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The preference of PE goats on poly-herb supplementation

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Abstract Our findings showed that there were no significant differences in sniffing and eating frequency also DMI. There is also an interaction amongst sniffing, eating frequency, pellets and DMI with the equation Y= 10.67- (0.405 Sniffing frequency) + (2.338 Eating frequency) - (0.706 pellet) +e, with the R^2 = 0.506. However, when preconditioning/pre-ingestive goats with specific polyherbal pellets were calculated. Group of goats that previously eat pellets 0 the Dry matter intake (41.62 g/30 minutes) RPI, selection index and CoP were significantly higher (<0.05) than the others. Three pellets (P0. P1, P2) were high acceptable by PE goat while P3 was medium acceptable. The result from Mann-Whitney Wilcoxon-Test indicates that frequency of eating, DMI (g/30 min), selection index and RPI were significantly higher in preconditioning goats.

Keywords: Coefficient of preference, Eating sniffing frequency, RPI

Introduction

The goats perform in particular an essential contribution in the sustenance of small farmers as an important component of mixed livestock farming systems, the livestock will produce meat, milk, leather, fibre and compost for a large number of landless and low-income or remuneration farmers (Wodajo *et al.*, 2020). Livestock makes a necessary and important contribution to economic, global calorie and protein supply (Durmus *et al.*, 2019; McLeod, 2011). Livestock thus takes part in guarantee food safety and relieve poverty (McLeod, 2011). Small ruminants are generally considered a key resource for small farmers who carry out a significant economic and cultural responsibility and can be raised in different agro-ecological systems.

Ruminants have multiple roles in household food and economic security (Mellor and Malik, 2017). Livestock also has a significant contribution to the food safety of millions of people today and will be important for the food safety of millions more in coming years.

In general goat production in developing countries are usually characterized by limited feed resources usually based on high roughage-based

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diets low quality feeds both quantity and quality (Kawas *et al.*, 2010). In several developing countries such as Indonesia, Nigeria, Vietnam goats are raised extensively on natural grasses and crop residues or a combination of integration between crops and livestock. Studies have shown that natural grasses cannot support adequate nutrients for optimal goats performance and production (Priolo *et al.*, 2002).

The incapacity of the farmers to give their livestock feed satisfactory continually is an important determinant to satisfy future needs for animal protein intake in the tropics. Therefore, nutrition was identified as a key factor for the survival and profitability of ruminants (Okoruwa, 2019). Although pastures are abundant in the tropics, they could do not always meet the nutritional requirements of ruminants, particularly during the dry season for its content of low nutrient content. (Salem, 2010) also reported that pasture is frequently inadequate nutrients cannot maintain ruminal microflora for its optimal digestion. In response to this challenge, farmers implementing natural grass with a concentrated mixture, but the lack of availability and the cost of the concentrated mixture is often non-applicable for the farmer. Therefore, one of the cheapest alternatives to improve the use of low-quality pastures is supplementation with natural herbs. (Asaolu *et al.*, 2012) reported the advantages of herbs as feed supplementation on livestock such as manipulate ruminal fermentation and improve nutrient utilization, meat quality, ovarian activity (Bachruddin *et al.*, 2019; Biosci *et al.*, 2017; Meza-Herrera *et al.*, 2013; Xazela *et al.*, 2012; Yusuf *et al.*, 2014).

The presence of secondary metabolic content in herbs could contribute to the sensory properties and the flavour of some herbs is considered the most dominating attribute and will affect the eating experience (Pavagadhi and Swarup, 2020). In this experiment the used combination of *Andrographis paniculata*, with *Curcuma mangga* or *Curcuma domestica* and *Nigella sativa* as a source of herb as feed supplementation. *Andrographis paniculata* or king of bitter is generally unpleasant taste, while the taste of curcumin was bitter, peppery and pungent. The performance of goat and normal rumen ecology was documented in goats with commercial polyherbal formulation for 45 days (Handekar *et al.*, 2010). Since the animals use the smell and display the senses to detect the differences of feed sources or formulation and they can select or avoid specific feed items, therefore our experiments were conducted to examine the preference test of poly herbs as feed supplementation.

