Nutrients intake by Awassi lambs as affected by the concentrate levels and addition of monensin

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Abstract

This study was conducted to investigate the effect of level of concentrate offered to Awassi lambs and addition of monensin on nutrients intake. Sixteen Awassi male lambs were used with 4-6 months of age and mean initial weight of 21.27 kg. concentrate diet was offered at 2 levels (2.5 and 3% of BW) with or without addition of monensin at rate 30 mg/kg DM, ground wheat straw was offered adlibitum. Results showed that intakes of dry matter (CDMI), organic matter (COMI) and crude protein (CCPI) in concentrate were significantly ($P<0.01$) increased due to increasing level of concentrate, and ($P<0.05$) due to addition of monensin, CDMI from 628.18 to 712.75, COMI from 574.15 to 651.45, CCPI 76.75 to 87.091, and TCPI from 83.71 to 95.68 g/day. Intakes of those nutrients in straw were slightly decreased with increasing concentrate level, but slightly increased due to addition of monensin. As a ratio of wheat straw to total feed intakes, higher ($P<0.05$) ratio was achieved by lambs fed low concentrate level with addition of monensin in comparison with those fed high concentrate level without monensin .

Key word: monensin, concentrate, rumen fermentation ,

Introduction

Feed intake is considered one of the basic criteria in evaluating feed, as well as being a goal in itself that breeders seek to achieve. With the purpose of improving sheep production, intensive growing lamb systems use diets with high levels of concentrates and feed additives that act as growth promoters [26]. Since feed quality and quantity are the major factors affecting ruminant productivity, incorporation of concentrate in its diets is intended to optimize the efficiency of feed utilization [34]. However, feeding high concentrate diet for long time probably result in reduced ruminal pH due to accumulation of organic acid and digestive disorder may arise [8.[

Monensin is a natural occurring polyether ionophore antibiotic and widely used as a rumen modifier, especially in high concentrate diets. It is believed that monensin affects the ruminal microbes by reducing the number of protozoa and methane-producing bacteria [9]. Silva, et. al., [29] showed that inclusion of monensin increases the efficiency of energy and nitrogen metabolism of ruminal bacteria and the host animals, in addition to reduce the

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digestive problems caused by abnormal fermentation in the rumen and thus improving the efficiency of utilization of feed and increasing growth rates .

Therefore, this study aims to evaluate
the effect of introducing monensin in concentrate diet offered at low and high levels with free choices of wheat straw on intake of nutrients by Awassi lambs considering the correlation between level of feed intake and production is vital to reduce additional costs and optimize the use of production means.

Materials and methods

This study was carried out at the animal field/Animal Production Department- College of Agriculture- Al-Qasim Green University. The study included feeding Awassi lambs two levels of concentrate diet, 2.5 and 3% of BW with or without addition of monensin. Concentrate diet was prepared by mixing several ingredients estimated to ensure that concentrate diet will contain about 12.25% CP. Monensin as 10% monensin sodium was added at level of 30 mg/kg DM .

Sixteen Awassi male lambs were bought from local market with an average initial weight of 21.275 ± 2.56 kg and 5 to 6 months of age were used in this study. Then lambs were randomly allotted into four treatments with 4 lambs per each and housed individually. About 4 weeks as preliminary period were passed before the beginning of the study for adaptation of lambs to individual cages and study conditions, during which, concentrate diets were offered gradually with two meals .

Concentrate diets were offered at rate of 2.5 and 3% of BW and the offered quantities were modified on the basis of the new weekly weight of lambs in addition to free choice of wheat straw. The allowances of concentrate diet based on live weight were divided into two meals, morning offered at 8 PM and evening meal offered at 4 AM. Both levels of concentrate were offered with or without addition of monensin. Samples of concentrate and straw were taken twice a week to determine chemical composition of diets according to [2]. Chemical composition of concentrate diet, its ingredients and wheat straw are shown table

Table (1). Chemical composition of concentrate diet, its ingredients and wheat straw (%)

Ingredients	DM	% in DM						ME MJ/100g
		Ash	OM	CP	CF	EE	NFE	
Wheat bran	91.75	5.48	94.52	14.27	13.96	3.77	62.52	1.23
Yellow corn	91.18	2.22	97.78	9.27	4.2	3.51	80.80	1.37
Barley	91.78	5.65	94.35	10.16	6.71	1.99	75.49	1.27
Soybean meal	91.93	7.87	92.03	45.48	3.75	1.83	39.35	1.18
Urea	-	-	-	287.5*	-	-	-	-
Concentrate	89.66	8.60	91.40	12.22	5.74	2.14	71.13	1.23**
Wheat straw	92.59	7.38	92.62	2.47	36.74	1.72	51.69	0.99**

