



Influence of dietary supplementation of yeast on milk composition and lactation curve behavior of Sohagi ewes, and the growth performance of their newborn lambs



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ABSTRACT

Thirty-nine pregnant Sohagi ewes were divided into three equal groups to investigate the effects of an active dry yeast (*Saccharomyces cerevisiae*- SC, 2.44×10^{11} CFU/g yeast product) on lactation curve, milk composition, blood components and growth performance of newborn lambs. Ewes in the control group were fed a basal diet without yeast supplementation (SC0), the second (SC5) and third (SC10) groups were fed the basal diet with 5 or 10 g per head/day of SC, respectively. Dry yeast supplementation increased ($P < 0.05$) daily milk yield, total milk yield, milk fat, protein, solids not fat contents but did not affect ($P > 0.05$) lactose and ash contents. Compared with the control treatment, total milk yield was improved in SC10 and SC5 by 20.3 and 14.3 %, respectively. Dry yeast supplementation resulted in significant changes ($P < 0.05$) in the lactation curve with greater average daily milk yield noted for SC5 and SC10 over a 12-week period. Greater ($P < 0.05$) total protein, albumin, glucose, urea and AST concentrations were noted with dry yeast inclusion. There were no differences in globulin, cholesterol, creatinine and alanine aminotransferase concentrations. Lambs from SC10 ewes had higher ($P < 0.05$) birth weight than lambs from the control group. Moreover, SC10 and SC5 lambs grew faster (18.4 and 13.8 %) and were heavier (16.6 and 11.9 %) than lambs from control ewes. Data suggested that dry yeast supplementation improved milk yield and composition of Sohagi ewes, modified the lactation curve and enhance growth performance of lambs.

1. Introduction

Small ruminants play an important role in the rural parts of Upper Egypt where sheep and goats represent the main source of income to landless and small landowners (Alary et al., 2015). There is a shortage of animal feeds (either in quality or quantity) to meet the nutritional requirements of existing animal population. Due to unstable low annual income, families in the rural area are unable to buy concentrate feeds for their livestock. Rearing small ruminants (which need little nutritional requirements) is more suitable for smallholder farmers than large ruminants. Small ruminants contribute to the development of areas where other activities are not possible; they constitute a way to face risky events such as drought or family urgent needs or social events (Faye and Alary, 2001). Sohagi sheep is one of the most prevalent types of sheep in Upper Egypt, which are used by small farmers to improve

their livelihoods and annual income. However, Sohagi sheep has not been widely reported in literature (Galal et al., 2005). In a previous study, Hamdon (2010) reported that Sohagi sheep is a non-dairy sheep and suggested intensive production system, early weaning and early lambs fattening system for Sohagi sheep because of their low milk production. In an attempt to improve productive performance of Sohagi sheep, Kassab et al. (2009) reported that inclusion of heat and chemically treated canola meal increased milk yield and contents and consequently lambs performance during the suckling period.

Currently, probiotics are widely used in the livestock industry to improve animal growth and productive performance (Shakira et al., 2018). Probiotics can provide some health benefits for ruminant animals and improve digestibility of forages (Sousa et al., 2018). Yeast (*Saccharomyces cerevisiae*) supplementation as probiotic was reported to increase nutritional value of poor-quality forages and high grain diets

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(Arambel and Kent, 1990). Other studies reported that yeast inclusion increased population of desirable bacterial in the rumen, stabilized rumen pH and improved gut health (Shehu et al., 2014; Uyeno et al., 2015); stimulated cellulolytic bacteria in the rumen and increased fiber digestion and flow of microbial protein from the rumen (Beauchemin et al., 2003; Jouany and Morgavi, 2007). Additionally, several studies reported improved feed intake and milk yield in dairy cows (Alshaikh et al., 2002; Bruno et al., 2009). Schingoethe et al. (2004) suggested that yeast can improve feed efficiency and milk production of heat stressed dairy cows in mid-lactation. Compared with dairy cows, there are fewer studies on the effects of probiotics on milk production and blood biochemical parameters of dairy ewes during lactation (Kafilzadeh et al., 2018). This study aimed to investigate the effects of an active dry yeast supplement in the diet of Sohagi ewes on lactation curve, milk composition, blood components and growth performance of newborn lambs.

