EFFECT OF YEAST-BASED PROBIOTICS SUPPLEMENTATION ON THE PRODUCTIVE PERFORMANCE OF BALADI MALE GOATS UNDER CONDITIONS OF ASWAN, EGYPT

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SUMMARY

This study was conducted to evaluate the effect of supplementing Baladi goat's ration with different levels of *Saccharomyces cerevisiae* (ACTISAC) on feed intake, rumen fermentation, blood parameters, digestibility, and growth performance under conditions of Aswan, Egypt. Sixteen Baladi goats, aged between 10 and 12 months and with an average body weight of 18.28 ± 0.8 kg, were divided into four groups, with four goats in each group. The experimental groups were fed a basal ration containing 50 % concentrate feed mixture and 50 % alfalfa hay plus 0, 2.5, 5.5, and 7.5 g yeast culture for groups T1, T2, T3, and T4, respectively, for an experimental period of 155 days. Results showed that goats in treated groups increased ($P < 0.05$) ruminal pH and ruminal temperature while ammonia-N and total volatile fatty acids (TVFAs) were not affected ($p > 0.05$) by ACTISAC. The levels of blood serum albumin, triglycerides, glucose, ALT, AST urea, creatinine, and uric acid were not affected ($P>0.05$) by the addition of yeast, while total protein, globulin, and cholesterol were increased ($P<0.05$) for goats fed ACTISAC. Moreover, dry matter intake was increased ($P<0.05$) compared to control group (T1), and the highest values were recorded for lambs fed 5.5 g ACTISAC (506.94 g/d). The supplementation of ACTISAC did not result in any significant effect on nutrient digestibility's. Goats' growth performance was affected by ACTISAC supplementation; total gain (TG) and average daily gain (ADG) values were higher ($P<0.05$) in the treated groups than in the control. In conclusion, ACTISAC supplementation improved growing goats' feed intake and blood parameters and enhanced their growth performance.

Keywords: *ACTISAC, blood parameters, ruminal temperature, productivity, Saccharomyces cerevisiae.*

INTRODUCTION

Escalating scientific and public apprehensions over using sub-therapeutic antimicrobials for production reasons has motivated researchers to investigate secure alternate approaches to enhance performance in ruminants. Presently, many distinct types of feed additives are considered safe for enhancing the performance of ruminant animals such as: probiotics, prebiotics, and phytogenic additives. The investigation into adding *Saccharomyces cerevisiae* to small ruminant diets was commenced by Adams *et al.* (1981) and Harrison *et al.* (1988). Yeast cultures typically consist of viable *Saccharomyces cerevisiae* yeast cells with densities of at least 10 billion colonies per gram (Calsamiglia *et al.*, 2007). *Saccharomyces cerevisiae* harbors enzymes, diverse vitamins, and unidentified cofactors that augment the rumen microflora's microbial activity and growth rate (Robinson and Erasmus, 2009). It also increases the degradability of hemicelluloses and positively affects the absorption of certain minerals (Lascano *et al.*, 2009). Adding Saccharomyces cerevisiae to ruminants has been shown to benefit their performance. This is demonstrated by changes in the proportion of TVFAs in the rumen, a reduction in rumen ammonia N concentration (Dawson, 2006), improved overall immunity (Broadway *et al.*, 2015; Mahmoud *et al.*, 2023),

increased feed intake, weight gain, and feed conversion efficiency (Stella *et al.*, 2007), as well as improved digestibility and decreased digestive issues in goats (Ishaq *et al.*, 2016). The objective of this study was to evaluate the effects of adding Saccharomyces cerevisiae (ACTISAC) to the diet of Baladi male goats in Aswan. The study assessed the influence on feed intake, rumen fermentation, blood parameters, digestibility, and growth performance.

