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Short Communication

Assessment of the Nutritive Value of Complete Feed Supplemented with Corn Stover and King Grass on Holstein Friesians Dairy Cattle

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ABSTRACT

This study aimed to evaluate the nutritional value of complete fed based on corns stover and king grass on Holstein Friesians (HF) Dairy cattle. Twenty-one HF (2.5-3.5 years old, weighted 250-300 kg) was adapted for 2 weeks by feeding with experimental feed. The experimental feed was formulated into three combinations: T1 (70% corn stover+0% king grass+30% concentrate; T2 (35% corn stover+35% king grass+30 % concentrate; T3 (0% corn stover+70% king grass+30% concentrate. Fecal of HF was collected every day for ten weeks after adaptation. Dry matter (DM), organic matter (OM), neutral detergent fiber (NDF), acid detergent fiber digestibility (ADFD), NH_3 synthesis and efficiency of microbial protein synthesis were analyzed. The highest dry matter digestibility (DMD), organic matter digestibility (OMD), neutral detergent fiber digestibility (NDFD), NH_3 concentration and efficiency of microbial protein synthesis (ESPM) were found in T2 group (64.04%, 65.05%, 60.63%, 189.36 $mg.L^{-1}$, and 24.10 gr $N.kg^{-1}$. $BOTR^{-1}$, respectively). While the highest ADF was found in the T3 group (56.37%). The study suggested that T2 group produce the highest nutritional value compared to other combinations. The high level of the protein content of corn stover was proven to increase microbial protein synthesis in the rumen.

Natural resource and crop residues were the predominant feed source for ruminants in many tropical and subtropical countries in the world (Sanh *et al*., 2002). One crop residue that became the primary forage as cattle diet was corn stover (Ferraretto *et al*., 2018). Corn stover is crop residues that consist of stalk, leaves, cob and flower of corn left in the field after harvesting at 45-46 days after planting (Garlock *et al*., 2009). Many studies have been proven that corn stover has high organic matter and dry matter digestibility in dairy cattle (Croce *et al*., 2016; Huang *et al*., 2017)

One of the natural resources used as primary feed in dairy cattle or sometimes as supplemented feed is king grass (*Pennisetum purpupoides*) (Tahuk *et al*., 2017). Although king grass has a crude protein content less than the minimum dietary crude protein (CP) concentration required (Kariuki *et al*., 2001), the combination of king grass with other foliage has been proven to increase the quality of feed (Katuromunda *et al*., 2012). Furthermore, the combination of king grass with other high protein content foliage like legume or corn stover proved to maximize milk production and be a better choice for smallholder resource-poor farmers who cannot afford commercial concentrates (Kabirizi *et al*., 2000).

Until now, feed production with the minimum standard requirement for dairy cattle is still challenging for dairy farmers (Ferraretto *et al*., 2018). Therefore, the development of alternative feed with complete feed (concentrate) and foliage like corn stover and king grass is needed. The primary purpose of any nutrition program is to formulate diets that meet the animal's nutrient requirements. Data on both proximate content and nutrient digestibility are needed to achieve this goal since the primary factor influencing nutrient utilization in dairy cattle was the relationship between intake and digestibility (de Souza *et al*., 2018).

Utilization and optimization of local foliage and potential agricultural industrial waste as sustainable local resources is a strategic program for food security based on

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availability and food independence based on cattle origin. The assessment of dairy cattle based on local resource foliage is urgently needed. Therefore, this study evaluated the nutritional value of complete feed based on corns stover and king grass on Holstein Friesians (HF) dairy cattle. This study provide a scientific evaluation of the new alternative feed for HF dairy cattle.

Materials and methods

This study was conducted from November 2019 until January 2019 at the Regional Technical Implementation Unit (UPTD) Institute of Livestock and Seed Farming development in North Sulawesi, Indonesia. Proximate analysis was performed in Animal Nutrition and Feeding Laboratory, Faculty of Animal Science, Sam Ratulangi University, while in vitro test was conducted in Animal Nutrition and Feeding Laboratory, Brawijaya University.

