Research Article

Effect of Yeast and Curcuma Supplementation in Palm Kernel Cake Local Feed on Jawarandu Goats' Performance

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Abstract | This study aims to evaluate the effect of yeast and Curcuma supplementation in feed on the performance of Jawarandu goats. In this study were used total of 20 goats Jawarandu, 1.-1,5 years old, weighing about 13,46±1.55kg. were divided into four treatments consisting of TR0 (basal ration of palm waste-based local feed without Curcuma and yeast), TR1 (basal diet with 0.5% yeast), TR2 (basal diet with 2% Curcuma flour) and TR3 (basal diet with 0.5% yeast and 2% Curcuma flour). Meanwhile, the variables measured include consumption, dry matter digestibility, organic matter, crude protein, NDF, ADF, daily body weight gain, feed conversion, and blood metabolism. Furthermore, the data obtained were analyzed using analysis of variance while differences between treatments were further analyzed with Duncan's test. The results showed that yeast + curcuma (TR3) supplementation had a significant performance by increasing consumption, dry matter digestibility, organic matter, crude protein, as well as neutral detergent (NDF), and acidic detergent fiber (ADF), average daily body weight gain, feed conversion, and blood metabolic profile (total protein, glucose, cholesterol, Ca and P). A mixture of yeast and curcuma supplementation from local feed-based rations significantly improved the performance of the Jawarandu Goat. concluded that the use of 0.5% yeast and 2% temulawak was the best in goat ration supplementation. Based on the results, it was concluded that the use of yeast ang curcuma supplements improves the performance of goat production.

Keywords | Jawarandu Goat, Digestibility, Daily gain, Performance

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INTRODUCTION

Increasing the production of Jawarandu goats as beef goats is done by increasing the livestock population, breeding and improving feed quality. The feed given is usually in the form of agricultural waste with low nutritional quality, therefore livestock productivity is not often in line with farmers' expectations. One of the efforts made to increase goat productivity is the use of natural feed additives such as Curcuma and yeast. The application of natural feed additives in the from of curcuma and yeast for livestock is more recommended rather than chemical drugs which leave chemical residues on the meat causing harm to humans' health.

Curcuma (*C. xanthorrhiza, Roxb*) is generally reportedly contains bioactive curcuminoids, essential oils, and xanthorrizol, which have broad functions as anti-inflammatory, antiviral, antitumor, hypocholesterolemic, antihepatotoxic, anticancer, and analgesics (Sumiwi and Sidik, 2008). In addition, it also functions as an anticandidal, antifungal, antimalasezia (anti-yeast as in dandruff), antibiofilm (Rukayadi et al., 2008) as well as antimicrobial, anti-inflammatory, anticancer (apoptosis, antiangiogenesis),

detoxification, neuroprotection, and antiaging (Hwang, 2008). Application of 2% the curcuma extract increased bile production, suppressed tissue swelling and LDL plasma in rabbits (Wientarsih and Meulen, 2008) and also showed high antibacterial (500 ug/ml) and antioxidant (100.22 ug/ml) activity compared to other solvents (Nurlidar dan Chosdu, 2008).

Meanwhile, yeast is a nutritional supplement that improves fermentative conditions in the rumen, thereby impacting milk performance and production (Sulistyowati et al, 2010). Moallem et al. (2009) reported that yeast addition had a significant effect on microorganisms in the digestive tract, especially in the rumen. Furthermore, the addition of yeast culture stimulates rapid growth of rumen anaerobic bacteria, therefore, the bacteria population, especially cellulolytic and lactic acid bacteria increases. Schingoethe et al. (2004) reported that the application of 60 g/head yeast to goats increased body weight gain by 0.5 kg/day.