2. Materials and methods

2.1. Animal and management

The present study was conducted at the experimental sheep farm of animal production department, Faculty of Agriculture, Sohag University, Egypt. Thirty-nine pregnant Sohagi ewes (during the last two month of pregnancy) at 2–4 years of age, 2–3 parities and with an average initial body weight 41.87 ± 2.83 kg were randomly divided into three equal groups (13 ewes/group). Ewes in the control group (SC0) were offered a basal diet of 60 % concentrate mixture and 40 % Egyptian clover (*Trifolium alexandrinum*) and wheat straw as roughage. The supplemented groups (SC5) and (SC10) were offered the basal diet in addition to 5 and 10 g per head/day, respectively of a commercial dry yeast product (EGYBELG®, LA ROYALE Instant dry yeast, manufactured by Egyptian Belgian Co. Egypt) throughout the trial period. The yeast product used was evaluated and live cells of *Saccharomyces cerevisiae* were counted according to the method of the American Society of Brewing Chemists (1988). Viable yeast cell concentration was 2.44×10^{11} CFU/g yeast product. Dry yeast was mixed homogenously with the concentrate mixture at morning feeding and diets were offered to the ewes to meet their daily requirements according to NRC (2007). Table 1 shows the results of the chemical analysis of the experimental ingredients. All animals were housed in shaded barns with rice straw as a bedding material with fixed drinking trough and fresh water was available throughout the day.

2.2. Milk production and composition

Milk yield and fat corrected milk (FCM6.5 %) of all individual ewes were recorded (morning at 7:00 a.m. and evening at 5:00 p.m.) once a week throughout the lactation period using the kid suckling technique during the suckling period (60 days) and then by hand milking from weaning until the end of experiment (45 days). Representative milk

Table 1

Chemical composition¹ of ingredients (% DM basis) used in experimental rations.

Ingredients	DM	OM	CP	EE	NDF	ADF	NFE
Concentrate mixture ²	88.92	88.49	15.73	3.87	233.4	54.2	55.92
Egyptian clover	15.22	86.12	16.31	1.87	417.3	232.5	47.48
Wheat straw	88.23	86.26	3.22	1.34	710.6	460.7	45.49
Dry yeast	91.83	92.58	46.13	3.85	–	–	39.24

¹ DM = dry matter, OM = organic matter, CP = crude protein, EE = ether extract, NDF = neutral detergent fiber, ADF = acid detergent fiber, NFE = nitrogen free extract (calculated by the difference).

² Concentrate mixture composed of: 50 % yellow maize, 35 % wheat barn, 12 % soybean meal, 2% limestone and 1% common salt.

samples about (50 mL) were taken once a week from both halves of the udder in the morning and evening on the same day. Samples were combined per ewe and analyzed for total solids (TS), fat, protein, lactose, solids not fat (SNF) and ash by using automatic milk analyzer (Lactoscan MCC, Lactoscan milktronic). Daily milk yield, FCM6.5 %, total milk yield (pre-weaning + post-weaning), total yield of fat, protein and lactose were calculated according to Ünal et al. (2008).

2.3. Blood samples

Blood samples were obtained from five pregnant ewes in each group via jugular vein puncture at 7:00 a.m. before morning feeding on day 45, 30 and 15 before lambing and on day 15, 30 and 45 during the suckling period. Blood samples were immediately centrifuged at 4000 rpm for 15 min; plasma was separated and stored at -20°C until laboratory analysis (Bakr et al., 2015). Total protein, albumin, glucose, cholesterol, urea, creatinine, alanine aminotransferase and aspartate aminotransferase were determined by spectrophotometer using commercial kits. Globulin concentration was calculated by the difference between total protein and albumin concentrations.

2.4. Lamb growth performance

All the newborn lambs were weighted at birth and then every two weeks (2, 4 and 6 weeks) until weaning (8 weeks). Average daily gain and total weight gain of lambs were calculated.

