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Effect of Urea in Total Mixed Ration and its Silage on Friesian Holstein Bull Calves Productivity in Tropic Condition

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Abstract | Urea addition into feed to some extent has been shown to increase crude protein content and improve feed efficiency. However, its addition in Total Mix Ration (TMR) and also TMR silage on calves' growth performance is yet to be elaborated. Therefore, the effect urea addition on TMR and its silage on performance of Friesian Holstein (FH) male calves were evaluated. The calves (n = 27; 5 mo to 7 mo, mo = month old) were divided into three groups, each group consisted of nine calves, based on age: 5 mo (100 kg to 105 kg), 6 mo (111 kg to 116 kg), and 7 mo (123 kg to 133 kg). All groups were divided into three types of feed, namely: conventional feed containing concentrate and forage without urea (CON), TMR, and TMR silage containing 1.5 % urea. The variables have been observed were feed intake and digestibility of dry matter (DM) and organic matter (OM) and average daily gain (ADG). The data were analyzed using Analysis of Variance (ANOVA) and followed by Least Significant Difference (LSD) test. The average DM intake (kg head^{-1} day^{-1}) for CON, TMR, and TMR silages were 5.15; 6.79; and 4.14 meanwhile OM intakes were 4.68; 6.04; and 3.94 respectively, TMR significantly higher than others ($P < 0.05$). Digestibility of DM and OM (%) showed the same pattern, TMR followed by CON then TMR silage (64.09; 62.98; 54.21 for DMD) and 73.92; 75.99; 63.78 for OMD. The age has non-significant effect into digestibility. Highest ADG (kg head^{-1} day^{-1}) were was obtained from TMR feed (0.70), followed by CON (0.65) and TMR silages (0.45). The older calves the higher ADG reached (0.65; 0.60 and 0.55). It could be concluded that addition urea 1.5 % in TMR could increase calves' performances, but on the contrary when it added to TMR silage.

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Introduction

Total mixed rations (TMR) are produced by mixing forages, byproducts, concentrates, minerals, vitamins, and additives (Bueno *et al.*, 2020). Friesian Holstein (FH) male calves could be used as a potential meat source due to the higher average daily gain (ADG) compared to Indonesian local cattle like Ongole crossbreed (0.86 to 0.92 kg head^{-1} day^{-1}vs 0.33 to 0.64 kg head^{-1} day^{-1}; (Putra *et al.*, 2018). But in

many dairy farms in Indonesia, male calves tend to grow less optimally, and can lead to high morbidity and mortality (Hendraningsih *et al.*, 2015).

For achieving target performance, bull growth is affected by many factors, and feeding management is one of the most important. In order to meet satisfy growth, to maintain decent condition of the body, and to reach an expected height and weight, calves rations must need to be balanced. Therefore, feeding system that has balanced nutrients is essential for optimizing calves' growth which leads to ensure the sustainability of dairy farm business. In conventional feeding system, feed-stuffs such as forage and concentrate are fed separately. Thus, selection of feed occurs, and tends to reduce the quantity of feed intake. Maekawa *et al.* (2002) reported that cows tended to consume high portion of concentrate in the conventional feeding, and could lead to increase rumen acidosis risk (Beauchemin *et al.*, 2002). To avoid that condition, Total Mix Ration feeding gives a better option. In contrast to adding concentrate to forage feeding, TMR feeding gives a chance for animals to get a complete nutritional balanced diet (Schingoethe, 2017). TMR improves condition of rumen, stabilizes rumen pH, and makes ideal atmosphere for rumen microbes. Feeding TMR to dairy cattle were reported to improve ruminal digestion, passage rate and intake of dry matter (DM; Soriano *et al.*, 2001). Nissanka *et al.* (2010) suggested that feed selection by young cattle could be avoided by feeding TMR for young cattle, that result better balance nutrient intake. The TMR in Indonesia consists of agro industrial by products, that are often deficient in protein. Protein insufficiency in TMR could be fixed by urea addition. Urea is a source of non-protein nitrogen (NPN) that is accessible, cheap and used as feed supplement to increase feed protein. The amount of urea that included in feed for cattle or sheep should not exceed 3 % and usually the addition of 1 % to 1.5 % will prove adequate (Panday, 2011), meanwhile Currier *et al.* (2004) suggested that urea can be added up to 6.7 % as long as animal and dietary factors are ideal.