The use of concentrate by breeders is rare because it is quite expensive (Hayyan et al., 2010; Ali et al., 2013). Therefore, to manage the high price of concentrate, locally available concentrates are needed to improve livestock performance and farmers' income. Palm kernel meal is one of the agro-industrial by-products of palm oil processing available at low prices and for small-scale farming. Furthermore, palm kernel meal supplementation has been shown to increase livestock consumption and productivity due to its higher water-soluble carbohydrates and unsaturated fatty acids contents (Rahman et al., 2013) which reduces methane gas production (Martinez et al., 2010; Ajayi et al., 2005). A frequently used forage to increase livestock production in the tropics is Glliricidia sepium because of its higher crude protein content, especially branched amino acids. Furthermore, the addition of amino acids in rations increased cellulolytic bacteria growth. This is demonstrated in the increased digestibility of dry matter (DM), organic matter (OM), and neutral detergent fiber (NDF) (Rahman et al., 2013: Puastuti et al., 2014; Tedeschi et al., 2015). Several studies reported that Curcuma supplementation increased cellulolytic bacteria population and reduced lactic acid accumulation and oxygen concentrations in the rumen thereby increasing the use of starch in the ration (Andriyanto et al., 2012; Souza et al., 2010). Other studies have also shown that Curcuma supplementation increased dry matter digestibility (DM), crude protein organic matter (OM), and fiber fraction, as well as microbial efficiency (Rostini et al., 2014; Puastuti et al., 2017; Chanjula et al., 2011). For this reason, it is necessary to modify nutrients that have dual functions, increase goat productivity by utilizing Curcuma and yeast as supplements and palm kernel cake as a source of concentrate constituent materials to improve goat performance. Therefore, this study aims to evaluate the effect of yeast and curcuma supplementation on Jawarandu goat performance.

MATERIALS AND METHODS

This study was conducted for four months in Gunung Kupang, Cempaka Village, Banjarbaru City, South Kalimantan Province, Indonesia. In this area, farmers cultivate rubber and oil palm plantations.

Research design

In this study were used total of 20 goats Jawarandu, 1.-1,5 years old, weighing about 13,46±1.55kg. (coefficient of diversity 12.14%) and were randomly allocated into four experimental treatments. Livestock was housed in individual cages (1.0 x 1.5 m), meanwhile, the trial was conducted for eight weeks and consisted of a two-week preliminary period, four weeks of the adaptation, and two weeks of feed intake, digestibility and calculated feces excretion measurements. In addition, bodyweight was measured every week before breakfast.

Feed

The experimental feed consisted of four diets namely TR0 (basal ration of palm waste-based local feed without curcuma and yeast), TR1 (basal diet with yeast 0.5%), TR2 (basal diet with 2% curcuma flour) and TR3 (basal ration with yeast 0, 5% and curcuma flour 2%.

Livestock were placed in individual cages to facilitate feeding as well as the storage of feces and urine, the animals were given parasitic worm medicine (Kalbazen) and vitamins before treatment. Furthermore, the rations were given ad-libitum for all treatments based on the dry matter requirement of goats up to 3.5% of live weight (NRC 2007). The treatment rations were given twice a day, in the morning at 08.00 and in the afternoon at 16.00. The feed nutrient composition is presented in Table 1.

Feed Consumption and Digestibility

Feed consumption was calculated by weighing the feed given, minus the residue after 24 hours each day. Furthermore, Samples of feed and feed residues are taken every day, both forage and concentrate for analysis.

Sample Chemical Analysis

Samples from swamp forage, Glliricidia sepium, palm kernel cake, and feces samples were analyzed proximately according to (AOAC, 2005), while neutral detergent fiber (NDF), and acid detergent fiber (ADF) were analyzed in line with (Van Soest et al., 1991). Furthermore, nutrient content was analyzed by Proximate (AOAC, 2005), while NDF and ADF were analyzed according to Van Soest (1990). Curcumin was analyzed by the maceration meth

Table 1: Nutrient content of feed ingredients (100% dry matter)

