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Growth Performance and Nutrient Digestibility in Awassi Lambs Fed on Different Levels of Lemongrass (*Cymbopogon citratus*) Leaf Powder

Taher Obaid Fahad and Anmar A.M. Al-Wazeer*

Department of Animal Production, Faculty of Agriculture, University of Kufa, Najaf, Iraq
** E-mail: anmar.alwazeer@uokufa.edu.iq*

Abstract: The total of 16 Awassi male lambs (4-5 months ages and 19.96 kg body weight) were divided randomly in a complete randomized design into four groups, to investigate changes in growth performance and digestibility of lambs fed different levels of lemongrass leaf powder (LLP, 0, 2, 4 and 6 g/head/day). There was significant superiority in lamb's total weight gain fed 2 and 4 g of LLP/head/day compared to those fed 0 and 6 g of LLP/head/day. Average daily gain (ADG) was significantly superior in lambs fed 2 and 4 g of LLP/head/day than those fed 6 g/head/day and control diet. The feed conversion ratio was improved in lambs fed 2 and 4 g LLP/head/day compared to fed on 0 and 6 g of LLP/head/day. The diet digestibility of dry matter and organic matter improved superiority in lambs fed 2 and 4 g of LLP/head/day compared to those fed on 0 and 6 g of LLP/head/day with no changes in diet digestibility of crude protein, crude fiber, ether extract, and nitrogen-free extract. It can be concluded that low levels of addition (2 and 4g/head/day) of lemongrass leaf powder enhance the digestibility and growth performance of Awassi lambs.

Keywords: Awassi lambs, Digestibility, Growth performance, Lemongrass leaf powder

The present tendency in ruminant feeding is for an alternative to antibiotics, growth promoters, and other hormones, which have been found to have negative effects and may pose future drug resistance dangers in humans who consume animal products (Al-Dobaib and Mousa 2009, Mirzaei et al 2012). The herbs and medicinal plants have been used in the feeding of ruminants as it has been discovered that the use can improve animal health and modified the rumen environment to improve nutrient digestion and metabolism, thereby improved production performance (Salem and El-Mahdy 1999, Wanapat et al 2008), increases milk production (Kholif et al 2017). Medicinal herbs and plants are also used in the treatment of various diseases in humans and animals (Kumar et al 2014, Cedillo et al 2015, Anes et al 2017). There are many herbs and medicinal plants that are used as feed additives in animal feeding, including the lemongrass (*Cymbopogon citratus*) leaves (Wanapat et al 2013). It is an aromatic perennial grass that belongs to the Poaceae family and contains many active compounds including saponins, flavonoids, alkaloids, phenols, anthraquinones, geraniol, and the most important component of which is the essential oils (Cheel et al 2005, Tajidi et al 2012). Lemongrass leaves or oil (citral) are also utilized as an anti-intestinal against worms that infect small ruminants in hot climates (Macedo et al 2015, 2019). Therefore, the present study aimed to investigate changes in growth performance and diet digestibility in Awassi lambs fed different levels of lemongrass leaf powder.

MATERIAL AND METHODS

This experiment was conducted in a field of small ruminants (sheep farm) Abulfadhl Station at AlKafeel General Investments Company, Karbala Province, Iraq, and was approved by the Committee on Bioethics Scientific Research at the University of Kufa. A total of 16 Awassi male lambs, aged between 4-5 months, with an average body weight of 19.96 ± 0.54 kg were distributed randomly into four groups according to weight (4 lambs each group). The individual feeding system was followed, and the animals were placed in cages per 1 x 2 m^2 area in a half-closed enclosure. Each cage was equipped with a feed for each of the roughage, concentrate feed, and drinking water facilities. All lambs were individually fed with diet twice a day at a rate of 3% of body weight as well as *ad libitum* offered wheat straw. Moreover, additions of LLP were introduced once daily before morning feeding to ensure that the whole amount of LLP was received (Kholif et al 2017). The experiment lasted for 65 days and the lambs were previously allowed 17 days as an adaptation period. Furthermore, lambs in the first group were fed the concentrated diet along with wheat straw denoted as control (without additives). The second, third, and fourth groups were fed on the control diet along with the addition of LLP at

