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Intake and digestibility of mix-herbal supplement blocks for Bali Cattle fed with agricultural by-product in Bengkulu, Indonesia

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Abstract The result of the Mix-Herbal Supplement Blocks (MHSB) on Bali cattle showed that the initial live and final weights did not differ ($p>0.05$) among the treatments. However, the average daily gain on group SCL differs significantly ($p<0.05$) with the others. Bali cattle fed with S0, SCL, and SZO formulas gained 0.39, 1.25, and 0.79 kg day^{-1} respectively. MHSB did not significantly ($p>0.05$) affect intake and digestibility in all treatments. It might be concluded from this study that the amount of mix-herbal supplements could be given in a higher amount to the Bali cattle.

Keywords: Agricultural by-product, Bali cattle, Digestibility, Mix-herbal

Introduction

The use of herbal feed additive (HFA) is becoming crucial in animal production due to the ban on the use of certain antibiotics, production of harmful residual effects and cost-effectiveness. The inclusion of herbal feed additive (HFA) for ruminant diet should be encouraged to enhance the animal's performance, improve feed utilization, maintain health and alleviate the adverse effects of environmental stress (Bhatt, 2015; Nanon *et al*., 2014; Hosoda *et al*., 2006; Uegaki *et al*., 2001).

Coincided with the antibiotic ban in ruminant nutrition, alternative methods of manipulating rumen fermentation received considerable attention in a lot of researches (Bhatt, 2015; El-din *et al*., 2012; Handekar *et al*., 2010). Controlling rumen fermentation could improve nutrient utilization (Meel *et al*., 2017). In China, the addition of herbal medicine in the basal diet of ruminant is an ancient method (Wang and Wang, 2016). The rumen plays a significant role in the process of digestibility, nutrient absorption, and ingesta assimilation in cattle (Handekar *et al*., 2010).

Herbs such as ginger have phytochemical compounds and can be used to stimulate appetite and digestion. The secondary compounds and

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essential oils in herbs such as in ginger, garlic, and turmeric could modify rumen fermentation, increasing symbiosis between rumen and micro organism and also decrease methane emission (Tekeli *et al*., 2007; El-din *et al*., 2012; Wanapat *et al*., 2008; Salem *et al*., 2012; Jiménez-Peralta *et al*., 2011 Mapiye *et al*., 2010; Mueller-Harvey, 2006). Curcumin isolated from the *Curcuma longa* has been used in traditional medicine as anti-bacterial. Due to its antibacterial activity, feeding curcumin in ruminant could interfere with the bacterial population in rumen which then will affect digestibility (Vorlaphim *et al*., 2011).

Wanapat *et al.* (2013) reported that the supplementation of herbs (lemongrass, garlic, and peppermint) caused lower ruminal protozoal and bacterial populations than control, but there was no significant difference in DM, OM, NDF, ADF among the treatments.

The other secondary plant compounds which can affect feed intake and digestibility are tannins (Wright, 2015). Leaf of *Melastoma malabatricum* is one of the plants that contain tannins. Our previous findings showed that addition of aqueous extract of *Melastoma malabatricum* at 250 mg/kg BW/2 at week interval in Haemonchosis goats increased significantly the fresh forage, dry matter, and crude fiber intake compared to those which received 250 mg/kg BW/3 week interval or negative control (Suteky *et al.,* 2018)**.** The type and chemical structure, as well as the amount of tannins consumed, will affect the voluntary feed intake, digestibility and digestive utilization (Frutos *et al*., 2004).

Nigella sativa L., commonly known as black seed or black cumin, is emerging as a natural remedy for several diseases including gastrointestinal disturbances. Researchers revealed that *Nigella sativa* L showed a wide range of pharmacological activities such as anti-bacterial, anti-cancer, appetite stimulant, analgesic and so on (Ahmad *et al*., 2013). Dietary supplementation of *Nigella sativa* seeds or *Rosmarinus officinalis* leaves and their combination increased feed intake and digestibility in goats (Hassan *et al.,* 2013; Shaker and Khasraw, 2009) and Dorper lambs (Odhaib *et al*., 2018). Habeeband and El-Tarabany (2012**)** found that the addition of *Nigella sativa* and Curcumin to the diet of Growing Zaraibi Goats increased feed intake and ADG.