%46 *nitrogen × 6.25

ME values were estimated according to [17] with subsequent conversion from MJ/kg DM to MJ/ 100 g DM in accordance with chemical composition based on percentage determinations:

**ME (MJ/ kg DM) = 0.012 CP +0.031 EE+0.005 CF +0.014 NFE

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NaCl and mineral-vitamin mix was added to concentrate diet at rate of 1% for each. Urea was added at rate of 0.62% to provide rumen microorganisms with sufficient quantities of rumen degradable nitrogen RDN [3 .[

Feeding trail was extended for 10 weeks during which lambs were weighed at the end of each week to adjust the quantities of concentrate diet offered to lambs according their new weight. Data obtained was statistically analyzed according to factorial experiments (2 × 2) in completely randomized design (CRD) to evaluate the effect of the main factors studied in the experiment. Statistical Analysis System, [27] was used for that purpose.

Results and discussion

Main effect of the concentrate levels and addition of monensin on nutrients intake :

Effect of the concentrate levels and addition of monensin on nutrients intake is presented in table 2. As shown increasing the concentrate level from 2.5 to 3% of BW significantly (P<0.01) increased intakes of concentrate dry matter (CDMI), organic matter (COMI) and crude protein (CCPI). Similar results due to increasing level of concentrate offered to the lamb were obtained with respect to CDMI [34, 20], CDMI and COMI [24], and CPI [4.[

Table 2- Effect of the concentrate levels and addition of monensin on nutrients intake (g/day ± SE(

Intake items[1]	Level of conc. % of BW[2]		Monensin mg/kg conc.		*P*[3]	
	2.5%	3%	0	30	Conc.[4]	Mon.[5]
CDMI	576.63[b] ±28.67	764.29[a] ±28.26	628.18[b] ±38.14	712.75[a] ±46.58	**	*
SDMI	351.22 ±40.68	279.07 ±17.41	282.21 ±25.38	348.08 ±37.08	NS	NS
TDMI	927.85 ±64.82	1043.36 ±44.86	910.39 ±41.28	1060.83 ±62.02	NS	NS
COMI	527.04[b] ±26.20	698.56[a] ±25.83	574.15[b] ±34.86	651.45[a] ±42.58	**	*
SOMI	325.30 ±37.67	258.47 ±16.13	261.37 ±23.51	322.39 ±34.35	NS	NS
TOMI	852.34 ±59.72	957.03 ±41.21	835.52 ±37.86	973.84 ±56.98	NS	NS
CCPI	70.45[b] ±3.50	93.39[a] ±3.45	76.75[b] ±4.66	87.09[a] ±5.69	**	*
SCPI	8.69 ±1.00	6.88 ±0.42	6.96 ±0.62	8.59 ±0.91	NS	NS
TCPI	79.12[b] ±4.30	100.27[a] ±3.85	83.71[b] ±4.57	95.68[a] ±5.84	**	*

1intake of concentrate dry matter (CDMI); straw dry matter (SDMI); total dry matter (TDMI); concentrate organic matter (COMI); straw organic matter (SOMI); total organic matter (TOMI);

concentrate crude protein (CCPI); straw crude protein (SCPI); total crude protein (TCPI); 2 body weight; 3probability of significance; 4concentrate;5 monensin

Means in the same row with different superscripts are significantly different; *(P<0.05) **(P<0.01) NS, Insignificant

The significant increase in concentrate intake of DM, OM and CP was expected since lambs consumed all the daily allowances of concentrate regardless to the level offered to them. Estifanos and Melaku [13] reported that the DMI was positively affected by the increased amount of concentrate in the animal diet. Moreover, higher intake associated with increasing concentrate levels was attributed to increasing energy contents [31]. Desnoyers, et. al., [11] reported that feeding a high-concentrate diet increased TDMI, due to low rumen fill effect of concentrate as compared to roughage. The increased DMI by lambs with increasing levels of concentrate could also be associated with the fact that the energy requirements of lambs were efficiently met [36 .[