MATERIALS AND METHODS

The research was carried out in the laboratory of the Animal Production Department, located in the Faculty of Agriculture and Natural Resources at Aswan University. This study sought to assess the impact of supplementing the diet of Baladi male goats with Saccharomyces cerevisiae on their productivity under the specific environmental circumstances of Aswan, Egypt. ACTISAC: is a product of yeast culture (Saccharomyces cerevisiae) containing $2x10^7$ cfu/ g

Experimental animals and rations:

Sixteen growing Baladi male goats (average 10 - 12 months old and weighed 18.28 ± 0.8 kg) were randomly divided into four similar groups (four animals each) according to their weight and age for a 155-day growth trial. (From September 2020 to January 2021). The animals were provided with a basal diet consisting of a 50% mixture of concentrate feed and 50% alfalfa hay to meet their nutritional needs based on their body weight, as NRC (2000) specified. The experimental groups received the basal diet with yeast culture doses of 0g, 2.5g, 5.5g, and 7.5g, for T1, T2, T3 and T4 respectively. The experiment lasted for 155 days. The experimental animals were given free access to potable and uncontaminated water. The goats' body weight was measured fortnightly before morning feeding throughout the experiment to monitor any fluctuations and make necessary adjustments to their food needs. The chemical compositions of the feed items employed in the experimental rations are presented in Table (1). All animals received comprehensive veterinary care in the animal house.

Chemical composition:

The CFM and alfalfa hay samples, as well as the feces, were tested in triplicate to determine dry matter (DM), ash, crude protein (CP), crude fiber (CF), and ether extract (EE) following the guidelines of AOAC (2000). Nitrogen-free extract (NFE) was calculated by subtracting the other measured components.

Table (1): The chemical composition of ingredients (on DM basis, %).

Item	Concentrate feed mixture	Alfalfa hay
Dry matter, %	87.97	88.22
Organic matter, %	86.60	83.60
Crude protein, %	14.77	13.26
Crude fiber, %	16.74	28.14
Ether extract, %	2.93	2.64
Nitrogen free extract, %	52.16	39.56
Ash, %	13.40	16.40

Digestibility trails:

After 4 months, all the animals involved underwent digestibility experiments. The digestibility trials comprised a primary period of 7 days and a collection period of 7 days. The animals were weighed at the beginning of the primary period and the end of the collection period. Excrement was gathered and measured daily using plastic bags during the designated collection period. A 5% portion of each animal's daily excrement was collected and processed using a solution consisting of 10% formaldehyde and 10% H_2SO_4. Subsequently, the processed specimen was desiccated in an oven set at 70°C for 24 hours. The dried samples from the collecting period were combined, and a composite sample, representing 10% of the total quantity, was retained for analysis. The feed residues, if any, were eliminated and quantified for each animal every morning to record feed consumption.

Rumen liquor sampling and analysis:

Liquid samples from the rumen of three animals in each group were obtained monthly. The samples were taken before the animals were fed in the morning and after the digesting experiment was over. Rumen fluid samples were collected via a stomach tube at 0, 2, 4, 6, and 8 hours post-feeding. The materials were filtered using a quadruple layer of cheesecloth. The pH value and temperature of the ruminal fluid were expeditiously assessed using a digital pH meter and a mercury thermometer, respectively. The AOAC (2000) recommendations were used to measure the concentration of total nitrogen (TN) and ammonia nitrogen (N). The TVFA concentration was determined using the methodology outlined by Warner (1964).

Blood sampling and analysis:

Before the morning feeding, blood samples were taken from the experimental animals via the jugular vein at the end of the feeding trial. The specimens were promptly gathered into a vacuum tube and centrifugated at 2500 revolutions per minute for 15 minutes. The serum was isolated and transferred into a polypropylene tube, then held at a temperature of -5º C until it could be analyzed for the concentrations of total proteins (g/dl) and albumin (g/dl) using the methods described by Weichselbaum (1946) and Doumas *et al.* (1971), respectively. Globulin concentrations (g/dl) were determined by subtracting the albumin value from the total protein content. The quantification of glucose was performed using the Burtis and Ashwood (1999) method. The concentration of urea (mg/dl) was calculated using the Henry and Davidsohn (1974). Creatinine (mg/dl) was measured according to Bartels' (1971) methods. Uric acid was quantified using the methodology outlined by Barham and Trinder (1972). The levels of alanine amino transaminase (ALT) and aspartate transaminase (AST) were measured using the Reitman and Frankel (1957) method. The concentration of cholesterol (mg/dl) was assessed using the method outlined by Boutwell (1972).

Statistical analysis:

The collected data were subjected to statistical analysis utilizing the general linear model (GLM) approach per the statistical analysis system (**SAS, 2016**). Duncan's multiple range tests (**Duncan, 1955**) were used to determine significant deviations between means. The data underwent statistical analysis using the following model:

$$Yij = \mu + Ti + Eij$$

Where:
Yij = Observed value of a given dependent variable.
μ = Overall adjusted mean.
Ti = The effect of treatments.
Eij = The experimental random error.

