P < 0.05$) in body weight, dry matter intake, growth performance, and digestibility in rams, with the highest value in the palm leaf roof. Likewise, substituting soybean meal with fermented kapok seeds makes a significant difference ($P < 0.05$) with the highest value in the R4 and R5 diet groups. However, there was no interaction between the roof of the stall and substituting soybean meal with fermented kapok seeds ($P \geq 0.05$) on body weight, dry matter intake, growth performance, and digestibility in rams.

Keywords | Fermented kapok seeds, Soybean meal, Growth performance, Digestibility, Sheep

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INTRODUCTION

Hot environmental temperatures are a nuisance for livestock. According to Marcone et al. (2021), the body's heat load increases when the temperature rises. The heat will be released into the environment as water as an evaporation product through the mouth, skin, and lungs. According to Serrano et al. (2022), Sheep exposed to heat stress experienced changes in biological functions, such as decreased feed consumption and disturbances in protein metabolism, energy, and metabolites in the blood.

Sheep are ruminant livestock that can utilize low-quality forage, such as corn leaf forage, as food for high-quality products due to the presence of microorganisms in the rumen. Using forage as a single ration causes the livestock in question to only obtain food substances for their basic living needs and little for production. Efforts to meet the nutritional content of forages can be carried out by adding solid foods or concentrates (Gonzaga dos Santos et al., 2019). Concentrates can increase the ration's protein, carbohydrates, minerals, or vitamins (Gonzaga dos Santos et al., 2019). However, giving concentrate depends on the quality of the forage provided. The higher the forage quality, the fewer nutrients are supplied from the concentrate (Metkono et al., 2011). According to Nugroho et al. (2021), foods that contain a lot of concentrates and high starch content will cause a high concentration of microorganisms, so digestibility increases. Furthermore, Supratman et al. (2016) stated that increasing livestock productivity is only possible by providing high-quality concentrates.

One type of concentrate that can be given to ruminants is soybean meal. Soybean meal contains crude protein: 47.11%, fat: 2.46%, crude fiber: 3.69%, and Nitrogen Free Extract (NFE): 27.81% (Tangendjaja, 2020). The availability of soybean meal for the global animal industry is limited, where daily use competes with human needs. Soybean production cannot meet livestock needs, so soybean imports increase rapidly in Indonesia. The high price of soybean meal affects the cost of animal feed in Indonesia. Therefore other alternatives are sought. One alternative to soybean meal is kapok seed (*Ceiba Pentandra*). Kapok seeds are widely available in various regions in Indonesia, and the price is relatively low.

According to the Directorate General of Plantations (2019), kapok seed production in 2018 reached 83,820 tons, while the DPPPST (2020) reported that kapok seed production in Central Sulawesi during 2019 reached 385.59 tons per year. This condition supports the need for animal feed ingredients because the crude protein content in kapok seeds is relatively high, reaching 28.78% (Primadona et al., 2013).

One obstacle in using kapok seeds as animal feed is their low palatability. In addition, they contain a type of poison, cyclopropenoid acid, and as much as 10-13% of their fatty acids. Efforts to eliminate or reduce the adverse effects of kapok seeds can be fermented using the services of *Neurospora sitophila*. *Neurospora sitophila* can grow freely at 25° - 30°c with a humidity of 70 - 90% and a pH of 4.5 - 6.5. *Neurospora sitophila* mold can produce protease enzymes which have the role of breaking down kapok seed protein into easily digestible amino acids, lipase enzymes which break down fats or glycerides into free fatty acids and amylase enzymes which convert carbohydrates into simple sugars; or esters which produce flavors and Attractive aroma at the end of the product. In addition, *Neurospora sitophila* can protect its products from aflatoxin poisons and even reduce them. The chemical composition (g/kg DM) of kapok seed fermented was DM 457 g/kg; organic matter 922 g/kg; crude protein 106 g/kg; ether extract 62 g/kg; neutral detergent fiber 324 g/kg; acid detergent fiber 223 g/kg; and acid detergent lignin 51 g/kg (Kaewpila et al., 2018).