The evaluation of TMR feeding for lactating cattle has often been conducted, but the effect of TMR on calves' growth performance is yet to be elaborated. To preserve the nutrient content, TMR that consist of wet by-product should be ensilaged. Ensiled TMR is able to maintain its nutrient content (Wahyudi *et al.*, 2017) and also can improve the conservation of wet forages (Bueno *et al.*, 2020). Xu *et al.* (2010) stated that TMR silage could reduce the energy cost related to drying of wet industrial by-product. This study was carried out to find out the impact of TMR and TMR silage with urea addition on nutrient digestibility and ADG of FH male calves under tropical environment was undertaken.

Table 1: *Ingredient and nutrient compositions of treatment feed.*

Ingredients		Treatments Diets			Nutrient requirements of post-weaning calf **
		TMR	TMR Silage	CON	
Wheat bran	%	-	-	27.30	
Rice bran	%	38.00	38.00	26.00	
Copra meal	%	36.00	36.00	9.75	
Corn meal	%	12.00	12.00	-	
Molasses	%	3.00	3.00	1.63	
Peanut hull	%	8.50	8.50	-	
Urea	%	1.50	1.50	-	
Minerals	%	1.00	1.00	0.33	
WPC	%	-	-	35.00	
Nutrient Composition*					
Dry matter	%	88.32	48.02	60.75	86.00
Ash`	%	10.01	11.29	6.55	12.00
Organic matter	%	89.99	88.71	93.45	88.00
Crude protein	%	15.52	14.64	14.02	≥ 12.00
Ether extract	%	9.94	9.02	8.01	6.00
TDN	%	68.04	71.29	69.43	65.00

CON = conventional feed with concentrate : WPC = 65:35, WPC = whole plant corn.
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Materials and Methods

Feed preparation

The study was conducted at in the Experimental Farm, University of Muhammadiyah Malang, East Java, Indonesia. Feedstuff ingredients were formulated for treatment feed that provided during the experimental period. Feed that prepares for the study were conventional feed (CON) consist of whole plant corn (WPC) and concentrate with 60:40 ratio, TMR, and TMR silage. Ingredient and nutrient composition of treatment feed is presented in Table 1.

Table 2: *Feed intake (kg) and nutrient digestibility (%).*

Variables	Diets	Age (Month)			Average
		5	6	7	
DM intake (kg)	CON	5.05±0.43	5.07±0.39	5.33±0.41	5.15±0.40^{b}
	TMR	5.55±0.91	7.38±0.95	7.46±0.72	6.79±0.81^{a}
	TMR Silage	4.60±0.44	4.07±0.49	3.75±0.27	4.14±0.34^{c}
	Average	5.06±0.62^{B}	5.50±0.77^{A}	5.51±0.55^{A}	
OM intake (kg)	CON	4.59±0.39	4.62±0.33	4.84±0.34	4.68±0.36^{ab}
	TMR	4.93±0.74	6.56±0.77	6.63±0.58	6.04±0.67^{a}
	TMR Silage	4.14±0.38	3.87±0..43	3.57±0.23	3.94±0.31^{b}
	Average	4.63±0.53^{B}	5.01±0.57^{A}	5.01±0.47^{A}	
DM digestibility (%)	CON	66.0±13.40	62.92±7.69	60.02±6.75	62.98±9.41^{a}
	TMR	61.97±4.78	64.04±1.56	66.26±3.01	64.09±2.77^{a}
	TMR Silage	51.53±8.31	57.80±5.12	53.30±7.33	54.21±6.32^{b}
	Average	59.83±9.59^{ns}	61.58±4.53^{ns}	59.86±5.45^{ns}	
OM digestibility (%)	CON	77.66±7.11	74.03±9.24	70.38±5.61	73.92±6.21^{a}
	TMR	72.91±9.31	77.11±5.26	77.96±6.22	75.99±6.33^{a}
	TMR Silage	68.01±11.20	60.63±8.14	62.72±10.21	63.78±9.12^{b}
	Average	72.88±9.71^{ns}	70.59±7.34^{ns}	70.35±7.58^{ns}	