As the response of ruminants to herbal feed supplementation is inconsistent, so there is a need for additional research in other ruminants and production systems. Bali cattles have a high fertility rate, high adaptation ability, promote social values, good ability to recover after poor usage (Martojo, 2003; Chamdi, 2005). Bali cattle rearing under the oil palm plantation has multi-purpose functions. These include as for weeding control, saving labor costs, providing manure compost, calf lifesaving and as working animal for transporting Fresh Fruit Bunch (FFB) of the oil palm without any effects in live weight (Dwatmadji and Suteky, 2012) and reproductive performance (Suteky and Dwatmadji, 2009).

The main objective of the present research was to investigate the effect of mix herbal inclusion to improve the digestibility and live weight gain of Bali cattle given feed based on agricultural by-products in Indonesia.

Materials and methods

The study site

The present study was carried out at an experimental farm located 20 km from the University of Bengkulu, Animal Science Laboratory Bengkulu University. Proximate Analysis was done in Microbiology and Biochemistry Laboratory, Research Center for Bioresources and Biotechnology (PPSHB), Bogor Agriculture University, Bogor Indonesia. This study was conducted according to the guidelines of the Committee on Use of Animals in Research and Experimentation.

Mix herbs and plant extract preparation

The herbs were used in this study were: *Curcuma longa* and *Zingiber officinale* were commercially available as a powder from the local herb market, while *Nigella sativa was* available as dried seed. The seeds were oven-dried at 60 ℃ before grinding. *Melastoma malabatricum leaves* were cut in small pieces dried at room temperature for 5-7 days and then ground. The crude extracts were prepared by maceration technique.

Experimental design

The experiment was laid out in a Randomized Complete Design, with three treatments and four replications. The experiment was conducted over 21 days consisting of a 14-day preliminary period and a 7-day measurement period.

Experimental treatment group and feeding plans

Twelve Bali steers of the same age (30 months), body (175.72 $\pm$ 21 kg) and Body Condition Score (BCS=5) were randomly divided into three treatments having 4 animals in each and were offered with three different mix-herbal supplement block (Table 1) as follows: S0=No supplementation, SCL= Supplemented with *Curcuma longa* (50 mg/kg live weight/day), and SZO= Supplemented with *Zingiber officinale* (50 mg/kg live weight/day). SCL and SZO group were also given a similar amount of *Nigella sativa* and *Melastoma malabatricum*.

Table 1. Composition of mix-herbal supplement block

Item	Treatments		
	S0	**SCL**	**SZO**
Ingredient composition, % Fresh Weight			
Molasses	25	25	25
Cement	20	20	20
Palm Kernel Cake (PKC)	13	13	13
Urea	10	10	10
Salt	4	4	4
Mineral mix	1	1	1
Rice bran	19	13	13
Cassava flour	8	5	5
Melastoma malabatricum extract	-	3	3
Nigella sativa	-	3	3
Curcuma longa	-	3	-
Zingiber officinale	-	-	3
Dry matter, %	62.48	61.7	62.03
Diet nutrient content, % DM			
Organic matter	42.44	41.94	42.12
Crude protein	38.21	38.27	38.59
Crude fiber	6.49	5.76	6.71

Feeds consisting of tofu by-product/waste, Palm Oil Sludge (POS) and Elephant grass (*Pennisetum purpureum*), were given *ad libitum* for all groups. During the measurement period, feed intake and fecal output were measured daily.

Table 2. Nutrient content of feeds given to all animals

Feed	Nutrient Content					
	DM (%)	OM (%)	CP(%)	CF (%)	EE (%)	GE (kcal)
Elephant grass	25.29	24.38	8.82	32.75	1.27	4,113
Palm Oil Sludge	6.05	5.21	14.02	20.81	14.05	4,927
Tofu by-product	5.41	5.22	19.72	18.19	19.83	5,326

Elephant grass and water were given *ad libitum*, while the POS and Tofu by-product was given at 9 kg/h/d and 6 kg/h/d respectively. During the measurement period, the animals were kept in the metabolic cages. Feed soffered, feed residue and fecal output of individual animals were collected, sub-sampled, sun-dried to be prepared later for feed analysis in the laboratory. Live weight was measured before the adaption period and during the collection period.

Sampling

The samples from each animal were pooled for each period before analysis. The representative samples of feed offered, feed residue and fecal output were taken to the laboratory for dry matter, organic matter, crude protein, crude fiber, and ether extract analysis as per AOAC (1990).