Research on combining soybean meal and fermented kapok seeds for fattening sheep is still limited. The findings of Hao et al. (2020) demonstrated that soybean meal could be effectively replaced by linseed meal in fattening sheep feeds. Kapok seeds contain 26.99% crude protein, 5.25% fat, and 21.10% nitrogen free extract (TSDP, 2017). In addition, kapok seed contains about lysine 2.30%, arginine 7.18%, aspartic acid 9.50%, methionine 0.87%, glutamic acid 12.41%, and trionin 2.43% (Kurnia et al., 2022). In addition, it has been reported that using kapok seeds is based on protein digestibility, the optimum enzyme concentration that gives the best digestibility value is 0.20% (68.43%) at an error rate of 0.05 (Primadona et al., 2013). However, it also contains Gossipol, an antifertility substance that affects the control of reproductive hormones and has a cytotoxic effect. Giving kapok seed extract (*Ceiba pentandra* Gaertn) can reduce testosterone levels and the weight of male rats' reproductive organs (Wiratmini et al., 2019). Therefore, we hypothesized that replacing an appropriate proportion of soybean meal with fermented kapok seeds could benefit lamb growth performance and nutrient digestibility. Therefore, this study aimed to determine the effect of replacing soybean meal portions with fermented kapok seeds in sheep feed on the growth performance and nutrient digestibility of sheep reared in stall with palm leaf and galvanized iron roofs.

MATERIALS AND METHODS

Animals And Experimental Treatment Diets

The study was conducted in the experimental land Faculty of Animal Husbandry and Fisheries, Tadulako University (Palu, Indonesia). The Animal Care and Ethics Committee of the Faculty of Animal Husbandry and Fisheries, Tadulako University, approved all animal procedures. Thirty local rams aged 8-10 months weighing 10-16 kg were randomly divided into three groups and assigned to one of the five treatment diets (Table 1).

The treatment diets contained a similar ratio of corn and Rice Bran but with different proportions the concentrate of SBM and FKS, which were as follows: R1 = 100% soybean meal; R2 = 75% soybean meal + 25% fermented kapok seeds; R3 = 50% soybean meal + 50% fermented kapok seeds; R4 = 25% soybean meal + 75% fermented kapok seeds; R5 = 100% fermented kapok seeds.

The manufacture of fermented kapok seeds consists of one part onggok (onggok is a solid waste in the form of dregs from cassava processing into tapioca) and four parts of kapok seeds. The two ingredients are mixed until homogeneous and steamed for 30 minutes, then cooled and sprinkled with *Neurospora sitophila* and stored in a place of 25°c - 30°c for two days. *Neurospora sitophila* was obtained from boiled corn cobs and stored at room temperature. The concentrate is 1.5% of the body weight of the animal. Comparison between forage and concentrate as a ration used in research is 50%: 50%. The pelleted total mixed ration was prepared using a horizontal feed mixer. The research implementation consisted of the first 10 days for an adaptation period and 50 days for the data collection stage.

Sample Collection And Analysis

Feed consumption was calculated daily. BW for each ram was measured on days 10 and 50 of the experimental period before the morning feeding. On day 51, all the sheep were moved to individual metabolism stalls to determine the apparent total tract digestibility. After five days of adaptation, the quantity of feeds and feces was recorded daily for each ram for five consecutive days.

The fecal samples collected for five days were then mixed homogeneously, and then a sub-sampling of 10% of the total sample was carried out for further analysis for the content of crude protein, crude fiber, and crude fat. The feed and feces samples obtained during the sampling period were baked in the oven at 65° C for 48 hours. Furthermore, the feed and feces samples were milled finely for analysis of crude protein, crude fat, and crude fiber content. The content of crude protein, crude fiber, and crude fat was determined following the Association of Official Analytical Chemists (2000) procedures. The chemical composition of R1-R5 is presented in Table 2.