CON = Conventional feed, TMR = Total Mix Ration, TMRS = TMR Silage, DM = dry matter, OM = organic matter.

The experimental diets were formulated based on 15 % of crude protein (CP) and 68 % total digestible nutrient (TDN). Each feed was given ad libitum twice a day at 07.00 and 15.00.

Samples collection and nutrients analysis

Feed intake was measured daily and weight gain was taken weekly for individual calf. Feces were collected in final 3 d consecutively each week and stored for analyses. Approximately 100 g of daily fecal excretion from each calf were subsampled into a plastic bag, and dried at 65 °C for 48 h and ground to pass a 1 mm screen with a Grinder-mixer (Panasonic MX-AC400, Japan). The dry matter (DM), organic matter (OM), crude protein (CP), and ether extract (EE) of feed, leftover feed, and feces were analyzed according to AOAC.

Research design

A total of 27 post weaned Friesian male calves were divided into three groups based on age, each group consisted of nine calves, *i.e.* 5 mo (100 kg to 105 kg, 6 mo (111 kg to 116 kg) and 7 mo (123 kg to 133 kg). Each group contains three replicates, and each replicate consists of three calves. At the beginning of this study, all animals were in good condition and validated by a veterinarian. Each bull was housed individually in a pen designed to protect animals from weather and feed bins from rain. Feed was weighed and offered twice daily at 7 am and 3 pm. The availability of water was always kept ad-libitum to the calves through-out the day. A preliminary period of 2 wk (week) was given to acclimatized the calves with the feeding and housing. Male calves were kept for 3 mo. Feed intake was recorded daily and daily gains were measured and recorded at 6th, 8th, and 10th week.

The data were analyzed using Analysis of Variance (ANOVA) and followed by Least Significant Difference (LSD) test if the ANOVA has any significant or very significant effect (Adinurani, 2016).

Results and Discussion

Feed intake and digestibility

The result showed that intake of DM and OM of TMR was higher than other feeds (Table 2). This study was in line with Lailer *et al.* (2010) and Teshome *et al.* (2017) who reported that TMR significantly improves DM intake. This result also supported by studies of Beigh *et al.* (2017) and Sharma *et al.* (2010). Pandya *et al.* (2005) stated that smaller particle in TMR leads to increase palatability and DM intake. The increase in DM intake was also observed with molasses-based liquid TMR in lactating cattle (De Vries and Gill 2012). These results are in accordance with Chander (2011) and Khan *et al.* (2010), that intake of DM and CP from pellet TMR is higher

than conventional feeding. Moreover, total mixed ration based on urea ammoniated straw increased the intake of DM compared to feeding wheat straw and concentrate individually (Pachauri *et al.*, 2010).

Unexpectedly, intake of TMR and OM is lowest in TMR silage to CON and TMR group. Silage that made from wet agricultural by product tends to have low DM content. Schingoethe *et al.* (2009) concluded that DM is insufficient when feeding large amounts of ensiled forages and wet by-products, such as wet distiller grains. High moisture in TMR silages, tend to alter the pattern of fermentation that followed by greater accumulation in fermentation end products, and proteolysis (Bueno *et al.*, 2020). Along with high water content, urea addition in this study was predicted to lead to butyric acid formation by clostridia in the silage. Kung *et al.* (2018) explain that high-moisture silages have higher concentrations of soluble N and NH_3-N than drier silages resulting from proteolytic activity from clostridia. Clostridial activity is undesirable for several reasons; produce ammonia like odor, fishy, and putrid (Kung *et al.*, 2018), decrease the palatability and depress intake (Muck, 2010).