In spite of the previously mentioned positive effect of increasing concentrate level on intake, such effect was not noticed or even had negative effect in other studies carried out with lambs. This may be related to the animal's satiety [16]. Oliveira, et. al., [19] reported that when receiving a high diet, animals adjusted their voluntary feed intake in relation to a physiological demand (metabolic regulation). Moreover, in ruminants, total feed intake generally influenced by concentrate to roughage ratio [15 .[

Results of a current study also showed that increasing the concentrate level from 2.5 to 3% of BW had no significant effect on intake of straw dry matter (SDMI), organic matter (SOMI) and crude protein (SCPI). Similarly, Rahman, et. al., [20] found that increasing concentrate level had no significant effect on SDMI which were, 260.49 and 260.38 g/day respectively. In the current study, increasing the concentrate level actually decreased straw intake of these nutrients though it was insignificant. As shown from table 2, mean values were decreased from 351.22 to 279.07 for SDMI, 325.30 to 258.47 for SOMI and 8.69 to 6.88 g/day for SCPI. The insignificant decrease in straw intake was probably caused by increasing lamb's allowances of concentrate with 0.5% of BW which may provide lambs with additional portion of their nutritional requirement. However, assumption that higher intake of straw can be achieved by feeding animals with low concentrate level such as 2–2.25% of BW need to be tested experimentally .

Sadq [24] pointed out that increasing the concentrate level decreased (P<0.05) SDMI from 398.5 to 228.3, SOMI from 264.6 to 185.5 and SCPI from 12.4 to 8.4 g/day by lambs. This may due to the bulkiness of diets for lambs fed high concentrate diets and may explain the depressed straw intake. Tripathi, et. al., [33] clarified that high concentrate intake may lower ruminal pH and this could inhibit cellulolytic bacteria thus reduce the digestibility of fiber leading to decrease straw intake.

Regarding the effect of the second factor studied in a current study, results showed that addition of monensin significantly (P<0.05) increased CDMI from 628.18 to 712.75, COMI from 574.15 to 651.45, CCPI 76.75 to 87.09, and TCPI from 83.72 to 95.68 g/day. Silva, et. al., [29] reported that monensin was more efficient to maintain ruminal pH at higher levels and this improve fermentation

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and may increase the DMI. The beneficial effects of monensin were found to associate with higher molar proportion of propionic acid in rumen fluid, and to a greater feed intake, nutrient digestibility and protein utilization [21]. The increase in diet digestibility leads to increase in the passage rate and a decrease in rumen fill which is considered as an effective factor for increasing feed intake in ruminants [7]. Moreover, monensin inclusion to basal diet resulted in increased time spent in eating, eating and chewing activity for each kg of DMI [1 .[

For the straw nutrients intake, results of the current study revealed that addition of monensin had no significant effect on SDMI, SOMI and SCPI. This may be attributed to the concentrate level. The increase in concentrate from 2.5 to 3% of BW may provide the biggest part of the lamb's nutritional needs, resulting in no change in the intake of straw [20]. However, the positive effect of monensin on intake that previously discussed, was not found in

many other studies This inconsistency may be related to the bad taste of monensin as reported by [30], may have harmed the diet taste, especially with young animals, a factor that probably increased the animal sensitivity to the ingredients with this characteristic .

Interaction effect between the concentrate levels and addition of monensin on nutrients intake:

Regarding the interaction effect between the concentrate levels and addition of monensin, table 3 shows that higher ($P<0.05$) CDMI was consumed by lambs fed higher level of concentrate (3%) with addition of monensin, whereas, those offered concentrate at lower level (2.5%) without addition of monensin consumed the lower CDMI, values were 821.46 and 549.23 g/day respectively. Similar results were obtained by [22], DMI was significantly increased ($P<0.05$) as affected by the interaction between the concentrate levels and addition of monensin, workers reported that in high-concentrate diets responses were larger than in high roughage diets. This may associate with increasing the rate of passage of digesta through rumen, thus increasing the feed intake, since feed intake is often considered to be a function of the initial rate of digestion [10.[

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Table 3- Effect of interaction between the concentrate levels and addition of monensin on nutrients intake1 (g/day ± SE(