Experimental Design

This study used a 2 x 5 Split Plot Pattern Randomized Group Design with three replications. Grouping livestock based on body weight. The main plot consists of 2 types of stable roofs, namely:

1. Stalls with palm leaf roofs
2. Stalls with galvanized iron roofs

Subplots consist of 5 levels of substitution of soybean meal with fermented kapok seeds, namely:

R1 = 100% soybean meal
R2 = 75% soybean meal + 25% fermented kapok seeds
R3 = 50% soybean meal + 50% fermented kapok seeds
R4 = 25% soybean meal + 75% fermented kapok seeds
R5 = 100% fermented kapok seeds

Statistic Analysis

Sheep production performance data such as body weight, dry matter intake, growth performance, and digestibility were analyzed using the PROC MIXED procedure from SAS (version 9.4; SAS Institute Inc. 2016, Cary, NC, USA), with stall treatment as plots main and substitution of soybean meal with fermented kapok seeds as subplots and body weight of sheep in the treatment group. Statistical significance was defined at $p < 0.05$; the trend is expressed at $0.05 < p \leq 0.10$.

RESULTS AND DISCUSSION

Dm Intakes And Growth Performances

Dry matter intake and growth performance in rams in each treatment is shown in Table 3.

The ram's body weight, dry matter intake, growth performance, and digestibility were significantly ($p < 0.05$) influenced by the type of roof of the stall (Table 3 and Table 4). Likewise, the feed treatment (substitution of soybean meal with fermented kapok seeds) significantly ($p < 0.05$) affected the ram's body weight (Table 3). However, the interaction effect between the stall's roof type and the substitution of soybean meal with fermented kapok seeds was insignificant (data not presented). It is suspected that there is a change in response caused by the effect of errors or residues due to random coincidences, so the cooperation between the combined factors is considered free (Tenaya, 2015).

The body weight of rams was significantly ($p < 0.05$) higher in the stall with a palm leaf roof when compared to the galvanized iron roofed stall. A palm leaf roof is a bad temperature conductor, receiving and reflecting heat. In contrast, a galvanized iron roof is a good temperature conductor (Ponni and Baskar, 2015), receiving heat and continuing it into the stall. The temperature of the stall using a palm leaf roof was 24°C - 30°C or an average of 27°C, while the temperature in the stall using a galvanized roof was 24°C - 36°C or an average of 30°C. An increase in the temperature of the stall can cause ration consumption to decrease so that the sheep's growth slows down. At high ambient temperatures, livestock will try to dissipate the heat received so that the temperature remains constant by reducing consumption and increasing evaporation. According to Gonzaga dos Santos et al. (2019), every 1°C increase can reduce ration consumption by 1.7%. In addition, if the temperature continues to increase, it can affect the central nervous system so that ration consumption decreases and water consumption increases, resulting in reduced sheep growth. Consumption of dry matter will decrease if there is an increase in temperature. According to Serrano et al. (2022), heat stress could affect feed consumption, where in heat stress with an ambient temperature of 25°C - 35°C, ration consumption decreases by 3 - 10%. This is relevant to the findings of Sudita (2016) and Dwipayana et al. (2019), who stated that livestock shelters affect dry matter consumption. There tends to be a higher level of dry matter consumption in shelters due to a higher

Table 1: Arrangement and chemical composition of experimental rations (%)

	Treatment				
Items	**R1**	**R2**	**R3**	**R4**	**R5**
Ingredients					
Forage Corn	50	50	50	50	50
Milled Corn	5	5	5	5	5
Rice Bran	5	5	5	5	5
Coconut Cake	20	20	20	20	20
Soybean meal	20	15	10	5	0
Fermented Kapok Seeds	0	5	10	15	20
Amount	100	100	100	100	100
Composition					
Dry Matter	54.00	54.00	54.00	54.00	54.00
TDN	60.25	60.20	60.15	60.10	60.05
Proteins	14.20	14.16	14.11	14.06	14.01
Crude Fiber	7.00	8.11	9.22	10.33	11.44
Fat	3.76	4.06	4.37	4.67	4.98

Note: R1 = 100% soybean meal; R2 = 75% soybean meal + 25% fermented kapok seeds; R3 = 50% soybean meal + 50% fermented kapok seeds; R4 = 25% soybean meal + 75% fermented kapok seeds; R5 = 100% fermented kapok seeds

Table 2: Composition and chemical composition (%) of soybean meal (SBM) and fermented kapok seeds (FKS)