RESULTS AND DISCUSSION

Feed intake and nutrient digestibility:

The data of feed intake presented in Table (2) showed that the group fed ration supplemented with 5.5 g/h/d yeast culture (T3) showed a significant increase ($P<0.05$) in forage, concentrate and total dry matter intake compared to the other experimental groups. The recorded levels of total intake were 506.94gm for T3 versus 450.99gm, 475.25gm, and 486.52gm for T4, T2, and T1 respectively. This may be due to that 5.5 g of yeast culture (ACTISAC) is effective dose to enhance deed intake and the lower and higher level of yeast culture is not effective. In this connection, the values of dry matter intake for T3 were in agreement with Elseed and Abusamra (2007) and Cai *et al.* (2021) who found that the dry matter intake was significantly increased ($P<o.o5$) with supplemented saccharomyces cerevisiae in goats' diets. In their study, Dann *et al.* (2000) saw notable enhancements in dry matter consumption when transition heifers were given yeast culture. This led to increased milk production and reduced weight loss after giving birth. These findings are in direct opposition to the data in the current literature. Also, Pradhan *et al.* (2021) observed a significant improvement ($P<0.05$) in the amount of dry matter consumed by the group that received the supplement as compared to control group.

Similarly, Mohammed *et al.* (2018) noted that including yeast Saccharomyces cerevisiae as ruminant feed additives can improve feed intake and performance. The present results were also, agree with those reported of Kamal *et al.* (2013), who provided evidence that incorporating live yeast substantially enhanced the quantity of dry matter ingested per kilogram of weight gain. Nevertheless, Titi *et al.* (2008) found that

including yeast culture did not impact the amount of feed consumed by fattening Awassi lambs and Shami juveniles.

The data presented in Table (2) clearly showed that including yeast culture had no substantial effect on the digestibility of DM, OM, CP, EE, and NFE. To summarize, including ACTISAC supplementation enhanced the ability to absorb nutrients (DM, OM, CP, EE, CF, and NFE) in treatment T3. The results align with the findings documented in the literature by Cai *et al.* (2021), which demonstrated significant (P<0.005) enhancement in the digestibility of dry matter in goats' diets when supplemented with saccharomyces cerevisiae.

Table (2): Effect of ACTISAC on dry matter intake and nutrient digestibility's.

Item	Experimental rations					p value
	T1	T2	T3	T4	SEM	
Dry matter intake (g/d)						
Concentrate	297.48^{b}	290.19^{bc}	312.36^{a}	279.89^{c}	3.29	<0.0001
Forage	189.03^{b}	185.05^{c}	194.59^{a}	171.11^{d}	0.70	<0.0001
Total	486.52^{b}	475.25^{b}	506.94^{a}	450.99^{c}	3.69	<0.0001
TDN	316.24	308.91	329.51	293.14	2.36	<0.0001
CPI	45.26	44.21	47.16	41.96	0.38	<0.0001
Nutrient digestibilities,%						
Dry matter	71.18	73.33	75.47	71.05	2.39	0.74
Organic matter	70.95	73.09	75.01	69.58	1.76	0.6023
Crude protein	70.70	73.79	75.97	70.05	4.53	0.767
Crude fiber	51.59	51.77	51.20	51.37	1.89	0.9995
Ether extract	60.62	61.92	59.78	57.66	1.64	0.9144
Nitrogen free extract	71.83	73.79	76.59	74.58	6.30	0.9494

$^{a, b}$*.. Means significantly different on the same raw with the different super scripts (p<0.05)..*

Moreover, Abd-Elkader *et al.* (2019), showed significant improvement (p<0.05) in nutrient digestibility when including saccharomyces cerevisiae in goats' diets. The disparity between the outcomes achieved and the present investigation could be attributed to variations in yeast strain, quantity of addition, experimental circumstances, and composition ratio.