Ingredient	Treatment			
	TR0	TR1	TR2	TR3
Rice bran	13,42	13,42	13,42	13,42
Ground corn	10,20	10,20	10,20	10,20
Soy bean meal	5,89	5,89	5,89	5,89
Palm kernel cake	10,49	10,49	10,49	10,49
Mineral	0,53	0,53	0,53	0,53
Gliricidia sepium	20,00	20,00	20,00	20,00
Swamp Grass	40	40	40	40
Yeast	-	0.5	-	0.5
Curcuma powder	-	-	2.0	2.0
Nutrition (DM base):				
Dry matter (%)	94.13	93.96	93.72	94.06
Ash (%)	8.48	7.96	7.82	8.21
Crude protein (%)	14,30	14,10	14.68	14.54
Crude fat (%)	7.66	8.14	7.96	8.77
Crude fiber (%)	20,80	20.57	19.60	19.51
Nitrogen free extract (NFE) (%)	49.12	49.18	49.43	49.60
Neutral detergent fiber (NDF) (%)	70.14	70.69	72.51	73.17
Acid detergent fiber (ADF) (%)	29.02	29.14	29.68	29.87
Ca (%)	0.71	1.10	1.02	0.89
P (%)	0.46	0.51	0.54	0.56
Ca/P	1.30	1.36	1.79	2.90
Oleate (%)	0.46	0.46	0.46	0.46
Valin (%)	0.83	0.83	0.83	0.83
Leusine (%)	0.16	0.16	0.16	0.16
Isoleusine (%)	0.18	0.18	0.18	0.18
Tannin (%)	0.47	0.49	0.49	0.49
Curcumin (%)	-	-	0.14	0.12

Note : Data were analysed by Nutrition and Feed Science Laboratory, Faculty of Agriculture Islamic University Of Kalimantan

Table 2: Consumption (g/d) of dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF), and acidic detergent fiber (ADF) by Jawarandu goat.

Intakes (g/d)	TR0	TR1	TR2	TR3	SEM	P value
Dry matter	812.44^{a}	824.13^{b}	842.54^{b}	882.8^{b}	0.235	0.042
Organic Matter	762.51^{a}	767.10^{b}	768.43^{b}	771.60^{b}	0.264	0.007
Crude protein	146.58^{a}	152.12^{b}	154.34^{b}	158.62^{b}	0.127	0.020
Crude fiber	151.06^{a}	167.96^{b}	170.96^{b}	179.96^{b}	0,223	0.012
Ether extract	71.24^{a}	76.23^{b}	77.56^{b}	78.30^{b}	0.023	0.026
Nitrogen free extract (NFE)	258.47	260.19	260.42	262.39	0.235	0.342
Neutral detergent fiber (NDF)	314.62	286.05	286.05	286.05	0.153	0.380
Acid detergent fiber (ADF)	192.05	189.96	189.96	189.96	0.114	0.640

Different superscripts on the same line showed significant differences ($P < 0.05$).TR0 (basal ration of local feed based on palm waste without Curcuma and yeast),
TR1 (same basal diet added with 0.5% yeast), TR2 (basal diet added with 2% Curcuma flour)
TR3 (basal ration added 0.5% yeast and 2 % Curcuma flour); SEM: mean standard error

Table 3: Digestibility (%) of dry matter (DM), organic matter (OM), crude protein (CP), neutral detergent fiber (NDF), and acidic detergent fiber (ADF) by Jawarandu goat

Digestibility (%)	TR0	TR1	TR2	TR3	SEM	P value
Dry matter	66.28[a]	70.17[b]	72.62[b]	77.27[b]	0.23	0.0042
Organic Matter	64.31[a]	65.13[b]	68.52[b]	71.43[b]	0.23	0.0007
Crude protein	61.24[a]	64.42[b]	69.74[b]	75.42[c]	0.30	0.0020
Crude fiber	66.75[a]	68.22[b]	70.26 0[b]	72.60[c]	0,15	0.0012
Ether extract	65.73[a]	66.16[b]	66.54[b]	67.76[c]	0.23	0.0026
Nitrogen free extract (NFE)	64.3.8[a]	65.45[b]	66.14[b]	68.74[c]	0.10	0.0002
Neutral detergent fiber (NDF)	62.84[a]	68.15[b]	68.15[b]	68.15[b]	0.12	0.0031
Acid detergent fiber (ADF)	60.72[a]	62.18[b]	65.36[b]	66.86[c]	0.11	0.0012