Level of conc.[2], % of BW[3]	2.5%		3%		P^5
Addition of mon[4], mg/kg conc.	0	30	0	30	
CDMI	549.23[c] ±45.47	604.04[bc] ±35.60	707.12[b] ±23.81	821.46[a] ±31.32	*
SDMI	324.20 ±40.29	378.25 ±74.91	240.22 ±14.47	317.92 ±14.14	NS
TDMI	873.43[b] ±75.25	982.3[ab] ±109.41	947.34[ab] ±37.15	1139.4[a] ±43.20	*
COMI	501.99[c] ±41.56	552.09[bc] ±32.54	646.31[b] ±21.76	750.81[a] ±28.63	*
SOMI	300.26 ±37.31	350.33 ±69.39	222.48 ±13.40	294.45 ±13.10	NS
TOMI	802.25[b] ±69.20	902.41[ab] ±100.91	868.79[ab] ±34.13	1045.26[a] ±39.64	*
CCPI	67.11[c] ±5.55	73.80[bc] ±4.35	86.40[b] ±2.90	100.37[a] ±3.82	*
SCPI	8.00 ±0.99	9.34 ±1.85	5.93 ±0.35	7.84 ±0.34	NS
TCPI	75.11[c] ±6.15	83.14[bc] ±6.14	92.33b ±3.22	108.22[a] ±4.10	*

1intake of concentrate dry matter (CDMI); straw dry matter (SDMI); total dry matter (TDMI); concentrate organic matter (COMI); straw organic matter (SOMI); total organic matter (TOMI); concentrate crude protein (CCPI); straw crude protein (SCPI); total crude protein (TCPI); 2concentrates; 3body weight; 4monensin; 5probabilities of significance ;

Means in the same row with different superscripts are significantly different * (P<0.05) NS, Insignificant

Results of a current study also showed that concentrate OM and CP intakes were significantly (P<0.05) affected by the interaction between the concentrate levels and addition of monensin. Considering both nutrients are parts of DM, COMI and CCPI followed the same change as DMI. In another word higher (P<0.05) COMI and CCPI consumed by lambs fed the high concentrate level with addition of monensin as compared with those consumed the low level of concentrate without addition of monensin can be explained on basis of the improvement in CDMI as affected by that interaction. Values were 501.99 and 750.81 for COMI and 67.11 and 100.37 g/day for CCPI. Higher (P<0.05) TDMI, TOMI and TCPI were consumed by lambs fed high level of concentrate with addition of monensin as compared with those offered the low level of concentrate without addition of monensin. The significant (P<0.05) increase in TDMI, TOMI and TCPI can be explained by the increase (P<0.05) in CDMI, COMI and CCPI .

Ratio of wheat straw to total feed intakes

Main effect of the concentrate levels

and addition of monensin on ratio of wheat straw to total feed intakes:

Effect of the concentrate levels and addition of monensin on wheat straw intake as a ratio of total feed intake is presented in table 4. Results revealed significant (P<0.01) decrease in that ratio from 37.81 to 26.63% for DM, 38.12 to 26.89% for OM and 10.94 to 6.83% for CP, due to increasing level of concentrate offered to Awassi lambs from 2.5 to 3% of BW. This result can be attributed to the negative effect of high concentrate intake. Lambs may receive most of their requirement when high level concentrate was offered to them as compared with the low level.

Results of a current study (table 2) showed that increasing level of concentrate decreased wheat straw intake by about 72.15 g/day. This result agrees with that observed by [24] who found that increasing the level of concentrate in the lamb's diet decreased (P<0.05) the ratio of barley straw to total diet intake from 27.9 to 17.9% for DMI, 25.93 to 16.89% for OMI and 10.22 to 5.08% for CPI. A significant decrease (P<0.05) in the ratio of straw DMI to TDMI from 33.64 to 23.05 in lambs was also observed by [28] due to increasing level of concentrate from 2.5 to 3.5% of BW. Similar result was obtained by [36] in DMI and CPI.

Table 4- Main effect of the concentrate levels and addition of monensin on wheat straw to total feed intakes (% ± SE(

Ratio of straw intake: total diet	Level of conc. % of BW[1]		Monensin mg/kg conc.[2]		P^3	
	2.5%	3%	0	30	Conc.	Mon.
SDMI: TDMI[4]	37.81[a] ± 1.68	26.63[b] 2.94±	31.24 2.44±	33.20 2.94±	**	NS
SOMI: TOMI[5]	38.12[a] ± 1.6	26.89[b] 0.63±	31.52 2.44±	33.49 2.29±	**	NS
SCPI: TCPI[6]	10.94[a] 0.72±	6.83[b] 0.20±	8.53 0.91±	9.32 0.92±	**	NS

