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Assessment of Saccharomyces cerevisiae as a feed additive to improve the metabolic status and reproductive performance of Farafra ewes in arid subtropical regions

Harby, A. Asmaa[1], Kasaab, A. Y. M.[1], Kholif, A. E.[2] and Hamdon, H. A.[1]

[1]Animal and Poultry Production, Faculty of Agriculture, New Valley University, El-Kharaga 72511, New Valley, Egypt.
[2]Dairy Science Department, National Research Centre, Cairo, Egypt

* Corresponding author

Harby, A. Asmaa

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Abstract

This study investigated the effect of Saccharomyces cerevisiae (SC) supplementation on the metabolic, hormonal, and reproductive efficiency of Farafra ewes in arid subtropical regions. Eighteen ewes were randomly assigned to three equal groups (six ewes each). The treatments were: C (control), T1, and T2, corresponding to dietary supplementation with SC at 0, 1, and 1.5 g/head/day, respectively. Blood samples were collected monthly from the jugular vein, and biochemical parameters were analyzed throughout the experiment. The results showed no significant differences among treatments in total protein, albumin, globulin, AST, ALT, ALP, urea-N, creatinine, total cholesterol, triglycerides, T3, and T4 levels. However, glucose concentrations were significantly higher ($P < 0.05$) in the SC-supplemented groups compared to the control. Conception rates were notably higher in SC-treated ewes (100%) compared to the control group (66.67%). Additionally, SC supplementation significantly ($P \leq 0.05$) improved reproductive performance, including the number of lambs born per ewe joined and the number of lambs born or weaned per ewe lambed. In conclusion, the findings suggest that Saccharomyces cerevisiae supplementation can enhance the metabolic status and reproductive efficiency of Farafra ewes in arid subtropical environments.

Keywords: Saccharomyces cerevisiae; Farafra ewes; Reproductive performance; Antioxidant

INTRODUCTION

When animals in the New Valley are exposed to heat stress (HS), particularly during summer heat waves, it can have adverse effects on their welfare and productivity. The New Valley is a desert governorate located in western Egypt, where ambient temperatures range from 43–48°C in the summer to around 8°C in the winter **(Kassab et al., 2020; Soliman et al., 2022).** Regardless of the adaptation shown by the native breeds, with the beginning of summer, a decline in production is observed, leading to a shortage of fresh milk and necessitating the import of powdered milk, which requires huge foreign exchange. Additionally, HS is the major factor contributing to poor fertility by causes decreased estrus expression, decreased fertilization rate, and increased embryonic mortality cows during HS which leads to an economic deficit in dairy production **(Kassab et al., 2021)**. HS can negatively impact pregnancy rates in farm animals inseminated during HS **(Turk et al., 2015).** Furthermore, stress may induce apoptosis in certain cells **(Mohamed *et al.,* 2024)**.

Farafra sheep flock was introduced to Mallawi Research Center in 1992; it is a local species of sheep found in El-Farafra Oasis in the Egyptian Western Desert. Yeast culture (YC) products contain SC fermentation metabolites (organic acids, amino acids, and B-vitamins) which act as stimulatory nutrients to specific organisms that digest fiber **(Wiedmeier et al., 1987).** Direct-fed microbes (DFM) act as rumen fermentation modifiers. The most important DFM used in ruminant nutrition are various strains of yeast **(Mehrez** et al., **2013).** Probiotics regulate the balance of the gut microbiota, reduce digestive disorders, and inhibit pathogenic intestinal microorganisms, especially E. coli **(Weng et al., 2021)**. Yeast production responses are usually associated with stimulation of cellulolytic bacteria and lactate utilization in the rumen, which increases fiber digestibility and the rate of microbial protein flow from the rumen **(Newbold et al., 1996).** Furthermore**, Galib (2006)** found that SC supplementation played a significant role in rams fed high-forage diets compared to those consuming high-concentrate diets.

