Effect on Nutrient Digestibility of Dairy Cows by Addition of Galangal (*Alpinia galangal*) Essential Oil

Dewi Ratih Ayu Daning[1,2] , Chusnul Hanim[1], Budi Prasetyo Widyobroto[1], and Lies Mira Yusiati[1*]

[1] *Faculty of Animal Science, Universitas Gadjah Mada Jl. Fauna No.03, Karang Gayam, Caturtunggal, Kec. Depok, Kabupaten Sleman, Daerah Istimewa Yogyakarta 55281*
[2] *Politeknik Pembangunan Pertanian Malang. Jl.Dr. Cipto 144 a, Bedali, Lawang.Malang 65200*
[*] *Corresponding author. Email: liesmira@ugm.ac.id*

ABSTRACT
Galangal essential oil (EO) with cineol as the main component has antimicrobial activity. The level of nutrient digestibility in dairy cows is determined by the mechanism of action of the rumen microbes. The addition of galangal essential oil to dairy cows feed is expected to reduce the activity of proteolytic bacteria, thereby increasing the total protein digestibility of dairy cows. Each treatment consists of the same basal feed (60% elephant grass and 40% concentrate) with varying doses of galangal EO as much as 0 (control), 1.25 and 2.50 g/head/day. The collection period for digestibility was carried out for seven days after a 30 day adaptation period of giving galangal essential oil. The data obtained were analyzed for variance using a completely randomized design with three treatments and four replications. The results showed that there was no significant difference between control and galangal essential oil in both nutrient intake and nutrient digestibility (dry matter, organic matter, crude protein, crude fibre, and nitrogen-free extract). This study concluded that galangal essential oil levels of up to 2.50 g/head/day were the optimal dose without a negative impact on nutrient digestibility of dairy cows.

***Keywords**: Galangal essential oils, nutrient digestibility, dairy cows ration, and in vivo*

1. INTRODUCTION

Strategies to increase the efficiency of dairy cow productions are to improve nutrition efficiency by rumen microbes and minimize energy and protein loss during fermentation [1, 2]. The use of feed additives from secondary metabolites has been shown to increase energy and protein utilization in the rumen, thereby increasing the production of dairy cows. The mechanism of plant secondary metabolites in rumen fermentation are reduced protein degradation [3], increasing volatile fatty acids [4], reduced methanogenesis [5], and modifying some rumen microbe that negatively affects feed utilization. Therefore, recent attempts have been made to identify some plant extracts that can raise the production efficiency of livestock

Essential oils are plant extracts obtained through the steam distillation process [6]. The content of bioactive compounds in essential oils is more than 100 types, but their activity still depends on the major type of bioactive components [7]. The mechanism of action of essential oil is due to its function as antimicrobials in the rumen [8]. The majority of rumen microbial groups are Gram-Negative, such as Bacteriodetes, which correlate with nutrient digestibility in dairy cows [9]. The activity of essential oils is mainly sensitive to Gram-positive[10], so essential oils are expected to increase the abundance of Gram-negative bacteria in the rumen. Essential oils have been shown to reduce protein digestibility [11] and increase volatile fatty acids [12] levels in rumen fermentation in vitro. These reports indicate good potential for dairy cows.

Essential oils can be obtained from various types of aromatic plants. Galangal is one of the spice plants with the third production in Indonesia and spread throughout Indonesia [13]. Based on previous research, galangal essential oil with cineole as the main component has more vigorous antimicrobial activity against Gram-positive [14]. It allows galangal EO as a feed additive in increasing nutrient efficiency in dairy cows. This study aimed to determine the effect of galangal essential oil in

dairy cows feed on nutrient digestibility using the in vivo technique.

2. MATERIALS AND METHODS

2.1. Dairy cows were grouped in each treatment

This study used Friesian Holstein (FH) mid-lactation dairy cows totalling 12 heads with an average production of 6 to 7 litters/head/day and a bodyweight of 400 to 450 kg. The group of dairy cows was divided into three groups, which consisted of 4 cows as control and eight cows as treatment with two different dosages of galangal EO, namely, 1.25 and 2.50 g/head/day.

2.2. Feeding treatments.

Adaptation in feeding was carried out at seven days, then continued with feeding treatment using galangal EO for 30 days. The ratio of basal feeding consisted of 60% of elephant grass:40% of the concentrate. The basal ratio was calculated based on NRC (National Research Council) 2001 for dairy cows. Forage was distributed after concentrate, two times a day at 07.00 am and 03.00 pm. Drinking water is provided ad libitum. The amount of feed intake for each animal was weighed and recorded daily. The residual of the feed was collected every day with the amount of 10% from a total of feed.

2.3. Nutrient digestibility.

Digestibility experiments were carried out with a total collection method with a three-day pre-collection and seven-day collection period. During the collection period, sample collection was carried out feed, feed residue, and feces. Feces were collected as much as 10% from the total feces of each day per cow. Feces was composited in fresh conditions. Nutrient analysis was carried out by proximate analysis tools using the AOAC method [15].

Data collection analysis consisted of feed ingredients, feed consumption, Feed residual and feces were dry matter (DM), organic matter (OM), crude fiber (CF), crude protein (CP), and ether extract (EE).

2.4. Experimental design.

Data obtained were analysed for variance using a completely randomized design with three treatments and four replications of Windows IBM SPSS 16 (IBM Corporation, New York, USA), and significance was set at $p<0.05$.