BW1, body weight; conc.2, concentrate; P3, level of significance; SDMI: TDMI, straw dry matter intake: total dry matter intake; SOMI: TOMI, straw organic matter intake: total organic matter intake; SCPI: TCPI, straw crude protein intake: total crude protein intake

Means in the same row with different superscripts are significantly different *(P<0.05) **(P<0.01) NS, Insignificant

The lower ratio of wheat straw to total feed intakes as a result of increasing the level of concentrate can be attributed to higher energy and protein supply. According to [25], the ration of high energy offered allows more microbial population growth and therefore more basal ration digestion and ultimately more provision of protein and energy to the animals. Moreover, lambs fed high level of concentrate diet may receive more palatable, nutritional value, high protein, low fiber content diet as compared with the low level [24]. This fact would support the idea that animals eat feed mainly to satisfy their need for energy [35.[

The negative effect of increasing concentrate level on ratio of wheat straw intake can also be associated with decrease ruminal pH [32], decreased rumination and salivation [5], and the consequent lowering of the buffering capacity, coupled with rapid microbial degradation of soluble carbohydrates.

Regarding the effect of addition of monensin on wheat straw to total feed intakes, results showed that addition of monensin at 30 mg/kg DM slightly increased SDMI: TDMI from 31.24 to 33.20%, SOMI: TOMI from 31.52 to 33.49% and SCPI: TCPI from 8.53 to 9.23%. Similar Results with respect to ratio of DMI of roughage to TDMI were obtained by [14] and [12] with addition of monensin to lambs' diet at level of 33 and 38 mg/kg DM respectively .

It seems reasonable since daily requirements for lambs in all treatments were almost completely met through their allowances of high-concentrate level, hence, there was no need to eat more straw which is very poor roughage in both nitrogenous fractions to participate with more of these nutrients. Even though, ruminants require some source of forage to ensure normal ruminal function [18.[

Effect of interaction between the concentrate levels and addition of monensin on wheat straw to total feed intakes:

Table 5 shows that higher (P<0.05) SDMI: TDMI was achieved by lambs fed the low (2.5%) concentrate level with addition of monensin, whereas, lower (P<0.05) ratio was achieved by lambs fed the high (3%) concentrate level without addition of monensin. Similar results obtained by [23 .[

Table 5- Effect of interaction between the concentrate levels and addition of monensin on wheat straw to total feed intakes (% ± SE(

Level of conc. % of BW[1]	2.5		3		P^3
Monensin mg/kg conc.[2]	0	30	0	30	
Ratio of straw intake: total diet					
SDMI: TDMI[4]	37.12^a + 2.18	35.51^a ± 2.90	25.36^b ± 0.63	27.90^b ± 5.40	*
SOMI: TOMI[5]	37.43^a + 2.19	38.82^a ± 2.91	25.61^b ± 0.62	28.17^b ± 0.61	*
SCPI: TCPI[6]	10.65^a ± 0.92	11.23^a ± 1.27	6.42^b ± 0.20	7.24^b ± 0.20	*

BW1, body weight; conc.2, concentrate; P3, level of significance; SDMI: TDMI, straw dry matter intake: total dry matter intake; SOMI: TOMI, straw organic matter intake: total organic matter intake; SCPI: TCPI, straw crude protein intake: total crude protein intake

Means in the same row with different superscripts are significantly different * P<0.05) **(P<0.01) NS, Insignificant

The increase in SDMI: TDMI ratio due to addition monensin has been attributed to an increase in the ruminal degradation of fiber because feed intake is often considered to be a function of the initial rate of fiber digestion [10]. Which alters the ratio of ruminal acetate to propionate thus improve lambs' performance. Similarly, higher (P<0.05) SOMI: TOMI and SCPI: TCPI ratios were achieved by lambs fed low concentrate level with and without addition of monensin as compared with those offered high concentrate level with and without addition of monensin. Similar result was reported by [6]. The higher

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intake by lambs fed monensin may be due to a metabolic effect on the use of energy (at a ruminal or systemic level), lambs fed monensin consumed more feed and therefore showed better growth performance [26.[

In conclusion, the better (P<0.05) ratio of straw to total feed intake observed in the current study at the low level of concentrate indicates the positive effect of monensin on straw intake and on that ratio accordingly, despite the negative effect of increasing the level of concentrate on straw intake.

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