This research used a completely randomized design with three treatments and seven replications. Twenty-one adult females of HF aged 2.5-3.5 years old and weighing 250-300 kg were included in this study. HF cow was adapted for two weeks by feeding with experimental feed. HF cow was hosted in an individual tie-stall barn (2 x 2.5m) equipped with a feeding and drinking area. The experimental feed was formulated into three combinations: T1 (70% corn stover+0% king grass+30% concentrate; T2 (35% corn stover+35% king grass+30 % concentrate; T3 (0% corn stover+70% king grass+30% concentrate. The experimental feed ingredient are shown in Table I.

Table I. Ingredient of the experimental feed.

Nutrition	Concentrate (%)	Corn stover (%)	King grass (%)
Dry matter	87.93	19.73	20.30
Organic matter	78.82	12.06	10.92
Protein	16.65	10.90	9.52
Crude fat	10.75	2.17	3.14
Crude fiber	11.23	33.21	31.26
NDF	27.23	69.81	73.52
ADF	14.39	40.20	44.49
Ca	0.73	0.39	0.35
P	1.82	0.23	0.28
Gross energy (Kkal)	3708.89	3791.00	3375.00

Fecal of HF dairy cattle were collected from the rectum of each cow every day for 10 weeks after the adaptation period. Nutrient content of corn stover and king grass were evaluated using proximate analysis. Dry matter (DM) and organic matter (OM) digestibility were performed by *in vitro* analysis based on Al-Arif *et al.* (2017). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) digestibility were analyzed in-vitro using a daisy system as described by Nair *et al.* (2018). The concentration of N-NH_3 was calculated using the Conway method (Yang *et al.*, 2014), while the efficiency of microbial protein synthesis (ESPM) was measured according to Zinn and Owners (1995).

All obtained data were subjected to one-way ANOVA using SPSS software for Windows (IBM Corp., USA). Tukey's HSD (honestly significant difference) test was performed where significant differences ($p<0.05$) detected.

Results and discussion

Dry matter (DM) and organic matter (OM) digestibility

The average DM digestibility of complete feed supplemented with corn stover, and king grass ranged from 60.25% - 64.04% (Table II). The highest DM digestibility was found in the T2 group (64.04%) and significantly different with T3 group but not significantly different with the T1 group (63.54%) (Table III). In the T2 group, a mixture of corn stover, king grass and concentrate resulted in more carbohydrate variations, both structural and non-structural, increasing the growth of more varied rumen microbes and then causing an increase of dry and organic matter. According to McDonald *et al.* (2002), a positive correlation effect of several feed sources combination could increase feed digestibility.

The average of OM digestibility varied among different treatment. The T2 group possessed the highest OM digestibility (65.05%), while the lowest was found in the T3 group (60.95%). This result has the same characteristic with DM digestibility, whereas the T2 group was significantly different from the T3 group and not substantially different from the T1 group. The high and low digestibility of OM depends on the high and low DM digestibility (Tuturoong *et al.*, 2013). Feed digestibility was fully affected by composition and the quality of feed ingredients.

Table II. Feeding digestibility and fermented product.

Treat-ment	Parameter					
	DMD (%)	OMD (%)	NDFD (%)	ADFD (%)	NH_3 (mg/l)	ESPM (gr N/ kg/BOTR)
T1	63.54[a]	64.55[a]	58.54[a]	54.24[a]	187.98[a]	24.06[a]
T2	64.04[a]	65.05[a]	60.63[a]	55.18[a]	189.36[a]	24.10[a]
T3	60.25[b]	60.95[b]	50.69[b]	56.37[b]	176.67[b]	20.92[b]

T1 = 70% corn stover+30% concentrate; T2 = 35% corn stover+35% king grass+30 % concentrate; T3 = 0% corn stover+70% king grass+30% concentrate.

The high content of corn stover's metabolic energy and crude fiber may be caused by the increase in feed digestibility (de Souza *et al*., 2018). The high metabolic energy content of corn stover is due to a readily available carbohydrate (RAC) contained in corn stover (Li *et al*., 2014; Sari *et al*., 2019). According to Tuturoong *et al*. (2013) the rate of rumen microbial synthesis is positively correlated with RAC. The more easily digested carbohydrates in the food consumed, the higher the rate of rumen microbial synthesis and, as a result, DM and OM digestibility will increase. Furthermore, crude protein content on the animal feed also affected the feed digestibility. McDonald *et al*. (2002) and Mayulu *et al*. (2013) stated that if the feed is low in protein content, the rumen ammonia concentration will be low so that rumen microbial growth will be slow. Consequently, the degradation of carbohydrates will be inhibited.

