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Effects of *Saccharomyces cerevisiae* supplementation on growth rate and nutrient digestibility in Awassi lambs fed diets with different roughage to concentrate ratios

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ABSTRACT

Thirty two Awassi male lambs with initial body weight (27 ± 1.78 kg), and four to five months old, were allocated into four equal groups in factorial experiment to study the effect of two roughage to concentrate rations (R:C, 60:40 and 40:60) supplemented with two levels of *Saccharomyces cerevisiae* (0 and 5 g *SC*/head/day) on daily intake, weight gain and digestion of nutrients. The diets were offered in quantity to achieve 150 g daily gain. Results revealed that R:C ratios had no significant effect on daily nutrients intake of dry matter (DM), organic matter (OM), nitrogen free extract (NFE), neutral detergent fiber (NDF) and hemicelluloses, while crude protein(CP), ether extract (EE) and metabolizable energy (ME) increased significantly ($P < 0.01$). Results showed significant ($P < 0.01$) decrease in crude fiber (CF), acid detergent fiber (ADF) and cellulose intake with high concentrate ration. DM, OM, CP, EE, NFE, ME, NDF, cellulose, and hemicelluloses intake were not affected by *S. cerevisiae* supplementation; whereas, CF and ADF increased significantly ($P < 0.01$) with *S. cerevisiae* supplementation. Results also indicated that final body weight (FBW), total BW gain (TBWG), daily body weight gain (DBG) and feed conversion ratio of lambs were not significantly affected by R:C ratios. FBW and TBWG were not affected by addition of *S. cerevisiae*, whereas, DBG was significantly ($P < 0.05$) affected, where, higher values were achieved by a group of lambs fed diet with added *S. cerevisiae*. The digestibility coefficients of DM, OM,CP, EE, NFE and TDN and DCP values increased significantly ($P < 0.05$) with increasing level of concentrate in the rations, while no effect on CF digestibility was observed. In contrast, the digestibility coefficients of all nutrients and nutritive values of experimental rations increased significantly ($P < 0.05$) with *S. cerevisiae* supplementation. Consequently, *S. cerevisiae* supplementation may improve DBG and nutrients digestibility of CP and CF in diets meant for lambs.

Keywords: *Saccharomyces cerevisiae,* Intake, growth, digestibility, lambs.

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INTRODUCTION

Recent research has focused on the feeding of *Saccharomyces cerevisiae* as feed additives because of its beneficial effects on animal performance (Ali and Goksu, 2013; Hassan and Saeed, 2013). Although, there have been numerous theories proposed, the mode of action of yeast culture has not yet been defined. *S. cerevisiae* are able to grow rapidly in the rumen and facilitate fiber digestion (Fuller, 1989). Micro-nutrients found in *S. cerevisiae* also stimulate cellulolytic bacteria growth (Dawson et al., 1990). In addition, *S. cerevisiae* also protect ruminal fermentation from lactic acid accumulation (Nisbet and Martin, 1991). Based on the theory proposed by Newbold et al. (1996), *S. cerevisiae* in the rumen environment can utilize the remaining dissolved oxygen and save anaerobic microorganisms from the toxic effect of oxygen. Some previous and recent researches focusing on feeding dairy cows and sheep with *S. cerevisiae* have variable results. Several reasons may account for these variations including levels of feeding (Hassan and Salim, 2009), protein levels and degradability (Hassan and Saeed, 2012, 2013), forage to concentrate ratio (Ali and Goksu, 2013), quality of the forage and nutrient composition of the diet (Hassan et al., 2009), amount of yeast supplemented, type and number of viable yeast. It was concluded that yeast supplementation in the diets of dairy cows and growing lambs increased the ruminal pH and volatile fatty acid (VFA) concentrations (Robinson and Erasmus, 2009). All of these factors have contributed to the variations in results of yeast culture studies. However, the digestive advantages of enhanced nutrient digestibility, rumen fermentation and subsequent production parameters provide justification for nutritionists to continue to research yeast culture supplementation. The objectives of this experiment therefore were to test the interactions between the *S. cerevisiae* supplementation and roughage to concentrate (R:C) ratios on daily feed intake, daily gain and digestion coefficients in Awassi male lambs.