Composition	**R1**	**R2**	**R3**	**R4**	**R5**
Dry Matter	17.2	17.2	17.2	17.2	17.2
TDN	14	14	13.9	13.9	13.8
Crude Proteins	8.52	8.51	8.46	8.42	8.37
Crude Fiber	1.17	2.28	3.36	4.5	5.61
Fat	0.34	0.65	0.95	0.26	1.56

Note: R1 = 100% soybean meal; R2 = 75% soybean meal + 25% fermented kapok seeds; R3 = 50% soybean meal + 50% fermented kapok seeds; R4 = 25% soybean meal + 75% fermented kapok seeds; R5 = 100% fermented kapok seeds

Table 3: Dry matter intake and growth performance in rams fed five experimental diets

Treatment	**BW (kg)**	**DMI (gr/day)**	**ADG (gr/day)**	**Feed efficiency**
Stall roof				
Palm leaf	23.84a	533.73a	101.85a	0.192a
Galvanized iron	16.45b	461.45b	70.25b	0.153b
Substitution of SBM with FKS				
R1	16.97a	485.95a	75.48a	0.155a
R2	18.30a	484.89a	79.64ab	0.165a
R3	19.61ab	494.91ab	83.73ab	0.170ab
R4	21.81bc	507.55b	91.24bc	0.178ab
R5	24.02c	514.66b	100.17c	0.195b

Note: different letters in the column indicate significantly different treatment at α = 5%; BW = Body Weight; DMI = Dry Matter Intake; ADG = average daily gain.

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Table 4: Digestibility in rams fed the five experimental diets (%)

Treatment	CP	CF	Fat
Stall roof			
Palm leaf	64.60a	42.33a	64.20a
Galvanized iron	61.93b	39.93b	57.20b
Substitution of SBM with FKS			
R1	59.83a	37.83a	57.50a
R2	61.00a	37.83a	58.83ab
R3	64.00b	39.33a	60.83abc
R4	65.17bc	43.67b	62.83bc
R5	66.33c	47.00b	63.50c

Note: different letters in the column indicate significantly different treatment at α = 5%; CP = Crude Protein; CF = Crude fiber

level of digestibility. The high level of digestibility correlated with the level of dry matter consumption. According to McDonald et al. (2002), feed digestibility and feed digested rate affect ration consumption.

Feed treatment responded positively to the BW of rams (P < 0.05), with the highest value in the R4 and R5 diet groups (Table 3). This indicates that fermented kapok seeds could replace soybean meal as animal feed. Hosoda et al. (2019) and Botkin et al. (1988) state that various types of rations containing dry matter, protein, crude fiber, and energy can increase body weight. Protein functions to form new tissue and replace damaged tissue (Harm et al., 2022). Kapok seeds can replace soybean meal after processing by fermentation. In fermentation, *Neurospora sitophila* can remove the toxic cyclopropenoid acid present in kapok seeds. Grubješic´et al. (2020) stated that fermentation causes improvements to specific properties of the basic food ingredients, changes in organoleptic properties, and can reduce toxic compounds. Other benefits of fermentation are changing the taste and feed aroma for the better, increasing durability, and reducing toxic compounds from the basic ingredients (Bernardini et al., 2012). In addition, fermented feed will have better palatability, so sheep prefer it (Palupi et al., 2023). Some studies have reported the protein content in kapok seeds is 28.79% (Primadona et al., 2013) and 31.70% (Hartutik, 2001), but the results of this study are lower. FKS is a good protein source for rams at concentrations of up to 54% of DM. In the present study, the partial replacement of SBM with FKS affects the DMI and increases the growth performance. Studies have shown that FKS and its by-products can improve the growth performance of animals (Primadona et al., 2013). Kapok fiber has a hollow tubular structure with a diameter of 14.5 ± 2.4 μm (Huang and Lim, 2006) and a length ranging from 0.8 to 3 cm (Vázquez Yanes et al., 1999). Due to these morphological characteristics, kapok fiber has been used for heavy metal absorption (Chung et al., 2008); this indicates that substituting soybean meal with fermented kapok seeds can improve livestock health. According to Wu et al., 2017 increased feed efficiency might be attributed to the balanced amino acid profile. Additionally, Quezada and Cherian (2012) and Hao et al. (2020) concluded that high antioxidant activity and higher phenolic and flavonoid content would enhance ADG animals. However, the actual concentration of those functional components in FKS and their effects on rams should be analyzed in the future.