Different superscripts on the same line showed significant differences ($P < 0.05$).
TR0 (basal ration of local feed based on palm waste without Curcuma and yeast),
TR1 (same basal diet added with 0.5% yeast),
TR2 (basal diet added with 2% Curcuma flour)

od (Soetrisno et al., 2008), while tannin was analyzed by modification of the Folin Ciocalteu method (Harborne, 1987). Moreover, calcium was analyzed using the Atomic Absorbance AA7000 Shimadzu Co. Serial number A 306647-00345 while phosphorus was analyzed via the wet ashing method and then quantified using a UV-200 RS UV VIS LW Scientific Spectrophotometer. Fatty acid methyl esters (FAME) were detected using gas chromatography (GC) Shimadzu 2010 series. (Schmidely et al., 2005) A metabolic test was carried out by taking 5 mL of goat blood (Dewanti et al., 2013), the sample was left at room temperature for about 1-2 hours until the serum and blood plasma were completely separated. The blood sample was then centrifuged at 4000 rpm for five minutes to completely separate the serum which was transferred to an Eppendorf tube and analyzed for levels of metabolic profile consisting of total protein, glucose, cholesterol, calcium, and phosphorus.

Data Analysis

The data obtained were analyzed using analysis of variance while differences between treatments were analyzed with Duncan'mutiple range test (Steel and Torri, 1991).

RESULTS AND DISCUSSION

The results showed that the TR3 feed treatment with yeast and curcuma supplementation increased the consumption ($p < 0.05$) of dry matter and crude protein, while the NDF and ADF fiber fractions did not show any significant difference. The increase in dry matter consumption was 13.73%, organic matter 22.04%, and crude protein 21.71% (Table 2). This was followed by an increase in dry matter digestibility (16.58%), organic matter (18.43%), crude protein (23.1%), NDF (10.04%), and ADF (12.50%) compared to the control ($P < 0.05$) (Table 3).

The difference in dry matter consumption is caused by the nutritional content, especially protein and carbohydrates of the feed (McDonald et al., 2010). Higher feed consumption was closely related to lower NDF fiber and higher crude protein content in the feed. This is in accordance with (Asaolu et al., 2011: Cunningham et al., 2005) which reported that feed consumption is closely related to fiber content, the lower the crude fiber content, the higher the feed consumption (Coleman and Moore, 2003: Eniolorunda et al., 2008). In addition, the regulation of feed consumption is based on the interaction between the characteristics of feed and livestock, depending on the rumen capacity and feed rate. (Mcleod., 1974: McDonald et al., 2010). In this study, the addition of Curcuma flour in the ration up to a dose of 2% dry matter increased daily dry matter consumption in goats. Curcumin and volatile content in Curcuma accelerates stomach emptying and increases appetite (Wijayakusuma, 2003). The increase in dry and organic matter, as well as crude protein in TR3 was due to the high crude protein content (19.67%), palm kernel cake (15.74%) and the combination of yeast and Curcuma in the feed as a source of fatty acids which contributes to the palatability of goats towards feed consumption. Similar results were reported by (Haeb et al., 2012: Frutos et al., 2000) which stated that the level of palatability and digestibility of feed nutrients was related to protein content. According to NRC (2007), the addition of fatty acids in goats generally reduces dry matter consumption. It is assumed that supplementation of yeast and Curcuma alter rumen conditions, therefore the effect of unsaturated fatty acids on dry matter consumption can be efficient. Furthermore, higher digestibility values tend to vary due to lower NDF and ADF fiber fractions and higher crude protein content of supplementary rations (Table 3). This is due to the potential for carbon skeleton work from yeast sources and Gamal leaves which increases rumen microbial growth by increasing rumen ration degradation. Gamal leaves

contribute to higher NDF, and ADF digestibility because these amino acids are a source of carbon skeleton for rumen microbial growth (Katongole et al., 2009; Ni Wayan et al., 2012: Machmuller et al., 2000). The result showed that the combination of yeast and Curcuma supplement (TR3) had a positive effect on crude protein by increasing dry matter digestibility (Cuningham et al., 2005). Furthermore, the administration of Glliricidia sepium supplement as a source of amino acids and organic minerals in waste rations made from palm kernel meal increases the digestibility of dry and organic matter, as well as average daily gain (ADG) (Rahman et al., 2013).