MATERIALS AND METHODS

Growth trial

Animals and management

Thirty two Awassi male lambs were paired by weight and each assigned to a sequence using 2×2 factorial experimental design. Lambs ranged from four to five months of age and with a mean weight of 27 ± 1.78 kg. Fourteen days prior to the start of the trial, lambs were vaccinated and dewormed. Lambs were assembled at the Animal Resources Department Field, College of Agriculture, University of Baghdad and housed individually in 1.5 × 1.5 m pens. Water was provided *ad libitum* and lambs housed and maintained in hygienic environment according to the farm system.

Diets

In the experiment ,two diets with a roughage :concentrate ratios of 60:40 (high roughage, HR) and 40:60 (high concentrate, HC) were formulated, both with and without the inclusion of a yeast (*Saccharomyces cerevisiae*, Lesaffire 59703 Marcq France). The experimental treatments diets were: D1) high roughage with no supplemental *S. cerevisiae* (HR); D2) high roughage with *S. cerevisiae* supplemented (HRSC); D3) high concentrate with no supplemental *s. cerevisiae* (HC); and D4) high concentrate with *S. cerevisiae* supplemented (HCSC). Paragraph supplemental *S. cerevisiae* was added to the concentrate as a top-dressing at each feeding at level of 5 g *S. cerevisiae*/hd/d within the total ration. Diets were formulated to meet recommended requirements for ME and CP and fed at levels to achieve 150 g/d (Al-Jassim et al., 1996). The concentrate ration was composed primarily of barley, yellow corn, wheat, wheat bran and soybean meal, while the roughage component was alfalfa hay. Proximate analysis of concentrate ingredients and alfalfa hay are presented in Table 1. Formulation and chemical composition of treatment diets are presented in Table 2.

Prior to feeding the treatment diets, all lambs were allowed 14 days acclimatization period and the experimental diets were also gradually introduced. The roughage and concentrate diets were offered once daily, refusals of the diets were collected and weighed before offering of another was made the next day. Offered and refused feed were sampled weekly and stored at -20°C freezer specify for subsequent chemical analysis. The quantity of roughage and concentrate diets offered for each lambs were weekly adjusted according to the body weight changes in order to ensure that the intake would be sufficient to achieved daily gain of 150 g. Recording of daily intake and live-weight gain were maintained for nine weeks throughout the feeding trial. The lambs were weighed weekly before compounding for that morning feeding. Feed intake was recorded daily and feed conversion ratio was estimated according to daily gain.

Digestibility trial

Digestibility trial was conducted to determine the digestibility coefficients of total diets. The sixth week was assigned for this trial using half the lambs' population in growth trial (that is, four lambs per treatment). The quantities of feed offered and the remnants were accurately recorded to estimate daily intake during the six days collection period.

Feces excreted by each lamb was weighed and about 10% were subsample daily and stored at -20°C. Feces were collected using special handmade digestion sacs suited for each lamb and ensured separation of urine without sticking to their movement inside the individual pens housed in. At the end of the collection period, samples of diets and feces were thoroughly mixed and one sample of each was obtained and stored in deep freezing for subsequent chemical analysis.

Chemical analysis

Samples of ingredients used in the formulation of concentrate diets, the offered and refused concentrate diets and alfalfa hay during feeding and digestibility trials were dried in electric oven at 100°C until constant weight, while feces were dried at 60°C (Yuangklang et al., 2010). Dried samples were then ground by grinder and kept in plastic well closed containers for chemical analysis. The commercial product of Baker's yeast (*S. cerevisiae*) containing about 5.6×10^8 colony forming unit (CFU) was used as additive. Chemical analysis of diets including DM, OM, CP, EE and CF were determined according to AOAC (1995). NDF, ADF and ADL were determined according to the method of Goering and Van Soest (1970).