different levels (2, 4, and 6 g/head/day). The dry matter intake was measured daily for each lamb. Lambs were weighed weekly during the trial period to record changes in body weight and adjust the quantities provided to the animal-based on 3% dry matter of body weight, Average daily gain was calculated. Feed conversion ratio (FCR) was calculated as the ratio between Average daily gain and dry matter intake. Digestion experiment was conducted one week before the end of growth experiment to estimate the nutrient apparent digestibility as were recorded total intake of roughages and concentrate diets daily for each animal, as well as recording feces of the excrement, using hand-make collection bags, taking into account the non-mixing of droppings with urine., the experiment lambs were subjected to this and the excreted excreta was collected daily before providing the feed in the morning for each animal for seven days and after weighing the feces, an amount was taken 10% and stored in nylon bags marked according to animal numbers and stored at -20 ºC, at the end of the collection period samples of feces were collected from each animal separately and dried at 60 ºC for 48 h and stored in airtight containers. The air-dried leaves of lemongrass were purchased from a local market in Iraq and ground to pass 1 mm screen and kept airtight containers until used for feeding lambs. Samples of concentrate diet, wheat straw, and lemongrass leaves, as well as feed, offered and feces were analyses for dry matter (DM), ash, crude protein (CP), crude fiber (CF), and ether extract (CF) were estimated according to the standard methods of AOAC (2005). The organic matter (OM) was calculated by subtraction 100-Ash. The nitrogen-free extract was calculated following equation NFE= OM-(CP+CF+EE). The chemical composition of concentrate diet, wheat straw, and lemongrass leaves used in this study are presented in Table 1. Data were analyzed statistically according to a completely randomized design using the procedure of SAS software (SAS, 2010).

RESULTS AND DISCUSSION

There were no significant differences in overall dry matter intake (DMI) for lambs fed lemongrass leaf powder compared with control. Feeding lemongrass leaf powder at all levels did not affect dry matter intake (Table 2). Similarly, Wanapat et al (2008) observed that feeding lemongrass leaves powder to cattle beef up to 300 g/day did not affect feed intake. Kholif et al (2017) also reported that the addition of 10g/day of lemongrass did not affect feed intake in Damascus goats. Hanafy et al (2009) observed that supplementing Barki lambs with lemongrass leaves did not

Table 1. Chemical composition of the concentrated diet wheat straw and lemongrass leaves (% DM)

Chemical composition (%)	Concentrate diet[1]	Wheat straw	Lemongrass leaves
Dry matter (DM)	90.46	90.69	90.88
Ash	7.46	7.71	9.03
Organic matter(OM)	92.54	92.29	90.97
Crude protein (CP)	12.70	2.18	5.78
Crude fiber (CF)	5.82	39.08	22.69
Ether extract (EE)	2.26	1.78	2.52
NFE [2]	71.76	49.25	59.98
ME(MJ/Kg DM)[3]	12.56	9.66	11.01

1 Concentrated diet consisted of 50% barley grains, 13% yellow corn, 25% wheat bran, 10% soybean meal, 0.5% limestone, 0.5% salt, and 1% vitamins & minerals mixture (Ruminant Premix 1% and prepared by INTRACO Ltd . Belgian) contains (per kg): Vit. A 1,000,000 IU, Vit. D3 500,000 IU, Vit. E 500 mg, Fe 5,000 mg, Cu 1,500 mg, Mn 5,000 mg, Co 150 mg, Zn 10,000 mg, I 150 mg Se 40,000 mg.
[2] Nitrogen-free extract calculated following equation NFE = OM-(CP+CF+EE)
[3] Metabolizable energy calculated following equation ME (MJ / kg DM) = 0.012CP + 0.005CF + 0.031EE + 0.014NFE (MAFF, 1975).

Table 2. Feed intake and growth performance of Awassi lambs fed different levels of lemongrass leaf powder (Means ± standard error)

Items	Level of LLP g/head/day				Sign.
	0	2	4	6	
DMI (g/day)	1029.4±10.7	1053.36±38.75	1028.3±23.83	1035.14±27.19	NS
DMI(g/kgW$^{0.75}$)	94.81±0.47	95.43±1.29	94.84±1.18	94.19±2.58	NS
IBW (kg)	20.35±0.48	20.58±1.40	19.17±0.77	19.74±1.62	NS
FBW (kg)	26.88±0.72	28.63±1.33	27.00±0.79	27.00±1. 27	NS
TWG (kg)	6.53^{b}±0.25	8.05^{a}±0.27	7.82^{a}±0.25	7.26^{ab}±0.41	*
ADG(g/day)	103.65^{b}±3.95	127.74^{a}±4.28	124.17^{a}4.01	115.20^{ab}±6.46	*
FCR(g/g)	9.97^{a}±0.32	8.28^{b}± 0.44	8.31^{b}±0.29	9.10^{ab}±0.74	*

a,b means with the same row having different superscript significantly different (P<0.05),
NS: non-significant; *: (P<0.05); LLP: Lemongrass powder; DMI: Dry matter intake; IBW: Initial body weight, FBW: Final body weight, TWG: Total weight gain, ADG: Average daily gain; FCR: Feed conversion ratio

Table 3. Percent nutrient digestibility in Awassi lambs fed different levels of lemongrass leaf powder (Mean ± standard error)