Statistical analysis

The data were analyzed by analysis of variance (ANOVA) using SPSS Software version 16.1. Treatment means which showed significant differences at the probability level of $p<0.05$ were compared using Least Significance Difference (Daniel, 1991).

Results

The initial live and final weight did not differ ($p>0.05$) among the treatments. However, the average daily gain on group SCL differs significantly ($p<0.05$) with the others. Bali cattle fed with S0, SCL, and SZO formulas gained 0.39, 1.25, and 0.79 kg day^{-1} respectively (Table 3).

Table 3. Mean value ± standard deviation of live weight and Average Daily Gain

Measurement	**Treatments**		
	S0	**SCL**	**SZO**
Live weight			
Initial weight (kg)	181.75 ± 26.5	179.75 ±12.2	189.25 ±16.2
Final weight (kg)	184.50 ±16.2	188.50 ±14.8	194.75 ±2.35
Average Daily Gain (kg)	0.39 ±0.16^{a}	1.25 ±0.57^{b}	0.79 ±0.43^{a}

Values in each row with different superscripts differ significantly ($p<0.05$). S0: No supplementation, SCL: Supplemented with *Curcuma longa* (50 mg/kg live weight/d), and SZO: Supplemented with *Zingiber officinale* (50 mg/kg live weight/d)

Dry matter (DM), organic matter (OM) intake (feed, herbal, total), fecal output, and digestibility are presented in Table 4. Results indicated that total dry matter intake numerically higher in SCL and SZO compare to SO which ranged from 6.323 to 6.807 g day^{-1}. If presented in DMI% body weight, the values were in the range of 3.59-3.55%. There were no significant differences ($p>0.05$) in DM and OM digestibility among all treatments. Also, there were no differences ($p>0.05$) on DM and OM intake (feed, herbal, total), and fecal DM and OM output (Table 4).

Results on crude protein (CP), crude fiber (CF) and ether extract (EE) intake (feed, herbal, total), fecal output and digestibility are presented in Table 5. The actual crude protein intake daily based on DM accounted for 679.79, 697 and 736.02 g/d, respectively. While EE intake 505.6 (SO), 504.3 (SCL) and 505.4 (SZO) g/d, DM. Our findings also recorded that there were no significant difference (p>0.05) in CP, CF, and EE digestibility among all treatments, similarly (p>0.05) CP, CF, and EE intake (feed, herbal, total), and fecal CP, CF, and EE output (Table 5).

Table 4. Mean value ± standard deviation of dry matter (DM) and organic matter (OM) intake, fecal output, and digestibility of all treatments

Measurement	Treatments		
	S0	**SCL**	**SZO**
Dry Matter (DM)			
DM Intake (g/d)			
Feed	6.259±506.5	6.457±222.9	6.735±617.1
Herbal	64.3±11.81	67.5±5.20	72.8±7.18
Total	6.323±505.1	6.525±227.5	6.807±624.1
Fecal output,(g/d)	1.369±124.1	1,394±101.5	1,430±83.7
DM Digestibility (%)	78.7±1.26	78.6±2.37	79.0±2.35
DMI % Body weight	3.59±0.48	3.66±0.29	3.64±0.28
Organic Matter (OM)			
OM Intake (g/d, DM)			
Feed	5,857±250.1	6,067±198.2	6,060±130.7
Herbal	48.1±8.85	47.6±3.67	48.9±4.76
Total	5,885±249.1	6,114±200.4	6,109±134.1
OM Fecal output (g/d, DM)	1,396±122.4	1,446±94.1	1,466±81.46
OM Digestibility (%)	75.8±1.79	75.9±2.02	75.5±1.68

Values in each row with different superscripts differ significantly (p<0.05). S0: no supplementation, SCL: supplemented with *Curcuma longa* (50 mg/kg live weight/d), and SZO: supplemented with *Zingiber officinale* (50 mg/kg live weight/d)

Discussion

The addition *of Curcuma longa* on the diet increased significantly (p<0.05) the ADG. The improvement of ADG could be due to curcumin as the main component of *Curcuma longa* (Jantan and Saputri,2012). Scientific evidence showed that curcumin or turmeric has a wide spectrum of biological actions which include antioxidant, anticoagulant, antibacterial, antifungal, antiprotozoal, antiviral and anti-inflammatory properties (Zhou *et al*., 2011; Habeeb. and El-Tarabany, 2012; Cervantes-Valencia *et al*., 2015). Due to its pharmacological activity as antibacterial, feeding curcumin in cattle will change rumen flora. Such a disturbance would affect macronutrient digestibility, nitrogen utilization and growth performance ((Vorlaphim *et al.*, 2011).