Statistical analysis

Data obtained during the experiment was statistically analyzed according to the procedures of SAS (2001). Duncan's multiple range test was used to separate the treatment means using the same software package and the treatments were partitioned into main effects and their interactions.

RESULTS AND DISCUSSION

Chemical composition of treatment diets

The effect of roughage to concentrate ratios on chemical composition of the experimental ration used in feeding

Table 1. Chemical analysis of the diets ingredients (% on dry matter basis).

Chemical composition %	Barley	Yellow corn	Soybean meal	Wheat	Wheat bran	Alfalfa hay
DM % of fresh	90.81	87.79	91.00	89.50	95.16	90.24
Organic matter (OM)	88.13	86.59	84.80	87.66	90.32	81.49
Crude protein (CP)	12.34	8.93	44.0	13.22	14.60	16.52
Crude fiber (CF)	6.02	1.97	5.9	2.60	11.06	23.60
Ether extract (EE)	2.01	3.54	4.9	1.9	2.91	1.63
Nitrogen free extract (NFE)	67.76	72.15	30.00	69.94	61.75	39.74
Neutral detergent fiber (NDF)	26.20	14.60	47.52	25.12	55.50	58.12
Acid detergent fiber (ADF)	4.42	7.25	9.62	5.16	13.16	36.73
Cellulose	3.66	3.49	8.66	4.94	11.20	30.91
Hemi cellulose	21.78	7.35	37.9	19.96	42.34	21.39
Acid detergent lignin (ADL)	1.09	1.89	2.22	1.34	3.49	5.82
Metbolizaible energy (ME, MJ/kg DM)*	12.2	13.1	13.0	12.9	12.9	6.31

*Metabolizable energy (ME) values are estimate according to following equation: ME (MJ/kg DM) = [-0.45 + (0.04453 × % TDN)] × 4.184. While TDN was estimated according to the equations of Kearl (1982) as follows: TDN for roughages (% of DM) = -17.2649 + 1.2120(%CP) + 0.8352% NFE+2.4637% EE+0.4475 %CF; TDN for energy feeds (% of DM) = 40.3227 + 0.5398% CP + 0.4448 % NFE + 1.4218% EE – 0.7007%CF.

Table 2. Formulation and chemical composition of treatment diets (% on dry matter basis).

Items	HR diet	HRSC diet	HC diet	HCSC diet
Diet number	D1	D2	D3	D4
Ingredients %				
Alfalfa hay	60	60	40	40
Barley	14	14	21	21
Yellow corn	4	4	6	6
Soybean meal	6	6	9	9
Wheat	4	4	6	6
Wheat bran	11.2	11.2	16.8	16.8
Minerals & Vitamins	0.4	0.4	0.6	0.6
Salt	0.4	0.4	0.6	0.6
S. cerevisiae (SC) g/h/d	-	5	-	5
Chemical composition %				
DM	92.86	92.86	94.1	94.1
OM	83.25	83.25	84.14	84.14
CP	14.9	14.9	14.13	14.13
CF	17.27	17.27	14.11	14.11
EE	2.25	2.25	2.57	2.57
NFE	48.83	48.83	53.33	53.33
NDF	49.35	49.35	44.97	44.97
ADF	25.63	25.63	20.09	20.09
ADL	5.94	5.94	6.00	6.00
ME MJ/Kg DM	9.7	9.7	10.3	10.3

HR: High roughage diet, HR SC: High roughage supplemented with *S. cerevisiae*, HC: High concentrate, HCSC: High concentrate supplemented with *S. cerevisiae.*

lambs (Table 2) showed that the contents of DM, OM and NFE tended to increase with increasing level of concentrate. However, the contents of CF, NDF and ADF tended to increase with increasing roughage level, while CP and ME contents were similar across treatments diets.