2.5. Statistical analysis

Data were analyzed by using the PROC MIXED of SAS (SAS 9.3, SAS Inst. Inc., Cary, NC) with repeated measurements. The statistical mixed model included the fixed effects of treatment (SC0, SC5 and SC10), time (weeks, 1–15), the random effect of animal, the interactions (treatment with time) and the residual error. The weight of lambs was included as a covariate in the experimental model. When the F-test was significant at $P < 0.05$, means were compared by applying the probability of difference option of the least squares means statement. Statistical model used to analyze the data was $Y_{ijkl} = C_i + T_j + (C_i \times T_j) + A_k + \epsilon_{ijkl}$ where Y_{ijkl} is the dependent variable, s is the overall mean, C_i is the fixed effect of yeast supplementation, T_j the fixed effect of time, A_k the random effect of animal and ϵ_{ijkl} is the random residual error.

3. Results

Over the lactation period of 105 days, daily milk yield, 6.5 % fat corrected milk (FCM6.5 %), total milk yield and total milk yield pre- and post-weaning were improved ($P < 0.05$) by yeast supplementation. Highest values ($P < 0.05$) were noted for SC10, followed by SC5 and SC0. Total milk yield was increased by 20.3 and 14.3 % in SC10 and SC5, respectively (Table 2).

Yeast inclusion had a positive effect ($P < 0.05$) on milk fat, protein and solids not fat percentage but there were no differences ($P > 0.05$) in lactose and ash percentage. Daily yield of fat, protein and lactose were improved ($P < 0.05$) in SC supplemented ewes compared to the control group (Table 2).

Supplementation with dry yeast in both SC5 and SC10 ewes had positive effect ($P < 0.05$) on milk yield from first week until week 12 of the lactation period with no effect on milk yield during late lactation (from week 13 to 15; Fig. 1).

All estimated blood constituents followed a similar trend irrespective of the sampling period (late pregnancy and suckling) and were within the normal ranges. With yeast supplementation, total protein and albumin levels were increased ($P < 0.05$) but there was no difference in the globulin level. Glucose, urea and aspartate aminotransferase were increased ($P < 0.05$) in SC ewes versus control. However, cholesterol, creatinine and alanine aminotransferase level were not affected

Table 2
Effect of dry yeast supplementation on milk yield and composition of Sohagi ewes.

	Diets ¹			SEM ⁴	P value
	SC0	SC5	SC10		
Daily milk yield, mL	646.3c	738.4b	777.2a	13.04	0.001
FCM 6.5 %, mL ²	610.7c	724.8b	771.2a	13.23	0.001
Total milk yield, 105-day, L	67.86 c	77.53 b	81.60 a	1.37	0.001
MY ³ pre-weaning,60-day, L	44.72 c	52.02 b	55.67 a	0.802	0.001
MY ³ post-weaning, 45-day, L	23.14 b	25.51 a	25.93 a	0.621	0.006
Total solid, %	17.41b	18.04 a	18.30 a	0.106	0.002
Fat, %	5.93 b	6.31 a	6.42 a	0.054	0.001
Protein, %	5.83 b	6.15 a	6.24 a	0.053	0.004
Lactose, %	4.81	4.69	4.72	0.020	0.051
Solids not fat,%	11.48 b	11.73 ab	11.89 a	0.057	0.015
Ash%	0.84	0.89	0.92	0.014	0.059
Fat yield, g/h/d	38.31 c	46.56 b	49.87 a	0.387	0.001
Protein yield, g/h/d	37.66 c	45.37 b	48.53 a	0.377	0.001
Lactose yield, g/h/d	31.06 c	34.66 b	36.67 a	0.143	0.001

abc mean values with a different superscript in the same row indicate significant difference (P < 0.05).

¹ Basal diet (60 % concentrate mixture and 40 % Egyptian clover (Trifolium alexandrinum) and wheat straw as roughage) supplemented with 0 (control-SC0), 5 (SC5) and 10 (SC10) g per head/day of commercial dry yeast.

² FCM 6.5 % = 6.5 % fat corrected milk according to Pulina and Nudda (2004).

³ MY = Milk yield.

⁴ SEM = Standard error of mean.