3. RESULTS AND DISCUSSION

The addition of galangal essential oil doses of 1.25 and 2.50 g/head/day in dairy cows feed showed no significant difference (P>0.05) on the digestibility of nutrients and nutrient intake consisting of dry matter, organic matter, crude protein, crude fibre, crude fat, and nitrogen free extracts. Nutrient digestibility data are shown in Table 1 and 2. It is reported that the dose of coriander essential oil EO 1.4 g/head/day of dairy cattle affected increasing the digestibility of organic matter (OM), ether extract (EE), neutral detergent fibre (NDF), and acid detergent fibre (ADF) [16]. The addition of essential oil from eucalyptus at a dose of 4.5 g/head/day in dairy cattle feed also showed the same results, namely an increase in dry matter digestibility, organic matter, crude protein, crude fibre, and NDF [17]. Furthermore, It is also reported a mixture of essential oils consisting of capsaicin carvacrol, cinnamaldehyde, and eugenol with a feed dose of 2.5 g/head/day increased the nutritional digestibility of dairy cows [18].

The effect of essential oils on nutrient digestibility varies because their activity on rumen microbe, the dose, type, and level of purity of the essential oil [19, 20]. Several studies using pure compounds such as thymol and carvacrol and essential oils of oregano and thyme at dose of 50 mg/g DM of feed-in dairy cattle also had no effect on nutrient digestibility [21],[22].

Table 1. Effect of galangal oil on nutrient intake

Measurements	Dosage of Galangal Essential Oils (g/head/day)		
	0	1.25	2.50
Dry matter intake (kg/ /head/day)	15.15±0.08	15.07±0.10	15.00±0.08
Organic matter intake (kg/head/day)	12.20±0.07	12.14±0.09	12.08±0.07
Crude fiber intake (kg/head/day)	4.54±0.03	4.51±0.04	4.49±0.03
Crude protein intake (kg/head/day)	2.02±0.07	1.95±0.09	1.89±0.07
Ether extract intake (kg/head/day)	0.41±0.02	0.41±0.01	0.40±0.03
Nitrogen free extract intake (kg/head/day)	5.22±0.01	5.22±0.02	5.21±0.01

Tabel 2. Effect of galangal oil on nutrient digestibility

Nutrient digestibility (%)	Dosage of Galangal Essential Oils (g/kg dry matter of feed)		
	0	1.25	2.50
Dry matter	76.62±3.41	77.32±3.77	75.00±1.69
Organic matter	76.82±2.46	74.81±2.79	74.82±2.48
Ether extract	84.00±1.16	84.01±1.76	84.22±1.14
Crude fiber	81.85±3.21	79.87±2.69	78.81±3.03
Crude protein	77.39±2.18	76.85±1.85	77.07±1.46
Nitrogen free extract	74.51±1.97	72.86±1.76	70.44±1.14

Furthermore, increasing the dose of a mixture of essential oils (Vertan®; EO) from 2 g/head/day to 4 g/head/day was reported not to affect the digestibility of DM, CP, and NDF [23]. Based on several research results that have been mentioned, it can be concluded that the effect of various essential oils on nutrient digestibility depends on the dose and type of essential oil. Its use as a feed additive needs to consider the effectiveness of the dose of essential oil.

Young [24] explained that the effectiveness of essential oils depends on the extraction method, plant growth, location, and plant maturation. Digestibility inconsistency in the in vivo method correlates with the dose of essential oil, single or mixed types of essential oil [25, 26]. [27, 28] reported that essential oil mixtures were more potent as rumen modifiers than single essential oils because several bioactive compounds had synergistic effects. CRINA is a commercial EO blend proving that several studies in vitro and in vivo have significantly improved nutrient digestibility, increasing crude protein digestibility[29, 30]. Galangal EO in dairy cows feed is intended as an antimicrobial that improves rumen fermentation patterns in vitro because it reduces protein digestibility and abundance of proteolytic bacteria (unpublished data). However, in in vivo studies, the results of nutrient digestibility were still unexpectedly significant compared to controls.

These results may have several reasons for bioactive activity, and the doses used were lower than in vitro calculations.[31, 32] also reported that in vitro dose of EO in in vitro rumen fermentation cannot be used in vivo because it required and interfere with the palatability of livestock. Other recommendations from the study [33] required long-term studies in dairy cows during lactation, rotational period studies to eliminate microbial adaptation to EO [34], and microencapsulated EO [35].

Based on in vitro rumen fermentation experiments, galangal EO reduced the abundance of the phylum *Bacteriodetes*, a group of Gram-negative bacteria (unpublished data). According to [43], *Bacteriodetes* correlate with nutritional efficiency and milk production because they have the function of degrading starch, polysaccharides, and xylan [44]. Indeed, the results of in vitro fermentation experiments are not always representative of what happens in vivo[45], and the doses used for in vitro experiments are usually much more significant than in vivo [46]. Galangal EO is expected to increase the total digestible CP in dairy cows by decreasing protein degradation in the rumen, thereby increasing protein digestibility in the post rumen/small intestine. However, the addition of galangal essential oil to dairy cows feed in vivo did not affect the digestibility of crude protein. Several studies reported that almost all essential oils in dairy cows had no significant effect on nutrient digestibility [36–38]. Rumen microbes may have adapted to the influence of essential oils [39] According to [40], cineol, as the main compound of galangal EO, has the characteristics of being able to be degraded in the rumen, and the carbon component contained in it becomes a growth stimulator of Gram-positive bacteria [41]. Groups of gram-positive bacteria in the rumen play a significant role in fibre degradation with fermentation products in the form of acetate, formate, lactate, H_2, and CO_2 [42].

4. CONCLUSION

This study concluded that galangal essential oil levels of up to 2.50 g/head/day were the optimal dose without a negative impact on nutrient digestibility of dairy cows.

ACKNOWLEDGMENTS

Thank you to the National Agency for the Extension and Development of Agricultural Human Resources, Ministry of Agriculture, Republic of Indonesia for giving the opportunity to continue a doctoral studies.

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