Table 3. Effect of roughage to concentrate ratios, *S. cerevisiae* (SC) supplementation and their interaction on total daily nutrients intake (g/day).

Items	DM	OM	CP	CF	EE	NFE	ME/MJ	NDF	ADF	ADL
Roughage: Concentrate ratio (R:C)										
HR	912 ± 30	758 ±25	127 ± 4.0^{b}	160 ± 5.8^{a}	22.7 ± 0.6^{b}	447 ± 34	9.6 ± 0.1^{b}	453 ± 19	238 ± 11^{a}	42 ± 2.6
HC	943 ± 29	795 ± 24	138 ± 3.8^{a}	137 ± 3.9^{b}	26.9 ± 0.7^{a}	491 ± 19	10.8 ± 0.2^{a}	426 ± 12	192 ± 14^{b}	37 ± 1.1
S. cerevisiae supplementation										
Without SC	914 ± 33	767 ± 27	132 ± 4.1	146 ± 6.1^{b}	24.6 ± 0.7	445 ± 38	9.8 ± 0.26	428 ± 16	205 ± 10^{b}	37 ± 2.1^{b}
With SC	941 ± 27	786 ± 23	133 ± 4.1	152 ± 5.9^{a}	24. 9 ± 0.9	494 ± 19	10.8 ± 0.29	451 ± 14	225 ± 11^{a}	43 ± 1.4^{a}
Interaction (R:C ratio with SC supplementation)										
HR	900 ± 50	749 ± 41	126 ± 4.3	157 ± 5.7^{a}	22.6 ± 1.0^{bc}	434 ± 23	9 ± 0.03^{b}	436 ± 33	230 ± 19^{ab}	36 ± 2.3^{b}
HRSC	924 ± 33	767 ± 28	128 ± 4.3	164 ± 10.0^{ab}	22.7 ± 0.8^{bc}	460 ± 32	9.6 ± 0.1^{b}	470 ± 16	246 ± 8^{a}	48 ± 0.9^{a}
HC	928 ± 25	785 ± 82	138 ± 3.5	135 ± 3.6^{b}	26.6 ± 0.6^{ab}	455 ± 66	10 ± 0.3^{b}	419 ± 11	180 ± 5^{b}	37 ± 1.0^{a}
HCSC	959 ± 51	805 ± 47	139 ± 7.1	139 ± 7.4^{ab}	27.2 ± 0.3^{a}	527 ± 25	11 ± 0.08^{a}	432 ± 23	204 ± 18^{a}	38 ± 2.1^{a}

HR: High roughage; HRSC: High roughage with *S. cerevisiae*; HC: High concentrate; HCSC: High concentrate with *S. cerevisiae*. a, b, c and d: Means in the same column for each item with different superscripts differ significantly (P < 0.05).

Feed intake

The lambs consumed most of the diets offered and differences in R:C ratio were successfully achieved. The main effect of R:C ratio and *S. cerevisiae* supplementation and their interactions on average daily feed intake by lambs are shown in Table 3. There were no significant (P>0.05) differences in intake (g/day) between R:C ratios in DM (912, 943), OM (758, 795) and ADL (42, 37) respectively. Whereas, differences in CP, CF, EE, ME and ADF intake occurred between R:C ratios (P > 0.05); These differences could be attributed to the differences in chemical composition of tested feedstuffs and R:C ratios. However, these differences were not statistically significant when daily intake was expressed as g/kg $W^{0.75}$. Similar observations were reported by Kumari et al. (2012) when male lambs fed different roughage to concentrate ratios.