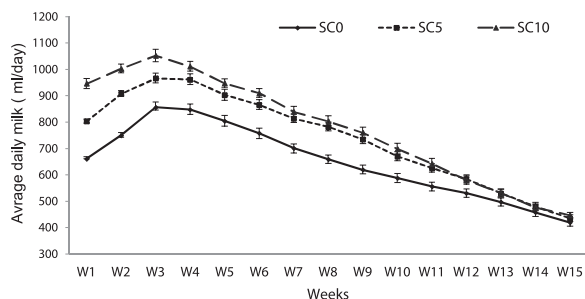


Fig. 1. Effect of dry yeast supplementation on lactation curve of Sohagi ewes.

(P > 0.05) by dry yeast supplementation (Table 3).

Birth weight was higher (P < 0.05) for SC10 lambs compared to the control. Similar birth weight was noted for the control and SC5 lambs. Total body gain and average daily weight gain of lambs from SC10 and SC5 were higher (P < 0.05) than those lambs from control ewes. This means that lambs from SC10 and SC5 ewes grew faster (18.42 and 13.81 %, P < 0.05) and heavier (16.57 and 11.89 %, P < 0.05) than lambs from control ewes during the suckling period (Table 4).

4. Discussion

Similar to our results, Mousa et al. (2012) and Zaleska et al. (2015) reported higher daily and total milk yield in dairy sheep supplemented with yeast. Other studies reported no differences in milk production during late lactation with yeast inclusion (Masek et al., 2008a, b). These discrepancies could be associated with differences in breeds, stage of lactation, forage type, source of the yeast culture and feeding strategy (Alshaiikh et al., 2002). Changes in milk composition noted in the present study is consistent with previous reports by Mousa et al. (2012) and Zaleska et al. (2015). Other studies did not observe any change in milk composition with dried yeast supplementation in dairy sheep (Masek et al., 2008b; Baiomy, 2011) and dairy goat (Salama et al., 2002). However, Erasmus et al. (1992) and Miller-Webster et al. (2002) reported that higher milk protein content in treated group could be due

Table 3
Effect of dry yeast supplementation on blood constituents of Sohagi ewes during late pregnancy and suckling period.

Period	Items	Diets ¹			SEM ⁴	P value
		SC0	SC5	SC10		
Late pregnancy	Total protein, g/dL	6.36b	6.58a	6.61a	0.019	0.001
	Albumin, g/dL	2.98 b	3.18 a	3.15 a	0.012	0.001
	Globulin, g/dL	3.38	3.40	3.46	0.018	0.165
	Glucose, mg/dL	55.30 c	59.13 b	60.24 a	0.137	0.001
	Cholesterol, mg/dL	171.74	169.13	170.23	0.430	0.056
	Urea, mg/dL	23.65 b	25.53 a	25.38 a	0.250	0.006
	Creatinine, mg/dL	1.03	1.08	1.09	0.012	0.157
	AST, IU/dL ²	30.87 b	32.41 a	32.56 a	0.235	0.009
	ALT, IU/dL ³	18.41	19.02	18.87	0.104	0.055
	Suckling	Total protein, g/dL	6.57b	6.86a	6.94a	0.022
Albumin, g/dL		3.04 b	3.22 a	3.26 a	0.013	0.001
Globulin, g/dL		3.53	3.64	3.68	0.021	0.083
Glucose, mg/dL		56.73 b	62.33 a	63.04 a	0.162	0.001
Cholesterol, mg/dL		174.08	175.03	176.15	0.359	0.075
Urea, mg/dL		24.27 c	27.33 b	28.27 a	0.132	0.001
Creatinine, mg/dL		1.02	1.06	1.07	0.011	0.191
AST, IU/dL ²		32.05 b	32.94 a	33.12 a	0.163	0.023
ALT, IU/dL ³		18.46	18.69	18.94	0.082	0.069

abc mean values with a different superscript in the same row indicate significant difference (P < 0.05).

¹ Basal diet (60 % concentrate mixture and 40 % Egyptian clover (Trifolium alexandrinum) and wheat straw as roughage) supplemented with 0 (control-SC0), 5 (SC5) and 10 (SC10) g per head/day of dry yeast.

² AST = Aspartate aminotransferase.

³ ALT = Alanine aminotransferase.

⁴ SEM = Standard error of mean.

Table 4
Effect of dry yeast supplementation on productive performance (kg) of Sohagi lambs during suckling period.