Despite their adaptation to arid environments, Farafra ewes exhibit productivity declines during periods of elevated heat Farafra ewes, a native breed adapted to the Egyptian Western Desert, still experience production declines during summer heat waves. Therefore, this study aimed to evaluate the effect of SC on reproductive performance and blood biochemical parameters in arid sub-tropical regions

MATERIALS AND METHODS

This study was performed at the animal production experimental farm, Faculty of Agriculture, New Valley University.

Experimental design

Eighteen ewes, with an average BW of 32 ± 1 kg, and their age ranging from 3 to 4 years, were distributed into three identical groups (6 ewes each) according to their BW. All ewes were fed 60% of their nutrient requirements as a CFM according to the guidelines **of NRC (1985)**, while Egyptian clover and wheat straw (WS) was given adlib to cover the rest of the ewes requirements. The chemical composition of the basal diet is shown in Table 1. Feeds amounts were adjusted based to ewes productive and physiological status. Ewes were weighed biweekly and feeds were changed based to the variations in body weight and the physiological conditions.

Table (1): Chemical composition of CFM and WS (on DM basis)

Item	CFM	Wheat straw
DM	89.33	91.85
OM	91.45	94.2
CP	14.62	2.6
CF	6.86	44.6
Fat	3.76	1.8
Ash	8.55	5.8
NFE	66.21	45.2

CFM: Concentrate Feed Mixture, **DM:** Dry Matter, **OM:** organic matter, **CP:** Crude Protein, **CF:** Crude Fiber, **NFE:** Nitrogen Free Extract

Blood sampling and analytical methods

Blood samples were drawn monthly at 08:00 am via jugular vein in to clean tubes. Blood sera were separated by centrifugation at 3000 rpm for 15 min., and then samples were frozen at -18 °C for further analysis. Serum analysis was done using jenway spectrophotometer. Serum albumin was estimated according to **Doumas et al. (1971).** Total protein (TP) and creatinine concentrations were measured by **Tietz (2006)** methods**.** Urea, AST, ALT, ALP glucose, and cholesterol were measured according to **Reed (2013).** Direct radioimmunoassay (RIA) technique was performed for determination of thyroid hormones. The concentrations of thyroxine (T4, µg/dl) and triiodothyronine (T3, ng/ml) were measured according to **Barker and Silverto, (1982)**.

Reproduction parameters

Ewes shown to be in estrus were mated with a healthy ram at the favorable time (8 hours after signs of estrus) for two consecutive cycles until pregnancy occurred. The reproductive indicators studied during this experiment were percentage of estrus and conception rate. conception rate.

Statistical analysis

Statistical analysis was performed using SAS (2009) according to the following model: $Yij=\mu+Rij+Eij$ where: µ is the overall mean of Yij; Rij is the effect of treatment; Eij is the experimental error

Duncan's new multiple range test was used to calculate differences between means

RESULTS AND DISCUSSION

Biochemical indicators in Ewes

The effects of two levels of SC supplementation on blood serum of ewes are showed in Table (2). Results clearly reported that ewes fed SC did not affect the concentrations of biochemical parameters of Ewes except glucose concentration. The concentration serum glucose was increased with increasing yeast level in the ration, While the lowest value were recorded in control group. Those results agree with **Abdel Rahman et al. (2012)** who showed that supplementation of YC at levels (2.5 or 5.0 g /h /d) YC) did not affect blood TP or globulin. Moreover, while increase in glucose concentration may be due to increasing the activity of cellulolytic bacteria that act on cellulose fibers degradation and thus produce more glucose and increase the glycogenic precursor propionate in rumen or decrease serum insulin and insulin-glucose ratio leading to an increase in gluconeogenesis **(El-Shimaa, 2022).**