Calves age did not influence the DM intake, but contradict with CON and TMR group that showed increasing along with the age, intake of TMR Silage decrease. In younger calves' group, butyric acid content in the silage was predicted to be used for rumen development. Bedford and Gong (2018) stated that in early post weaning, young ruminants, butyric acid is used for development of rumen papillae. This result also supported by Serbester *et al.* (2014) study indicates that the DM intake tends to decrease in post weaned calves with butyric addition in the feed. Intake of OM showed the same response to the diets as of DM. The intake of OM is strongly influenced by DM intake (Prima *et al.*, 2018).

Poor silage produced in this study was predicted to not only influence the intake but also the digestibility. Calves fed with TMR Silage diet had the lowest digestibility of DM and OM. Oliveira *et al.* (2016) concluded that silage digestibility is affected by ensiling process. Ensilage produces ammonia that enters the N recycling cycle of the calves, and depresses intake of DM and increase the animal energy costs. This mechanism seems to be the case in this study. Urea addition in TMR has good effect and tends to increase the N availability, but on the other hand in contrast not toward in the silage. The low dry matter content of silage as that already mentioned in this study above could be also the factor that depresses the digestibility, because it leads to butyric acid formation by clostridia. Concentration of butyric acid is negatively correlated with digestibility (Oliveira *et al.*, 2016).

The data on performance of animals is presented in Table 3. Higher ADG was reached by TMR group followed by CON and TMR Silage. This was in accordance with DM and OM intake and also digestibility in this study. Showed that TMR has highest value than to the other feeds. High intake and digestibility will provide sufficient nutrients that would be converted into production or ADG. These results are consistent with Liu *et al.* (2016) that DM intake and ADG Limousine fed TMR is higher than group fed with separate TMR silage and concentrate.

Table 3: *Average daily gain.*

Parameter	Feeds Diets	Age (month)			Average
		5	6	7	
ADG (kg)	CON	0.57	0.64	0.74	0.65[b]
	TMR	0.52	0.71	0.89	0.70[a]
	TMR Silage	0.57	0.45	0.33	0.45[c]
	Average	0.55[c]	0.60[b]	0.65[a]	

CON = Conventional feed, TMR= Total Mix Ration, TMRS = TMR Silage

Conclusions and Recommendations

Additional of 1.5 % urea in TMR increased both dry matter and organic matter of intake compare to conventional feeding, but contrary effect found from urea use in TMR silage. Calves from TMR and CON treatments had significantly higher dry matter and organic matter digestibility. Age has non-significant effect into digestibility. TMR feed gave highest ADG when it compared to CON and TMR silages feed. While the older calves the higher ADG reached.

Novelty Statement

Feeding, in the form total mix ration (TMR) to cattle, is increasingly done by farmers in Indonesia. Urea supplementation has been widely used in cattle feed formulation, due to the cheaper crude protein resources and it can improve feed efficiency. But, the

addition of urea in TMR and also its silage on calves' growth performance is yet to be elaborated.

Author's Contribution

AW conceptualized and designed the study, elaborated the intellectual content, performed literature search, data acquisition, data analysis, statistical analysis, and manuscript preparation. SS and LH defined the intellectual content, carried out literature search, manuscript review and manuscript revision. AP carried out experimental studies and manuscript review. ZV-G and IZ elaborated the intellectual content, performed literature search, performed manuscript review/revision and guarantor.

Conflict of interest

The authors declares that there is no conflict of interests regarding the publication of this article.

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