Materials and methods

Study site experimental animal

Research conducted in the Animal Science Laboratory University of Bengkulu for pellet preparation and field experiment is located in Babatan Seluma Bengkulu Provence (-35.9018300 latitude and 102.360022 longitudes). An experimental animal was already adapted to the environment and feed (based on oil palm sludge, tofu waste and rice brand). A preference trial was conducted to evaluate sniffing/eating frequency, DM intake, RPI etc., of different formulations of polyherbal namely: P0 =Non-poly herbs pellets; P1=6 gram *Andrographis paniculata* + 6 gram *Curcuma mangga* + 0.5 gram *Nigella sativa*); P2: 6 gram *Andrographis paniculata* + 6 gram *Curcuma domestica* + 0.5 gram *Nigella sativa* and P3= 6 gram *Curcuma mangga* + 6 gram *Curcuma domestica* + 0.5 gram *Nigella sativa*. All the poly-herbs were combined thoroughly mixed with the palm kernel Cake, rice bran, mineral, mix, and molasses to become pellets.

The test was done using 32 female PE goats), goats were housed individually in 140 × 80 cm pens. Each pen had a feeder and 5-L bucket for the drinker. Female PE growing goats with initial life weight 16.47± 2.10 kg and 7-8 months of age were used in this experiment, all goats maintaining in an individual pen of (1.4 m x 0.8 m). 32 goats were divided into 4 groups (8 goats in each group).

Preference experiment

During preconditioned the first group of goats were given pellets (P0); second group P1 dan the others P2 dan P4, pellets were given 50gram from 08.00 to 09.00, for 8 weeks before starting the preference test. A cafeteria system of 4 formulations of pellets was used to study the preferences. The short-term intake rate (STIR) was used to evaluate the preference rank based on the intake of four pellets on the first day of the pellets offer. 50gram pellet of each formulation was offered in a plastic feeding box, the positions of the pellet were changed every 3-4 minutes so all experimental goats had free access to all the pellets. Goats were allowance to eat all pellets in 30 minutes, each occasion when goats switched (sniff or eat) from one pellet to the other were recorded. The pellets that were not consumed during 30 minutes were weighed and recorded. Parameter measures were sniffing and eating frequency, feed intake (DMI) in 30 minutes. Relative preference index or RPI calculated according to feed consumption divided by that of the highest feed intake and expressed as a percentage (Okoruwa, 2019), the result then classified in each goat and separated classified of high (>60%), medium (35-55%) and low palatability (<25%). The coefficient of preference (CoP) = Intake of individual feed/mean intake of all the feed offered. Preference of supplementation was rated higher when CoP is equal to or higher than one (1), while selection rank was ranked based on CoP (Ziblim *et al.*, 2019).

In this research, we also compared the effect preconditioning and non-preconditioning/non-experience on preference test of poly-herbs pellets. 16 female PE goats were used as non-preconditioning/experience, all 16 goats were treats with some condition and management with preconditioning goats except no experience of eating the pellets.

Statistical analysis

All the data were tabulated and analysed through a computer statistical program The IBM® SPSS® 24. The differences between treatment effects were analysed based on analysis of variance (ANOVA), Duncan's multiple range test was applied to identify differences between the means. The effect of preconditioning on all the parameters was analysed using regression and correlation. To evaluate the effect of preconditioning and non-preconditioning, the two independent sample test was carried out, normality test using the Shapiro-Wilk was perform, if the results of the $p>0.05$ test are followed by the Student t-test if $p<0.05$ then the non-parametric test Mann-Whitney U-test was used.

Results

Results revealed that no significant differences in sniffing eating frequency and Dry Matter Intake of Poly herbs-pellets.

Table 1. Sniffing, eating frequency and Dry Matter Intake of Poly herbs-pellet

Groups	Sniffing frequency		Eating frequency		Total DMI (g/30 min)	
	Average	SE	Average	SE	Average	SE
P-0	8.38	0.91	23.75	1.92	137.15 [a]	9.14
P-1	4.88	0.44	20.50	2.31	103.00 [ab]	18.18
P-2	8.00	1.94	25.25	1.95	137.37 [a]	10.20
P-3	5.63	0.78	20.63	1.59	81.29 [b]	9.12
P	ns		ns		0<0.01	

The range of sniffing frequency was 4.88-8.38 and dry matter intake (DMI) of all pellets in 30 minutes were about 81.29-137.37 gram.

Table 2. Relative Preference Index, Preference rank, selection index and Coefficient of Preference of goats on Poly herbs-pellet

Groups	Relative Preference Index	Preference Rank	Selection Index	Selection Rank	Coefficient of Preference
P-0	76.94 ^{a}	High	0.76 ^{a}	2.00	1.195 ^{a}
P-1	57.78 ^{ab}	High	0.57 ^{ab}	3.00	0.898 ^{ab}
P-2	77.07 ^{a}	High	0.77 ^{a}	1.00	1.197 ^{a}
P-3	45.61^{b}	Medium	0.45 ^{b}	4.00	0.708 ^{b}
P	ns		ns		ns