Digestibility

The digestibility in CP, CF, and fat of ram livestock rations during the study is shown in Table 4.

Substitution of Soybean Meal with Fermented Kapok Seeds at increasing levels increased digestibility in CP, CF, and fat (P = 0.05), with the highest value in the R4 and R5 groups. The highest crude protein digestibility results were in R4 (65.17%) and R5 (66.33%). These results are higher than the research by Rahman et al. (2013), which stated that the digestibility of crude protein in goats fed palm kernel meal was 52.1%. However, this is lower than the results of Třináctý et al. (2009) study, which stated that the digestibility of crude protein in goats-fed corn cobs was 70.1%. Hao et al. (2020) reported that a positive effect on nutrient digestibility in sheep could occur because different ingredients are combined in appropriate proportions. Digestibility can be influenced by several factors, such as the composition of feed ingredients, the composition ratio between one feed ingredient and another feed ingredient, feed treatment, enzyme supplementation in feed, livestock, and feed level (McDonald et al., 2002). Gultom et al. (2016) added that the administration of rations with physical (chooper), biological (chooper and Aspergillus niger), and chemical (chooper and urea) treatments affected the digestibility of crude protein. Paramita et al. (2008) stated that in vivo, the quality of the feed ingredients given was seen through consumption and the magnitude of the digestibility value, which indicates the amount of nutrients that can be used as necessities for life and growth. The higher digestibility coefficient of crude protein is directly proportional to the increase in the body weight of livestock. Tillman et al. (2005) stated that one factor affecting the digestibility of crude protein is the protein content in the ration consumed by livestock. Rations with low protein content generally have low digestibility and vice versa. Therefore, the level of protein digestibility is influenced by the protein content of the ration ingredients and the amount of protein that enters the digestive tract.

The highest crude fiber digestibility results were in R4 (43.67%) and R5 (47.00%). These results are lower than the results of Antisa et al. (2020) study, which stated that the digestibility of crude fiber in corn stalks in rams was 56.44%. According to McDonald et al. (2002), the fraction of feed fiber greatly determines digestibility in the amount and chemical composition of the fiber itself. Reinforced by the opinion of Tillman et al. (2005) states that the digestibility of crude fiber depends on the crude fiber content in the ration and the amount of crude fiber consumed. Too high levels of crude fiber can interfere with the digestion of other substances. In addition to the content and amount of crude fiber in the ration, another factor that affects the digestibility of crude fiber is the activity of cellulolytic bacteria in the rumen. Maynard et al. (2005) stated that several factors, including fiber content in the feed, the composition of the crude fiber constituents, and the activity of microorganisms, influenced the digestibility of crude fiber. The highest crude fat digestibility results were in R4 (62.83%) and R5 (63.50%). These results are lower than the results of Mastopan et al. (2014) study, which stated that the digestibility of crude fat in a diet Containing Oil Palm in rams was 95.76%. This is to the statement of Prakash et al. (2023), which states that the digestibility of a feed depends on the quality of the nutrients contained in the feed. In addition, it affects the growth of microorganisms. Tillman et al. (2005) stated that digestibility was not only influenced by the composition of a feed but also affected by the composition of other foods consumed with the feed.

CONCLUSION

We evaluated the substitution of soybean meal with fermented kapok seeds on body weight, dry matter intake, growth performance, and digestibility in rams. The results showed that livestock stalls with palm leaf roofs are better livestock-rearing facilities than those with galvanized iron roofs. The soybean meal can be substituted with fermented kapok seeds for animal feed. Fermented kapok seeds are a good source of protein, fiber, and fat, so they are a healthy food choice for livestock. Further research is needed regarding the actual concentration of the functional components of fermented kapok seeds and their effects on livestock. In addition, it is also necessary to carry out a cost-efficiency analysis for the commercialization of the proposed feed.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest regarding the publication of this article.