Nutrient supplementation including carbohydrate and protein is optimized for microbial growth by utilizing fibrous feed which increases consumption and digestibility values (Souza et al., 2010; Rostini et al. 2020), and also adds nutrients for body tissue formation. The administration of palm kernel cake and certain local fermented feed ingredients up to 10%/day increased dry matter intake by 5.78 kg and feed digestibility by 73.14% (Chanjula et al. 2011: Badarina et al., 2017). The results showed an increase in digestibility by yeast + Curcuma supplementation in the TR3 diet. Andriyanto et al. (2012); Shankar et al. (2018), Based on previous studies, Yeast + Curcuma supplementation increased the population of cellulolytic bacteria and reduced lactic acid accumulation and oxygen concentrations in the rumen, thereby increasing the use of starch in the ration (Kumar et al., 2013; Pinloche et al., 2013). In this study, the results showed that the average ADG of goats treated with yeast + Curcuma in the feed (TR3) was higher ($P < 0.05$) compared to the control (TR0). This result is in line with Rochmi and Wahjuni (2017) which stated that the addition of Curcuma at a dose of 1% on complete feed for beef cattle increased body weight gain. Hence, this supplementary diet had a better FCR compared to the control (Table 4).

Goat body weight gain is closely related to the nutrition and digestibility level of feed. Rations with high nutritional content and good palatability level rapidly increases the body weight gain of goats for fattening (Ajayi et al., 2005: Chanjula et al., 2011). Meanwhile, bodyweight gain is influenced by several factors such as the amount of protein consumption per day, type of livestock, age, genetic and environmental conditions, as well as rearing management (NRC, 2007).

This result is in line with Ni Wayan et al. (2012) which stated that supplementation of Glliricidia sepium (gliricida spium green) in fermented palm waste-based feed showed higher ADG in goats compared to treatment with only fermented Kumpai grass. Furthermore, the addition of Curcuma as a dietary supplement in feed potentially improves the rumen ecosystem, thereby increasing the microbial population. Increased digestibility and feed intake provide nutrients to body tissues (Andriyanto et al., 2012: Shankar, 2018). The feed conversion value is highly dependent on the digestibility and nutrient metabolism in the body. Consumed feed is used for basic life and production, meanwhile, the feed conversion value depends on the feed quality, the higher the nutrients contained, the better the feed conversion produced (Asaolu et al., 2011).

Goat Blood Metabolism

The metabolic process of feed in the blood of the goat's body plays a role in converting food substances into compounds needed for the life processes of goats. The average total protein content of the TR3 treatment reached 7.96 mg/dL (Table 4). This is because the yeast and Curcuma feed supplement efficiently improves protein absorption. Solido et al. (2016) stated that protein is absorbed into the body in the form of amino acids and the availability of sufficient protein improves the activity and growth of microorganisms, therefore digestion and consumption processes also increase. Furthermore, Oktarina et al. (2004) stated that improvement in the crude protein content of feed increases the rate of reproduction and rumen microbial population, therefore the ability to digest feed becomes greater. Blood glucose metabolism (62.71 – 67.06 mg/dl) was higher in this study compared to goats with tea supplements (Zhong et al., 2011). The highest blood glucose was found in treatment (TR3) (67.06 mg/100 ml), while (TR1), in contrast, showed the lowest blood glucose (Table 5). Feed supplemented with yeast + Curcuma (TR3) improve the physiological status of goats as indicated by high glucose metabolite yields. This is because yeast which is important during fermentation in the rumen, while Curcuma flour contains curcumin which has antimicrobial activity and suppresses protozoa in the rumen, hence, the nutrient metabolism process is improved, as well as blood metabolism, and bodyweight gain. Therefore, the synergistic function between the two supplements has a positive impact on goat's blood glucose values. (Singh and Ludri, 2002).