Table 3. The effects of pre-conditioning on sniffing eating frequency and Dry Matter Intake of goats on Poly herbs-pellet

Pre-conditioning	Treatments	Sniffing frequency		Eating frequency		DMI (g/30 min)	
		Average	SE	Average	SE	Average	SE
P0-Pellet 0	Pellets 0	1.88	0.350	5.38	0.925	41.62^{a}	1.75
	Pellets 1	2.38	0.263	5.88	0.549	33.09 ^{ab}	2.18
	Pellets 2	2.50	0.598	7.13	0.990	33.48 ^{ab}	4.35
	Pellets 3	2.13	0.441	5.38	1.085	28.96 ^{c}	3.03
	P	ns		ns		<0.05	
P1-Pellets 1	Pellets 0	1.25	0.25	6.50	0.60	27.71	2.31
	Pellets 1	1.13	0.13	5.25	0.88	29.71	2.05
	Pellets 2	1.00	0.00	4.38	0.91	25.17	2.27
	Pellets 3	1.50	0.33	4.38	0.92	20.41	1.98
	P	ns		ns		ns	
P2-Pellets 2	Pellets 0	2.38	0.65	5.50	0.94	33.27	4.47
	Pellets 1	2.38	0.75	7.75	0.59	35.00	4.31
	Pellets 2	2.13	0.61	5.88	0.61	36.81	3.01
	Pellets 3	1.63	0.50	6.13	0.79	32.29	3.04
	P	ns		ns		ns	
P3-Pellets 3	Pellets 0	1.63	0.26	5.38	1.03	18.36	2.59
	Pellets 1	1.75	0.31	4.75	0.77	18.01	2.13
	Pellets 2	1.25	0.25	5.75	0.88	22.18	3.52
	Pellets 3	1.13	0.13	4.75	0.98	22.41	3.03
	P	ns		ns		ns	

There was also an interaction among sniffing, eating frequency, pellets and DMI with the equation Y= 10.67- (0.405 Sniffing frequency) + (2.338 Eating frequency) -(0.706 pellet) +e, with the R^2 = 0.506. Preference rank (Table 2 and 4) was based on the percentage of Relative Preference Index according to Okoruwa (2019), high (>60%), medium (35-55%) and low palatability (<25%). Three formulations of pellets were highly palatable while pellet containing *Curcuma mangga* and *Curcuma domestica* was the medium preference (Table 2).

Table 4. The effects of pre-conditioning on Relative Preference Index, Preference rank, selection index and Coefficient of Preference of goats on Poly herbs-pellet

Pre-conditioning	**Treatments**	**Relative Preference Index**	**Preference Rank**	**Selection Index**	**Selection Rank**	**Coefficient of Preference**
Pellet 0	Pellets 0	93.50[a]	High	0.94 [a]	1.0	1.50 [a]
	Pellets 1	73.50[ab]	High	0.73 [ab]	3.0	1.00 [ab]
	Pellets 2	74.75 [ab]	High	0.74 [ab]	2.0	1.18 [ab]
	Pellets 3	65.25[c]	High	0.65 [c]	4.0	0.64 [c]
	P	<0.05		<0.05		<0.05
Pellets 1	Pellets 0	62.25	High	0.62	2.0	0.97
	Pellets 1	66.00	High	0.66	1.0	1.04
	Pellets 2	56.75	Medium	0.57	3.0	0.88
	Pellets3	46.00	Medium	0.46	4.0	0.71
	P	ns		ns		ns
Pellets 2	Pellets 0	74.75	High	0.41	3.0	1.18
	Pellets 1	77.75	High	0.40	4.0	1.23
	Pellets 2	83.00	High	0.50	2.0	1.29
	Pellets 3	72.75	High	0.51	1.0	1.13
	P	ns		ns		0.0<5
Pellets 3	Pellets 0	41.25	Medium	0.41	3.0	0.64
	Pellets 1	40.00	Medium	0.40	4.0	0.63
	Pellets 2	50.00	Medium	0.50	2.0	0.78
	Pellets 3	50.50	Medium	0.51	1.0	0.78
	P	ns		ns		ns

Values in the same row with different superscripts differ ($P \leq 0.05$)