Table 5. Mean value ± standard deviation of crude protein (CP), crude fiber (CF), and ether extract (EE) intake, fecal output, and digestibility of all treatments

Measurement	Treatments		
	S0	**SCL**	**SZO**
Crude Protein (CP)			
CP Intake (g/d, DM)			
Feed	679.79±55.43	697.48±25.29	736.02±41.19
Herbal	22.6±3.66	23.8±1.62	22.1±1.89
Total	702.40±54.01	721.30±27.11	758.10±43.24
CP Fecal output (g/d, DM)	227.95±24.94	235.89±21.80	230.42±21.43
CP Digestibility (%)	67.45±3.52	67.15±4.20	69.273±4.47
Crude Fibre (CF)			
CF Intake (g/d, DM)			
Feed	1559.7±138,52	1595.9±59.80	1561.7±137.55
Herbal	3.83±0.70	3.58±0.27	4.55±0.44
Total	1615.3±138.35	1673.6±60.07	1756.6±137.97
CF Fecal output (g/d, DM)	255.3±32.92	230.8±29.60	262.3±38.54
CF Digestibility (%)	84.13±1.625	86.15±2.139	84.93±2.457
Ether Extract (EE)			
EE Intake (g/d, DM)			
Feed	505.3±3.79	503.8±2.81	504.6±6.38
Herbal	0.33±0.054	0.52±0.035	082±0.070
Total	505.6±3.77	504.3±2.85	505.4±6.46
EE Fecal output (g/d, DM)	136.0±25.30	133.7±35.19	143.7±24.15
EE Digestibility (%)	73.1±4.43	73.4±3.24	71.3±5.18

Values in each row with different superscripts differ significantly ($p<0.05$). S0: no supplementation, SCL: supplemented with *Curcuma longa* (50 mg/kg live weight/d), and SZO: supplemented with *Zingiber officinale* (50 mg/kg live weight/d)

The present experiment indicated that addition of Mix-Herbal Supplementation Blocsk (MHSB) did not affect ($p>0.05$) feed intake and digestibility (DM, OM, CP, CF, and EE) on Bali cattle. Our result seems to be similar to the research using cattle by Wanapat *et al*. (2012) in which the DMI and apparent digestibility of DM and OM were not affected by dietary herb supplementation. In another experiment, Wanapat *et al*. (2013) also reported that supplementation of lemongrass and peppermint powder at different levels had no effect on DMI and nutrient digestibility.

Experiment conducted by Vorlaphim *et al.* (2011) to evaluate dietary treatments consisted of concentrates containing curcumin using crossbred Brahman bulls showed that feed intake was not affected by adding curcumin in ration. The addition of curcumin had increased bacterial but lowered the protozoal counts in the rumen fluid. Similar result on digestibility was also found when *Nigella sativa* L. seeds supplementation was given to lambs (Odhaib *et al*., 2012). Another experiment, however, showed that when Zaraibi goat was supplemented with a combination for medicinal herbs one of them is *Nigella sativa, the* DM, OM, and CP digestibility was reported to have improved (Mirzaei and Venkatesh, 2012).

Our experiment showed different results with El-din *et al*. (2012), in which addition of herbs (garlic juice and ginger) improved energy, dry matter, organic matter digestibility in vitro. The chemical constituents of ginger are documented having the ability to stimulate digestion and absorption by increasing the activity of muscular in the alimentary tract (Zadeh and Kor, 2015). Supplementation with 75 or 150 g of ginger roots powder/cow/day significantly increasds the total feed intake but no significant effect on live weight (Al-dain and Jarjeis, 2015).

It might be concluded from this study that the amount of mix-herbal supplements, both *Curcuma longa* and/or *Zingiber officinale*, could be given in a higher amount (more than 50 mg/kg live weight/day) to the Bali cattle. Other researchers have given herbs of 100 g/head/day to cattle (Ngamsaeng *et al*., 2006; Kongmun *et al*., 2009; Wanapat *et al*., 2008a; Wanapat *et al*., 2008b). It seems that the response to herbs supplementation also differs between goat and cattle. According to Riaz *et al.* (2014), the dynamics of digestive systems in ruminants are relatively not the same because goats have smaller reticulo-rumen and better capability to break down fibrous feed components than other ruminants.

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