Cholesterol levels in the blood is related to changes in the degree of free fatty acids which are converted into co-acetyl-A and further into acetyl Co-A which is the main precursor of cholesterol formation (Maurya et al., 2004). The cholesterol content in this study ranged from 62.60 mg/dl for TR3 and 79.90 mg/dl for TR0 but was lower than the normal goat cholesterol standard. Normal goat cholesterol values according to Astuti et al. (2011) ranges from 65.86-70.26mg/dl. The low cholesterol value is caused by the low crude fat concentrate (5.89%) and the presence of tannins in the feed, therefore goats lack crude fat intake. Furthermore, the quality of feed greatly affects cholesterol biosynthesis, because in every metabolism, ace-

Table 4: Average daily body weight gain (ADG, kg/day) and feed conversion ratio (FCR) of Jawarandu goats

Variable	TR0	TR1	TR2	TR3	SEM	P value
Final body weight (kg)	16.21[a]	17.52[b]	17.95[b]	18.12[b]	0.07	0.0042
Weight gain (kg)	2.75[a]	4.06[b]	4.46[b]	4.63[b]	1.24	0.035
Average daily gain (g/d)	49.10[a]	72.60[b]	72.60[b]	72.60[b]	0.054	0.0034
Feed conversation (FCR)	10.43[a]	8.22[b]	8.14[b]	8.02[b]	0.08	0.0011

Different superscripts on the same line showed significant differences (P < 0.05).
TR0 (basal ration of local feed based on palm waste without Curcuma and yeast),
TR1 (same basal diet added with 0.5% yeast),
TR2 (basal diet added with 2% Curcuma flour)
TR3 (basal ration added 0.5% yeast and 2 % Curcuma flour); SEM: mean standard error

Table 5: Total levels of protein, glucose, cholesterol, calcium and blood phosphorus levels of Jawarandu goats supplemented with yeast and Curcuma.

Variable	TR0	TR1	TR2	TR3	SEM	P value
Total Protein (g/dL)	7,14[a]	7.22[b]	7.45[b]	7.96[b]	00.07	00.42
Glucose (mg/dL)	62.75[a]	64.06[b]	65.06[b]	67.06[b]	01.24	0.035
Cholesterol (mg/dL)	79.10[a]	72.60[b]	65.60[b]	62.60[b]	0.054	00.34
Ca(mg/dl	12.43[a]	14.02[b]	15.02[b]	16.72[b]	00.08	00.11
P(mg/dl)	6.23	6.87	6.96	6.96	0.096	0.009

Different superscripts on the same line showed significant differences (P < 0.05).
TR0 (basal ration of local feed based on palm waste without Curcuma and yeast),
TR1 (same basal diet added with 0.5% yeast),
TR2 (basal diet added with 2% Curcuma flour)
TR3 (basal ration added 0.5% yeast and 2 % Curcuma flour); SEM: mean standard error

-tyl CoA is produced as a basic ingredient.

Calcium is the most abundant mineral in the body, over 98% of Ca is in bones and teeth or 46% of the total body minerals (McDowell, 1992). The average blood calcium levels in this study ranged from 12.43 to 16.72 mg/dl. Calcium levels are within normal limits for growing male goats as the calcium content of the treatment feed was 0.71% - 1.10%. However, Ca levels in the blood did not show a significant difference between treatments. Furthermore, phosphorus plays an important role in the process of bone mineralization, it is consumed in ruminants, about 70% is absorbed into the blood plasma while 30% is excreted through feces. The absorbed phosphorus mineral is distributed to the bones and teeth (Tanritanir et al., 2009). In this study, the concentration of phosphorus in the blood did not differ from other treatments, ranging from 6.23 mg/dl for TR0 and 6.96 mg/dl for the TR3 treated goats. The P content in goat blood was within normal limits for livestock, according to Ahmed et al. (2000) which stated that the average P level in the blood of young and adult goats ranges from 6.4 to 8.7 mg/dL.

CONCLUSIONS

Supplementation of yeast and temulawak in local feed based on palm kernel cake significantly improved the performance of Jawarandu goats as indicated by nutrient consumption, digestibility, and daily body weight, and blood metabolism of glucose, cholesterol and blood Ca compared to control goats.

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CONFLICT OF INTEREST

All researchers stated consciously that they had no conflict of interest in this study.

AUTHORS CONTRIBUTION

Tintin Rostini, Irwan Zakir and Danang Biyatmoko contributed to the design and implementation of the research, to the analysis of the results and to the writing of the manuscript.

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