NOVELTY STATEMENT

A study on the Substitution of Soybean Meal with Fermented Kapok Seeds and its Effect on the Growth Performance and nutrient digestibility of Sheep has never been done before.

AUTHORS CONTRIBUTION

Abdullah Naser conceptualized this study. Then, Abdullah Naser and Effendy surveyed the literature and drafted and revised the manuscript, while Nirwana and Sri Wulan edited and suggested changes. In addition, Zaenal and Mustafa also studied and played a part in drafting the manuscript. Finally, all authors checked and approved the final version of the manuscript for publication in this journal.

REFERENCES

Antisa A., Natsi A., Syahrir S. (2020) Digestibility of crude protein, crude fat and crude fiber complete ration contains the main ingredients of corn stalk in Capra aegagrus. Bulletin Nutrisi dan Makanan Ternak., 14(2): 1-13. https://doi.org/10.20956/bnmt.v14i2.12548

Association of Official Analytical Chemists (AOAC). (2000). Official methods of analysis, 17th edition. AOAC, Arlington, VA, USA

Bernardini D., Gerardi G., Peli A., Costa N., Amadori M., Segato S. (2012). The Effects of different enviromental conditions on thermoregulation and clinical and hematological variables in long-distance road-transported calves. J. Anim. Sci., 90: 1183-1191. https://doi.org/10.2527/jas.2011-4113

Botkin M.P., Field R.A., Johnson C.L. (1988). Sheep and woll. scinece, production and management. Prentice Hall, Inc. Englewood Cliffs, New Jersey.

Chung B.Y., Cho J.Y., Lee M.H., Wi S.G., Kim J.H., Kim J.S., … et al. (2008). Adsorption of heavy metal ions onto chemically oxidized Ceiba pentandra (L.) Gaertn. (kapok) fibers. J. Appl. Biol. Chem., 51:28–35. https://doi.org/10.3839/jabc.2008.006

DPPPST (Dinas Perkebunan and Peternakan Provinsi Sulawesi Tengah). (2020). Livestock Statistics. Department of Plantation Dati I Province of Central Sulawesi. https://