	Diets ¹			SEM ²	P value
	SC0	SC5	SC10		
Birth weight	2.94 b	3.11ab	3.25 a	0.046	0.028
Weight at 2nd week	5.70 b	6.55 a	6.78 a	0.057	0.001
Weight at 4th week	8.13 c	9.31 b	9.70 a	0.067	0.001
Weight at 6th week	10.27 c	11.62 b	12.17 a	0.078	0.001
Weaning weight at 8th week	12.19 c	13.64 b	14.21 a	0.084	0.001
Total weight gain	9.25 c	10.53 b	10.95 a	0.065	0.001
Average daily weight gain, g	154.2 c	175.5 b	182.6 a	1.080	0.001

abc mean values with a different superscript in the same row indicate significant difference (P < 0.05).

¹ Basal diet (60 % concentrate mixture and 40 % Egyptian clover (Trifolium alexandrinum) and wheat straw as roughage) supplemented with 0 (control-SC0), 5 (SC5) and 10 (SC10) g per head/day of commercial dry yeast.

² SEM = Standard error of mean.

to the role of yeast on rumen fermentation and nutrient digestibility, which improve ammonia uptake and microbial protein production. Increased milk fat in early lactation was related to excessive negative energy balance and rapid mobilization of body fats. Moreover, Dawson et al. (1990) suggested that yeast enhances fiber digestion and increases the number of cellulolytic bacteria in the rumen and this could influence milk fat content. Mousa et al. (2012) pointed out that conflicting results from various yeast studies might have resulted from variations in feeding systems (feeding frequency, ration composition, dose of yeast and strains employed), animal (species, age and physiological state)

and environmental conditions.

Changes in lactation curves reported in the present study agrees with Zaleska et al. (2015) who reported that the average daily milk yield of ewes receiving yeast supplements was higher than control group and this trend was observed throughout the lactation period (28 day). Masek et al. (2008a) reported no effect on total milk yield and lactation curve during late lactation, and explained that this could be due to low milk production in late lactation.

Increased serum total protein, albumin, glucose, urea and AST concentrations noted in the present study are in accordance with those reported by Mousa et al. (2012). Contrary with the present results, Masek et al. (2008b) reported no differences in blood constituents in dairy ewes. Erasmus et al. (1992) explained that increase in total protein and albumin in dairy cows supplemented with *S. cerevisiae* was associated with an increased flow of microbial protein leaving the rumen and enhanced supply of amino acids entering the small intestine. Increase in blood glucose level may be related to enhanced dietary carbohydrates hydrolysis and absorption rate in the gut of animals fed a yeast supplement (Mousa et al., 2012). However, all the blood parameter values were within the normal ranges (Saleem et al., 2017) which indicated that the animals were healthy.

Improved birth weight and growth performance of lambs from yeast supplemented ewes are consistent with some previous studies. Helal and Abdel-Rahman (2010) and Mousa et al. (2012) reported that yeast inclusion in the diets of ewes during nursing period increased birth weight and weight gain of lambs. Masek et al. (2008) explained that *S. cerevisiae* addition tend to balance energy and acid-base metabolism in sheep resulting in a higher milk production and this is an important factor for the production of robust lambs at weaning. Nevertheless, Tripathi et al. (2008) reported that feeding lambs diets supplemented with yeast before weaning did not affect dry matter intake, digestibility and average daily gain.

5. Conclusion

Results from the present study showed that milk yield and composition of Sohagi ewes were improved as a result of dry yeast inclusion during late pregnancy and lactation periods. Milk yield improved by 14.3 and 20.3 %, fat yield by 21.5 and 30.2 % and protein yield by 20.5 and 28.9 % by yeast supplementation at 5 and 10 g/head/day, respectively. Improvement in milk production performance of Sohagi ewes increased birth weight of lambs by 5.8 and 10.5 % and average daily gain during the suckling period by 13.8 and 18.4 %. Improvement in milk production and lamb growth of ewes that received 10 g/ head/day was higher than those that received 5 g/ head/day.

Recommendation

Landless and small landowners in rural regions can use dry yeast supplementations in diets of small ruminants to improve their productivity which could result in significant annual income and improve their quality of life.

Declaration of Competing Interest

None.

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