Neutral detergent fiber (NDF) and acid detergent fiber (ADF) digestibility

The NDF and ADF digestibility average varied from 53.17%–60.63% and 54.24%-56.37%, respectively. The highest value of NDF and ADF digestibility was obtained by T2 (60.63 %) and T3 (56.37%), respectively, whereas the lowest NDFD and ADFD were obtained by T3 (53.37%) and T1 (54.24%), respectively. The results showed significant differences between T2 and T3 NDF groups and not significantly different between T3, T2 and T1 ADF groups. The high quality of corn stover nutrient compared to king grass, especially the OM, CP and energy content and the low NDF and ADF of corn stover, complementing nutrients from a combination of two different feed sources caused differences in the digestibility level of NDF. In comparison, the digestibility of ADF was not significantly different.

The digestibility level of NDF and ADF in the rumen was affected by the number of fibre-digesting microbial populations (Jabari *et al*., 2014). Protein from the feed is not used directly by rumen microbes. Still, it is hydrolyzed by rumen microbes into amino acids and subsequently becomes ammonia as a nitrogen source for microbial growth (Tuturoong, 2014).

NH_3 concentration from the experimental feed (Table II) ranged from 176.67 – 189.36 mg/l. Based on diversity analysis, there was a significant difference in the concentration of NH_3 ($p<0.05$). There was a significant difference ($p<0.05$) between T2 and T3 group and not significantly ($p>0.05$) different between T2 and T1 groups. The total concentration of NH_3 has met the requirement of microbes for maximum growth since the total concentration of NH_3 needed by microbes to grow was 85–300mg/l (McDonald *et al*., 2002). Rumen microbes need NH3 as a source of N for microbial growth, but because the needs exceed production, the excess will be absorbed through the rumen and transported to the liver to be converted to urea. Total concentration of NH_3 varied from 176.67-189.36 mg/l. The highest concentration of NH_3 was obtained by T2 (189.36 mg/l) followed by T1 (187.98 mg/l) and T3 (176.67 mg/l). The variations of NH_3 concentrations in T1, T2 and T3 group was able to support the activity of rumen microorganisms in synthesizing proteins that are beneficial for ruminants.

The generated urea will be excreted in the urine, and some will re-enter the rumen through saliva. NH_3 concentration was used to estimate protein degradation by rumen microbes. NH_3 is an intermediate product in protein degradation by microbes and microbial protein synthesis. High and low concentrations of NH_3 in the rumen indicated the quality of feed digestibility and rumen microbial activity.

The average microbial protein synthesis (ESPM) varied from 20.92-24.10 (g N/kg/BOTR). The highest ESPM was obtained by T2 (24.10 g N/kg/BOTR) followed by T1 (24.06 g N/kg/BOTR) and T3 (20.92 g N/kg/BOTR). The results showed a significant difference ($p<0.05$) between T2 and T3 and not a significantly ($p>0.05$) difference between T2 and T1.

ESPM value in our study was higher than reported by Wassie *et al*. (2019). Three factors affect microbial protein synthesis in the rumen: physical, chemical, and biological (Harun and Sali, 2019). The crucial physical factor affecting microbial protein synthesis is pH and the buffer system. Increasing rumen performance occurs when pH is above 6.0, whereas when rumen pH decreases below 6, a microbial enzyme in the rumen does not function, causing declining bacterial growth (Iskenderov and Mamedova, 2013).

Nitrogen compounds, vitamins and minerals, antimicrobial chemicals, and feed type are the chemical factors affecting microbial protein synthesis in the rumen (Harun and Sali, 2019). Furthermore, bacteriophage found in the rumen, bacterial lysis, and protozoa predation includes biological factors affecting the level of microbial protein synthesis. Understanding the effect of each factor and how to solve them is the crucial thing that we have to improve when we want to increase the digestibility of protein and microbial protein synthesis.

Conclusion

In conclusion, complete feed (concentrate) (30%) supplemented by corns stover (35%) and king grass (35%) has the highest nutritional value compared with other combinations. High nutritional value in this study correlated with the proximate value of each corn stover and king grass. Furthermore, the high level of the protein content of corn stover was proven to increase microbial protein synthesis in the rumen.

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Statement of conflict of interests

The authors have declared no conflict of interest.

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