Digestibility (%)	Level of LLP g/head/day				Sign.
	0	2	4	6	
DM digestibility	67.16^{b}±1.50	74.02^{a}±2.07	72.13^{a}±1.29	68.19^{ab}±3.01	*
OM digestibility	73.12^{b}±1.06	78.45^{a}±1.79	76.91^{a}±0.92	73.66^{ab}±2.56	*
CP digestibility	76.26±5.49	82.47±1.66	80.45±4.90	72.06±5.00	NS
CF digestibility	63.35±1.43	68.75±2.32	68.00±2.30	63.01±6.16	NS
EE digestibility	79.47±1.40	84.52 ±1.33	80.15±1.81	77.26 ±5.53	NS
NFE digestibility	75.90±2.01	81.58± 1.71	79.57±1.49	77.43±1.87	NS

a,b means with the same row having different superscript significantly different (P<0.05), NS: non-significant, *: (P<0.05); LLP: lemongrass leaf powder; DM: dry matter; OM: organic matter; CP: crude protein; CF: crude fiber; EE: Ether extract; NFE: Nitrogen free extract

affect feed intake. The final body weight in Awassi lambs was not affected by adding LLP (Table 2). The total weight gain (TWG) was significantly higher in lambs fed 2 and 4 g LLP/ head/day (8.05 and 7.82 kg, respectively) than in those lambs fed 0 and 6 g LLP /head/day (6.53 and 7.26 kg, respectively). The results also showed a significant superior higher (P<0.05) average daily gain (ADG) in lambs fed 2 and 4 g LLP/ head/day (127.74 and 124.17g /day, respectively) than in those lambs fed 0 and 6 g LLP /head/day. The results also indicated that feed conversion ratio (FCR) was significantly improved for lambs fed 2 and 4 g LLP/head/day (8.28 and 8.31, respectively) compared with levels 0 and 6 g LLP/ head/day. This improvement in total and daily weight gain and feed conversion ratio in the present study may be attributed to the improvement in the digestibility of nutrients (Table 3). These results agreed with (Hanafy et al 2009) when using lemongrass leaves in feeding Barki lambs at the level of 100 and 200 mg /kg of body weight significant increases in the average daily gain with 200 mg lemongrass leaves /kg of body weight. In addition, the beneficial effects of LLP in reducing the negative effect of *Haemonchus contortus* in small ruminant were reported by Macedo et al (2019). The lemongrass leaves is a rich source of minerals and vitamins such as vitamin C (Ravinder et al 2010). The positive effect on total and daily weight gain in the current study may be attributed to the fact that the lambs did not suffer from the effect of internal parasites as a result of the effect of lemongrass leaves or its oil (citral) which works as an anti-intestinal against worm-like *Haemonchus contortus* (Macedo et al 2015) as these worms are considered one of the most pathological nematodes that infect sheep and goats, especially those that live in hot regions (Macedo et al 2019).

The effect on 2, 4, and 6 g/head/day of LLP on nutrient digestibility in Awassi lambs indicate higher superiority in the dry matter digestibility (DMD) at levels 2 and 4 g LLP//head/day (74.02 and 72.13%, respectively) compared control 0 and 6 g/head/day(67.16 and 68.19% , respectively (Table 3). The same trend happened with the organic matter digestibility (OMD) where higher superiority was at levels 2 and 4 g LLP/head/day (78.45 and 76.91%, respectively) compared to control 0 and 6 g/head/day (73.12 and 73.66%, respectively). The results also showed that there was no significant effect when increasing levels of addition of LLP on digestibility of crude protein, crude fiber, ether extract, and nitrogen-free extract compared to control (0 g/head/day). The improvement in DMD and OMD may be attributed to the fact that these levels of lemongrass leaves have led to an improvement in rumen fermentation parameters. This finding agreed with Hanafy et al (2009) when feeding Barki lambs on lemongrass leaves at 0, 100, and 200 mg/kg of body weight, as there was an improvement in the digestibility of dry matter and organic matter and a significant increase in the digestibility of crude fiber at the low level compared to the high level and the control. Similar results also reported by El-Bordeny et al (2005) and Samal et al (2018) when feeding buffalo calves on lemongrass leaves, obtained the highest values in digestibility of dry matter, organic matter, and crude fiber compared to control diet. The current study results agreed with the results of other studies using lemongrass oil (Nanon et al 2014, Zulfa et al 2019). Nanon et al (2015) reported a significant improvement in digestibility of dry matter, neutral detergent fiber, and acid detergent fiber (measured *in vitro* batch culture) when using citral oil at levels 0, 200, 400, and 800 mg/kg, but it did not get improvement when increasing the level to 1600 mg/kg, and the reason for this was the improvement of the fermentation parameters in the rumen.

CONCLUSION

The addition of lemongrass leaf powder (LLP) to concentrate diet enhanced nutrient digestibility and growth performance of Awassi lambs (2 and 4 g/head/day).

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