Table (2): Effects of SC yeast supplementation on biochmical parameters on Ewes

Item	Treatments			SEM	P-value
	Control	SC 1g	SC 1.5g		
Total protein (g/l)	7.47	7.47	7.55	0.146	0.894
Albumin (g/dl)	3.51	3.32	3.31	0.091	0.901
Globulin (g/dl)	3.95	4.13	4.24	4.24	0.853
AST (U/l)	36.82	36.33	35.21	0.093	0.561
ALT (U/l)	18.93	18.74	19.04	0.738	0.073
ALP	164.75	174.09	169.90	7.532	0.742
Urea-N (mg/dl)	41.07	38.15	39.97	1.534	0.751
Creatinine (mg/dl)	1.150	1.079	1.14	0.048	0.598
Glucose (mg/dl)	77.66 ^{c}	80.77^{b}	83.61^{a}	0.869	0.001
Total Cholesterol (mg/dl)	132.32	137.37	131.10	3.051	0.693
Tri glycerides	70.82	69.87	71.09	4.082	0.983
T3	1.67	1.48	1.71	0.076	0.360
T4	4.85	4.69	4.91	0.164	0.758

a,b,c Means in the same row lacking a common superscript differ (P<0.05) **AST**, aspartates aminotransferase, **ALT**, alanine aminotransferase.

El-Shimaa (2022) showed that there was no significant difference in creatinine, Urea-N, triglycerides and cholesterol between the different groups by adding yeast. Furthermore**, Elaref et al. (2020)** mentioned that the creatinine level in the Sohagi ewes was not affected by supplementation of YC. **Mousa et al., 2012; Malekkhahi et al., (2014) and Tayeb and Yaseen, (2018)** founds that the blood urea concentration was not affected by yeast supplementation. However, **Soren et al. (2013)** reported that the activity of ALT was significantly (P<0.032) lower in control than the probiotic supplemented groups. On the other hand, **Kholif and Khorshed (2006)** and **Abdel-Khalek et al (2000)** found that the activity of AST was not affected by using YC or salinized yeast.

Reproductive performance of ewes

Results pertaining to the impact of SC on reproduction performance of sheep were given in Table (3). This study found that all ewes exhibited no difference in the responses to synchronization due to treatments. As all the animals taken in each treatment were cyclic, thus all the ewes showed normal estrus so all the animals in these groups were inseminated at the appropriate time of estrus as per the observations of the signs of estrus. Data in Table (3) clearly indicated that dietary supplementation of SC significantly (P≤0.05) improved conception rate, reproductive ability, lambs born per ewes joined and lambs born or weaned per ewe lambed. Results are agreed with those reported by **Łopuszańska-Rusek and Bilik (2011)** who found a higher conception rate with fibro lytic enzymes and YC for cattle compared to control. Also**, Zaleska et al., (2015)** reported that the stimulation of the reproductive performance in ewes was improved by SC, resulting in the increases in the number of ovulating ova and higher prolificacy. Moreover, **Abou-Seri et al., (2020)** found that pre-and post-partum diets supplemented with YC and fibro lytic enzyme

are beneficial to reproductive performance of buffaloes and growth rate of their offspring.

Table (3) Effect of SC supplementation (1 and 1.5 g/h/d) on the reproductive performance of ewes

Item	Treatments		
	Control	SC 1g	SC 1.5g
Number of ewes	6	6	6
Estrus response	100%	100%	100%
Conception rate, (%)	66.67%^{b}	100%^{a}	100%^{a}
Lambing rate, (%)	100%	100%	100%
Number of lambs born	5^{b}	8^{a}	9^{a}
Single	5 (5)	4 (4)	3 (3)
Twins	-	2 (4)	3 (6)
Number of viable lambs at weaning	4^{b}	8^{a}	8^{a}
Gestation length (day)	154.4	152.7	153.5

a,b Means in the same row lacking a common superscript differ significantly ($P<0.05$).

CONCLUSION

Supplementation with Saccharomyces cerevisiae (SC) during periods of heat stress (HS) had a significant positive impact on reproductive performance. Additionally, metabolic and biochemical parameters were noticeably improved. In conclusion, SC supplementation during HS appears to be an effective strategy for enhancing reproductive performance by improving the nutritional metabolism of ewes under the environmental conditions of the New Valley.

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