sulteng.bps.go.id/subject/24/peternakan.html
Dwipayana I.K.B., Suryani N.N., Mahardika I.G. (2019). Nutrition consomption, dry matter and dry weight digestability of bali cattle ration in evacuation zone at Nongan Vilage. Karangasem. Peternakan Tropika, 2019; 7(2): 559- 569. https://ojs.unud.ac.id/index.php/tropika/article/view/49945
Gonzaga dos Santos A.C., Yamin M., Priyanto R., Maheshwari H. (2019). Physiological response on local sheep in rearing system and different concentrate. J. Ilmu Produksi dan Technol. Hasil Peternakan, 7(1): 1-9. https://doi.org/10.29244/jipthp.7.1.1-9
Grubješic G., Titze N., Krieg J., Rodehutscord M. (2020). Ruminal fermentation characteristics and related feeding values of compound feeds and their constituting single feeds studied by using in vitro techniques. Animal, 2020; 14:9: 1829–1840. https://doi.org/10.1017/S1751731120000889
Gultom E.P., Wahyuni T.H., Tafsin M. (2016). Digestibility of crude fiber and crude protein diet containing oil palm frond treated by physical, biological and chemical on sheep. J. Peternakan Integratif, 4(2): 193-202. https://doi.org/10.32734/jpi.v4i2.2795
Hao X.Y., Yu S.C., Mu C.T., Wu X.D., Zhang C.X., Zhao J.X., Zhang J.X. (2020). Replacing soybean meal with flax seed meal: effects on nutrient digestibility, rumen microbial protein synthesis and growth performance in sheep. Animal., 14:9: 1841–1848. https://doi.org/10.1017/S1751731120000397
Harm T.A., Smith J.D., Cassmann E.D., Greenlee J.J. (2022). Combinatorial treatment of brain samples from sheep with scrapie using sodium percarbonate, sodium dodecyl sulfate, and proteinase K increases survival time in inoculated susceptible sheep. Res. Vet. Sci., 152: 497–503. https://doi.org/10.1016/j.rvsc.2022.09.002
Hartutik H. (2001). The effect of using kapok seed meal (*Ceiba pentandra*, Gaertn.) in concentrate on consumption and digestibility of rations in male PFH cattle with rumen fistula. Media Peternakan J. Anim. Sci. Technol., 24(3): 91-93. https://journal.ipb.ac.id/index.php/mediapeternakan/article/view/11661
Hosoda K., Ohmori H., Nakamura Y.N., Kamiya M. (2019). Effect of inclusion rate of corn silage in ensiled total mixed ration on dry matter intake, nutrient digestibility, and ruminal fermentation in Japanese Wagyu steer. Livest. Sci., 229: 126-130. https://doi.org/10.1016/j.livsci.2019.09.028
Huang X., Lim T. (2006). Performance and mechanism of a hydrophobic–oleophilic kapok filter for oil/water separation. Desalination. 190: 295–307. https://doi.org/10.1016/j.desal.2005.09.009
Kaewpila C., Sommart K., Mitsumori M. (2018). Dietary fat sources affect feed intake, digestibility, rumen microbial populations, energy partition and methane emissions in different beef cattle genotypes. Animal., 12(12): 2529–2538. https://doi.org/10.1017/S1751731118000587
Kurnia A., Muskita W.H., Hamzah M., Yusnaini Y., Abidin L.O.B. (2022). Replacement of soybean meal with kapok seed oil waste meal (Ceiba Petandra (L.) Gaertn.) on growth, survival and intestine histology of milk fish (Chanos-Chanos Forsskal, 1775). IOP Conf. Series: Earth Environ. Sci., 1118: 012011. https://doi.org/10.1088/1755-1315/1118/1/012011
Marcone G., Kaart T., Piirsalu P., Arney D.R. (2021). Panting scores as a measure of heat stress evaluation in sheep with access and with no access to shade. Appl. Anim. Behav. Sci. 240: 105350. https://doi.org/10.1016/j.applanim.2021.105350
Mastopan, Ma'ruf Tafsin M., Hanafi N.D. (2014). Crude Fat Digestibility and TDN (Total Digestible Nutrient) of diet containing oil palm frond treated by physical, chemical, biological and their combination on sheep.
Maynard L.A., Loosil J.K., Hintz H.F., Warner R.G. (2005). Animal nutrition. McGraw-Hill Book Company. New York, USA.
McDonald P., Edward R.A., Genhalgh B.F.D. (2002). Animal nutrition. 2nd. Longmen, New York.
Metkono O.A.F., Kardaya D., Sudrajat D. (2011). Local sheep performances FED natural grass and tahu waste product under traditional rearing. J. Pertanian, 2(2): 88-96. https://ojs.unida.ac.id/jp/article/view/562
Nugroho J., Purwadi, Suhardi. (2021). The effect of adding beer druge in the rate on the growth and consumption of local male sheep. Trop. Anim. Sci., 3(2): 16-21. https://ejournal.uby.ac.id/index.php/tas/article/view/707
Palupi R., Lubis F.N.L., Pratama A.N.T., Muhakka. (2023). Effects of lactobacillus-fermented feed on production performance and carcass quality of broiler chickens. J. World Poult. Res., 13(1): 127-135. https://doi.org/10.36380/jwpr.2023.14
Paramita W.L., Susanto W.E., Yulianto A.B. (2008). Digestibility and consumption of dry matter and organic matter in haylage complete feed ongole crossbreed steers. Media Kedokteran Hewan, 24: 59-62. http://journal.unair.ac.id/download-fullpapers-10-Widya%20MT.pdf
Ponni M., Baskar R. (2015). Comparative study of different types of roof and indoor temperatures in tropical climate. Int. J. Engineer. Technol., 7(2): 530-536. https://www.researchgate.net/publication/282926251_Comparative_study_of_different_types_of_roof_and_indoor_temperatures_in_tropical_climate
Prakash S., Maas R.M., Peter-Melvin M.M.F., Kokou F., Schrama J.W., Philip A.J.P. (2023). Effect of feed ingredients on nutrient digestibility, waste production and physical characteristics of rainbow trout (Oncorhynchus mykiss) faeces. Aquaculture., 574: 739621. https://www.sciencedirect.com/science/article/pii/S0044848623003952 https://doi.org/10.1016/j.aquaculture.2023.739621
Primadona F., Wardoyo S.E., Hasan O.D.S. (2013). Protein digestibility of kapok seeds in vitro for fish feed. Jurnal Sains Natural Universitas Nusa Bangsa., 3(2): 112 – 128. https://doi.org/10.31938/jsn.v3i2.61
Quezada N., Cherian G. (2012). Lipid characterization and antioxidant status of the seeds and meals of Camelina sativa and flax. European J. Lipid Sci. Technol., 114: 974–982. https://doi.org/10.1002/ejlt.201100298
Rahman M.M., Abdullah R.B., Wan Khadijah W.E., Nakagawa T., Akashi R. (2013). Feed intake, digetibility and growth performance of goats offered napiergrass suplemented with molasses proctected palm karnel cake and soya waste. Asian J. Anim. Vet. Adv., 8(3): 527-534. https://doi.org/10.3923/ajava.2013.527.534
Serrano J.O., Mayea A.L., Villares-Garachana A., ... et al. (2022). Effect of short-term radiation stress on physiological and hematological parameters in Pelibuey sheep in Cuba. Small Rumin. Res., 210: 106679. https://doi.org/10.1016/j.smallrumres.2022.106679
Sudita I.D.N. (2016). Fulfillment of nutrients for bali cows in the