In contrast addition of *S. cerevisiae* supplementation shown no significant effect on DM, OM, CP, EE, NFE, ME and NDF intake, except that daily intake of CF, ADF and ADL increased significantly (P < 0.01) from 146, 205 and 37 g to 152, 225 and 43 g respectively with *SC* supplementation. These results agreed with other findings, which reported a positive influence of *SC* on intake in growing animals (Pezzi et al., 2005; Lascano and Heinrichs, 2007; Sinclair et al., 2006; Lascano et al., 2009). The positive effects of addition of *SC* on daily intake of CF, ADF and ADL might be attributed to: 1) stimulation development of cellulolytic and lactate-utilizing bacteria in the rumen (Jouany and Morgavi, 2007), which can improve voluntary feed intake (Wohlt et al., 1998). Other authors (Wiedmeier et al., 1987) suggested that *S. cerevisiae* provides stimulatory factors such as amino acids, and peptides that increase the number of cellulolytic bacteria; 2) The alterations in ruminal fermentations relating to decreased lactic acid concentrations which can be reflected in improved intake (Jouany, 2001).

Statistically, interaction (P > 0.05) in daily feeds intake of CF, EE, ME, ADF and ADL were shown between R:C ratios and *S. cerevisiae* supplementation; CF, EE and ME significantly (P < 0.05) increased with high concentrate and *S. cerevisiae* supplementation; whereas, ADF and ADL significantly (P < 0.05) increased with high roughage and *S. cerevisiae* supplementation. These increases in daily intake may be related to the positive effect of addition of *S. cerevisiae* by stimulation of cellulolytic and lactate-utilizing bacteria in the rumen (Jouany and Morgavi, 2007). Sontakke, 2012) revealed that *S. cerevisiae* increased feed intake. Ghasemi et al. (2012) observed *S. cerevisiae* supplementation was associated with increased ADL intake.

Live weight gain and feed conversion ratio

The effect of R:C ratios and *S. cerevisiae*

Table 4. Effect of roughage to concentrate ratios, *S. cerevisiae* supplementation and their interaction on live weight gain and feed conversion ratio.

Items	Initial BW (g)	FBW (kg)	T BWG (kg)	DBG (g/day)	FCR (g DM/DBG)	FCR (g CP/ABG)	FCR (MJ ME/ABG)
Roughage: Concentrate ratios							
HR	28.33 ±1.0	36.76 ± 1.0	8.4 ± 0.45	135.9 ± 7.2	6.90 ± 1.14	0.93 ± 0.26	0.064 ± 0.01
HC	27.62 ± 0.9	36.21 ± 1.2	8.6 ± 0.74	139.0 ± 12	6.95 ± 0.57	0.99 ± 0.07	0.079 ± 0.00
SC supplementation							
Without SC	27.91 ± 0.9	36.08 ± 0.9	8.16 ± 0.66	131.7 ± 6.6b	6.98 ±1.09	0.95 ± 0.4	0.070 ± 0.00
With SC	28.00 ± 0.2	36.90 ± 1.2	8.9 ± 0.56	143.7 ± 5.1 a	6.87 ±0.54	0.97 ± 1.0	0.068 ± 0.01
Interaction (roughage: Concentrate ratio with SC supplementation)							
HR	28.16 ± 1.6	36.33 ± 1.5	8.2 ± 1.22	131.6 ± 19b	6.73 ± 0.57	0.92 ± 0.2	0.068 ± 0.00
HRSC	28.50 ± 1.5	37.20 ± 1.3	8.7 ± 0.66	140.3 ± 16ab	7.07 ± 1.14	0.95 ± 0.1	0.067 ± 0.01
HC	27.66 ± 0.9	35.83 ± 1.3	8.2 ± 0.65	131.7 ± 10b	7.24 ± 1.09	0.99 ± 0.1	0.072 ± 0.01
HCSC	27.5 ± 1.7	36.60 ± 2.1	9.1 ± 0.93	146.4 ± 15a	6.67 ± 0.54	1.00 ± 0.1	0.070 ± 0.00

BW: Body weight; FBW: Final body weight; DBG: Daily body gain; FCR: Feed conversion ratio. a, b: Means in the same column for each item with different superscripts differ significantly ($P < 0.05$).