Table 5. Results of Mann-Whitney Wilcoxon-Test: preference of poly-herbs

Variables		N	Mean Rank	Sum of Ranks	Mann-Whitney U	Wilcoxon W	Z	*p*-value
Pellets formulation	Preconditioning	32	24.50	784.00	256.0	392.0	0.00	1.00
	Non-Preconditioning	16	24.50	392.00				
Frequency of sniff	Preconditioning	32	26.70	854.50	185.5	321.5	-1.56	0.12
	Non-Preconditioning	16	20.09	321.50				
Freq-eat	Preconditioning	32	31.00	992.00	48.0	184.0	-4.56	0.00
	Non-Preconditioning	16	11.50	184.00				
DMI (g/30 min)	Preconditioning	32	32.28	1033.00	7.0	143.0	-5.45	0.00
	Non-Preconditioning	16	8.94	143.00				
Selection index	Preconditioning	32	32.08	1026.50	13.5	149.5	-5.36	0.00
	Non-Preconditioning	16	9.34	149.50				
CoP	Preconditioning	32	24.98	799.50	240.5	376.5	-0.34	0.73
	Non-Preconditioning	16	23.53	376.50				
Relative Preference Index	Preconditioning	32	32.28	1033.00	7.0	143.0	-5.45	0.00
	Non-Preconditioning	16	8.94	143.00				

Discussion

Result indicated that sniffing and eating frequency was not affected by the formulation of pellets. Sniffing frequency is thought to assume a significant part in smell information processing (Wesson *et al.*, 2009). Medium correlation (R = 0,571) was analysed between sniffing and eating frequency with dry matter intake (g/30 min). Raynor *et al.*(2015) reported that based on metanalysis in the three studies all found no significant difference in intake and eating frequency conditions when experimental test less than 1 month. When the research was conducted for more than one month the results were also inconsistent. One experiment found significantly less feed intake in the higher eating frequency, another experiment finding significantly greater intake with higher eating frequency, while a significant difference between consumption and eating frequency was not found in another study (Raynor *et al.*, 2015).

When pellets consumption was recorded at 30-minutes, the total dry matter intake of pellets 3 was significantly lower ($P<0.05$). An animal can choose several diets, one of which has more intake and the other less, of an essential nutrient than is necessary for optimum requirement, so feeding preferences can be monitored through their diet selection (Forbes and Kyriazakis, 1995). According to Villalba *et al.* (2011) goats receiving a diversity of flavours (diversity treatment) showed less ($P < 0.05$) intake than those in the control. Relative preference and intake could be used as palatability indicators (Sultan *et al.*, 2007), Forbes, 2010) also said that flavour and another sensory characteristic of feed could refer to palatability and will influence the feed intake While the rate of potential intake is affected by the level of tenderness, the relative preference index is influenced by chemical factors (Rahim *et al.*, 2013). Personius *et al*. (1987) reported that herbivores can detect a toxic compound in fodder through their sense of smell, before or shortly after the first bite. Diet selection was affected by the combination of nutrient and metabolic seconder in the plant (Ulappa *et al*., 2014).

The pellets formulation in P0-P2 showed high preference rank than that of P3, the same results were also in RPI, selection index, and Coefficient of Preference. These differences could be due to the secondary compound and flavours and taste of the pellets (Ziblim *et al.*, 2019), however, the correlation between pellets formulation and DMI were weak ($R = 0.370$). A bioactive fraction in herbs, such as phenols, flavonoids, isoflavones, terpenes, and glucosinolates, contribute to bitter, acidic, peppery or astringent flavour. Scientific evidence also suggests that bitter and sweet tastes, when present together, can enhance, or suppress each other (Drewnowski, 2001) The relationship between preconditioning goats with specific polyherbal pellets found that DMI (g/30 minutes) of Pellets 0 was significantly higher ($P<0.05$) than the others in goats that were previously pre-condition with the same pellets. Forbes and Kyriazakis (1995) said that the principle of a training period or preconditioning allows the animal to learn to associate a particular set of sensory properties with a certain metabolic sensation.

A result from Mann-Whitney Wilcoxon-Test indicates that frequency of eating, DMI (g/30 min), selection index and RPI were significantly higher in the preconditioning group. The effect of preconditioning is significantly higher ($P<0.01$) in eating frequency, DMI (g/30 min), CoP, selection index and RPI compared with non-preconditioning goats. It seems that the goat recognizes the taste of the pellets due to preconditioning. Goats are more likely to accept a diet they have already experienced (Ikhimioya, 2008). Kissileff, (1990) also suggested the concept of "learned palatability", which is related to responses based on the animal's previous feeding experience. However, Scherer *et al.*,

2019) said that the mechanism of the perception is primarily based on sensory characteristics related to post-meal feedback or whether post-meal feedback is activated in each case before a selection is made. In addition, information about the length of the memory process and whether memory is activated mainly by smell or by a combination of smell and taste was not clear. In conclusion, goats express the preference from DMI of each pellet when an option is given and their preferences could monitor by their diet selection. Frequency of eating, DMI (g/30 min), selection index and RPI were significantly higher in preconditioning goats.

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