"SIMANTRI" program livestock group in Bali. Prosiding Seminar Nasional Peternakan,. 25 Agustus 2016; Makasar (ID): Universitas Hasanuddin. pp 57–66.

Supratman H., Setiyawan H., Budinuryanto D.C., Fitriani A., Ramdani D. (2016). Effect of balance complete forage and feed concentrate on consumption increse of body weight and sheep feed conversion. J. Ilmu Ternak., 16(1): 31-35. https://jurnal.unpad.ac.id/jurnalilmuternak/article/view/9822

Tangendjaja B. (2020). Nutrient content of soybean meal from different origins based on near infrared reflectance spectroscopy. Indonesian J. Agricult. Sci., 2020; 21(1): 39–47. https://doi.org/10.21082/ijas.v21n1.2020.p39-47

Tenaya I.M.N. (2015). Interaction effects and interaction values in factorial experiments. AGROTROP, 2015; 5(1): 9-20. https://ojs.unud.ac.id/index.php/agrotrop/article/view/18369

Tillman A.O., Hartadi A., Reksohadiprodjo, Prawirokusumo S., Lebdohadiprodjo. (2005). Ilmu Makanan Ternak Dasar. Gajah Mada University Press, Yogyakarta.

Třináctý J., Křížová L., Richter M., Černý V., Říha J. (2009) Effect of rumen-protected methionine, lysine or both on milk production and plasma amino acid of high-yielding dairy cows. Czech J. Anim. Sci., 54(6): 239–248. https://doi.org/10.17221/1730-CJAS

TSDP (2017). Kapok seed meal as poultry feed. Teknologi solusi dunia peternakan (TSDP). https://www.peternakankita.com/bungkil-biji-kapuk/

Vázquez Yanes C., Batis MuñozAlcocer Silva A.I., Gual Díaz M.I., Sánchez Dirzo M.C. (1999). Árboles y arbustos nativos potencialmente valiosos para la restauración ecológica y la reforestación. México: CONABIO - Instituto de Ecología, UNAM.

Wiratmini N.I., Setyawati I., Narayani I. (2019). Rats testosterone level and reproductive organ weight treated by kapok (Ceiba pentandra Gaertn.) seed extract. IOP Conf. Series: Earth Environ; Sci;, 347: 012023. https://doi.org/10.1088/1755-1315/347/1/012023

Wu X.D., Zhao J.X., Liu W.Z., Jin Y.Q., Ren Y.S., Zhang C.X., Zhang W.J., Xiang B.W., Zhang J.X. (2017). Effect of replacement of soybean meal by oil cake of flax seed in diet on growth performance, meat quality, fatty acid content and blood biochemical indicators of sheep. Chinese J. Anim. Vet. Sci. 78: 1260–1270.