supplementation on final body weight (FBW), total BW gain (TBWG), daily body weight gain (DBG) and feed conversion ratio (FCR) of lambs are shown in Table 4. Results revealed that FBW, TBWG, DBG and FCR of lambs were not significantly ($P > 0.05$) affected by R:C ratios. As well as statistical analysis revealed that FBW and TBWG were not significantly ($P > 0.05$) affected by addition of *S. cerevisiae*, whereas, DBG was significantly ($P < 0.05$) affected by *S. cerevisiae* supplementation. Higher values of DBG were achieved by a group of lambs fed diet supplemented with *S. cerevisiae* (143.7 g/d). These increases was associated with significant ($P < 0.05$) interaction between R:C ratios and SC supplementation, which shown higher DBG by lambs fed HC supplemented with *S. cerevisiae* (146.6 g/d). Many studies reported increasing gain due to the addition of *S. cerevisiae* to sheep diet (Garg et al., 2009; Milewski, 2009), goat kids (Fadel-Elseed and Abusamra, 2007). Ahmed and Salah (2002) estimated higher increase (13.8 and 30.2%) due to addition of *S. cerevisiae* to sheep at rate of 4 and 8 g/(h day), respectively over the control diet. Similar results were observed by other studies (Lascano et al., 2009). In the current study, addition of *S. cerevisiae* had no effect on FCR value when it was estimated as a ratio of g DBG to DM, CP and ME intake respectively. This result disagree with Ahmed and Salah (2002) who reported that lambs fed the *S. cerevisiae* supplemented diets utilized their feed more efficiently. Similar results were observed by other studies (Lascano et al., 2009). Numerical improvement of FCR with addition of *S. cerevisiae* was also observed by El- Hassan et al. (1996) when bulls were given *ad libitum* access to feed. In that study, however, failure to reach statistical difference was attributed to the increase in DMI induced by *S. cerevisiae*. In the current study, although, there was no significant response to the addition of *S. cerevisiae* on DMI, the high lambs allowances of palatable concentrate may cover clear response on FCR. Robinson (2002) reported that FCR increased due to addition of *S. cerevisiae* a razor thin average of 1.8%, and only occurred in 60% of reported experiments.

Digestibility coefficients and nutritive values

Digestibility coefficients and nutritive values of experimental rations are presented in Table 5. The digestibility coefficients of DM, OM, CP, EE, NFE and total digestible nutrients (TDN) and digestible crude protein (DCP) values increased significantly ($P < 0.05$) with increasing level of concentrate in the rations, while no effect on CF digestibility. These results may be due to the differences in chemical composition of experimental rations as shown in Table 2. Yang et al. (2001) reported that reducing the ratio of forage to concentrate improved total digestion. As

Table 5. Nutrients' digestibility and nutritive values of experimental rations by Awassi lambs (%).

Item	Digestibility coefficients %						Nutritive values %	
	DM	OM	CP	CF	EE	NFE	TDN	DCP
Roughage :Concentrate ratio (R:C)								
HR	66 ± 1.4^{b}	66 ± 0.9^{a}	66 ± 1.2^{b}	58 ± 1.4	54 ± 2.7	76 ± 0.88	60 ± 0.7^{b}	9.9 ± 1.0
HC	71 ± 1.1^{a}	71 ± 0.6^{b}	71 ± 1.6^{a}	58 ± 2.0	59 ± 1.2	79 ± 1.1	63 ± 1.17^{a}	10 ± 0.2
SC supplementation								
Without SC	68 ± 1.6	67 ± 1.3	67 ± 1.9^{b}	55 ± 1.2^{b}	55 ± 1.7	76 ± 1.3	60 ± 1.1^{b}	9.7 ± 0.2
With SC	70 ± 0.4	69 ± 1.2	71 ± 1.1^{a}	61 ± 1.2^{a}	58 ± 2.8	79 ± 0.7	63 ± 1.0^{a}	10.2 ± 0.1
Interaction (R:C ratio with *SC* supplementation)								
HR	65 ± 2.4	65 ± 1.4^{c}	64 ± 1.0 ^{b}	56 ± 2.4^{ab}	52 ± 1.4	75 ± 1.1^{b}	58 ± 0.2^{b}	9.6 ± 0.2
HRSC	67 ± 1.6	67 ± 1.2^{c}	69 ± 1.2^{ab}	60 ± 1.3^{ab}	56 ± 5.7	77 ± 0.9^{ab}	61 ± 0.7 ^{b}	10.3 ± 0.2
HC	70 ± 1.7	70 ± 0.6^{a}	70 ± 3.1^{ab}	54 ± 0.87^{b}	58 ± 2.2	78 ± 2.2^{ab}	61 ± 1.7^{b}	9.9 ± 0.4
HCSC	72 ± 1.6	71 ± 0.6^{a}	73 ± 1.3^{a}	62 ± 2.2^{a}	60 ± 1.3	80 ± 0.7^{a}	65 ± 1.7^{a}	10.2 ± 0.2

HR: High roughage; HRSC: High roughage with *S. cerevisiae*; HC: High concentrate; HCSC: High concentrate with *S. cerevisiae*. a, b, c and d: Means in the same column for each item with different superscripts differ significantly (P < 0.05).

well as the digestibility coefficients of all nutrients and nutritive values of experimental rations increased significantly (P < 0.05) with *S. cerevisiae* supplementation. The interaction between R:C and *S. cerevisiae* supplementation were significantly (P < 0.05) effected on digestibility coefficient. Higher increases in digestibility were shown in lambs fed high concentrate diet supplemented with *S. cerevisiae*. Results revealed that digestibility of nutrients were improved with different extent due to addition of *s. cerevisiae*. These improvement may be related to the beneficial effect of *S. cerevisiae* inclusion on digestibility was well documented by many studies (El-Waziry and Ibrahim, 2007; Gaafar et al., 2009). However, DM, OM, EE and NFE digestibility were little (P > 0.05) affected by addition of *SC* (2.0, 1.7, 3.5, 2.6 and 2.5 units, respectively). El-Hennawy et al. (1994) reported that unlike anaerobic microorganisms, yeast fail to hydrolyze bile acids, and the emulsion of fats in mixed micelles is not decreased, therefore fat digestibility is not affected by the presence of *S. cerevisiae* in the digestive tract. Addition of *S. cerevisiae* caused a significant (P < 0.01) improvement in CP and CF digestibility (4 and 5.8% respectively). Gaafar et al. (2009) reported 1.86 and 2.31 units increase (P < 0.05) in digestibility of DM and OM, respectively, due to the addition of *S. cerevisiae* to high concentrate diets. Williams (1989) reported that yeast may provide factors which stimulate rumen cellulolytic and proteolytic bacteria especially when high concentrate (> 50%) diets are given. Crude protein digestibility (CPD) was increased by 3.5 units due to *S. cerevisiae* addition in the current study. Similar increase was obtained by Ahmed and Salah (2002) where Naemy lambs were fed 50% good quality hay and 50% concentrate, and found that CPD increased by 2.96 units due to addition of *S. cerevisiae* at a rate of 4 g yeast/head/day. *S. cerevisiae* addition may stimulate cellulolytic bacteria and improve digestibility (Williams, 1989). Increasing numbers of rumen cellulolytic bacteria leads to improve CF digestion. Lascano et al. (2009) reported that positive stimulation of ruminal bacterial numbers associated with *S. cerevisiae* incorporation can affect DMD because bacteria are required for rumen fiber degradation. Increased digestibility of DM, NDF, hemicellulose, and CF has been reported with supplemental *S. cerevisiae* (Robinson, 2002).

In conclusion, addition of *S. cerevisiae* to the high concentrate diet may improve CP and CF digestibility and ADG in Awassi male lambs.

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