Ruminal fermentation:

The current data demonstrated that adding yeast (ACTISAC) with a level of 7.5 gm/h/d significant increased (P < 0.05) in the average ruminal pH values for T4, compared to the other experimental treatments, T1, T2, and T3. However, non-significant differences were observed between T4 and T3, and non-significant differences were found among T1, T2, and T3. The findings are consistent with the studies conducted by Abd El-Ghani (2003) and Ozsoy *et al.* (2013), who found that adding yeast to goats' diet resulted in notable elevations in ruminal pH. Supplementing the diets of goats primarily given concentrated feed with live yeast culture reduced the buildup of lactic acid in the rumen. That created a stable environment for rumen fermentation by raising the pH level (Harrison *et al.*, 1988). Supplementing with ACTISAC increases ruminal pH, which is advantageous for creating a more suitable environment for the activity of cellulolytic bacteria, as stated by Stewart (1977). The discrepancies between the current findings and those reported in the literature may be attributed, in part, to various factors, including variations in experimental conditions (such as the choice of animal, strain, chemical composition of the diet, and stage of animal growth) as well as differences in the type and quantity of yeast supplements and the amount of viable yeast present in the products.

Moreover, Table (3) data indicate no statistically significant differences in the mean concentrations of TVFAS, Ammonia – N, and TN across the various experimental groups. The present findings align with previous studies conducted by Abd El-Ghani (2003), Stewart and Smith (2005), Monnerat *et al.* (2013), Kamal *et al.* (2013), Kholif *et al.* (2017) and Pradhan *et al.* (2021) who demonstrated that adding yeast culture (Saccharomyces cerevisiae) does not impact the levels of ammonia, TVFAs, and total nitrogen.

Table (3): Effect of ACTISAC on ruminal fermentation parameters of Baladi male goats.

Item	Time (hrs)	Experimental rations				p value
		T1	T2	T3	T4	
Rumen pH	0	6.27	6.52	6.39	6.83	
	2	5.39	5.83	6.13	6.3	
	4	6.57	5.62	6.73	6.65	
	6	6.1	6.04	6.09	5.95	
	8	5.05	5.46	5.15	6.29	
	Mean	5.88^{b}	5.89^{b}	6.10^{ab}	6.40^{a}	0.0452
	±SEM	0.24	0.16	0.19	0.14	
TVFA (meq/dL)	0	7.67	7.00	5.67	7.00	
	2	6.00	6.67	4.00	6.67	
	4	7.00	7.33	6.00	7.00	
	6	6.33	6.00	9.00	7.67	
	8	6.33	7.00	5.00	6.67	
	Mean	6.67	6.80	5.93	7.00	0.5448
	±SEM	0.40	0.43	0.67	0.35	
Ammonia-N (mg/dL)	0	28.93	28.00	26.13	29.87	
	2	29.87	28.00	33.6	28.93	
	4	31.73	33.60	30.8	28.93	
	6	30.80	28.00	34.53	32.67	
	8	28.93	26.13	27.07	28.00	
	Mean	30.05	28.75	30.43	29.68	0.7586
	±SEM	1.46	1.03	1.36	1.08	
Total nitrogen (mg/dL)	0	128.30	140.00	134.17	116.67	
	2	116.67	122.50	128.33	105.00	
	4	134.16	128.33	128.33	134.17	
	6	122.50	128.33	105.00	134.17	
	8	116.67	122.50	128.33	105.00	
	Mean	123.67	128.33	124.83	119.00	0.1532
	±SEM	3.18	4.72	4.48	3.89	

$^{a, b}$.. Means significantly different on the same raw with the different super scripts (p<0.05).

Blood serum parameters:

The findings presented in Table (4) indicate a substantial rise (P<0.05) in the average concentration of serum total protein, globulin, and cholesterol in the blood of goats treated with ACTISAC (2.5 - 5.5 - 7.5 g/head/day), specifically in the T3 (5.5 gm/h/d) group compared to the other experimental groups.

Table (4): Effect of ACTISAC supplementation on blood serum parameters of Baladi male goats.

Item	Experimental rations					p value
	T1	T2	T3	T4	SEM	
Total Protein g/dl	7.61^{b}	7.78^{ab}	8.49^{a}	7.60^{b}	0.18	0.0732
Albumin g/dl	4.02	3.67	3.83	3.79	0.15	0.6308
Globulin g/dl	3.58^{b}	4.11^{ab}	4.67^{a}	3.81^{ab}	0.21	0.0863
Triglycerides mg/dl	118.18	143.43	170.45	176.51	18.84	0.1435
Cholesterol mg/dl	116.67^{ab}	103.70^{b}	104.33^{b}	135.41^{a}	3.35	0.0202
Glucose mg/dl	86.11	101.65	101.24	100.92	6.37	0.3156
Urea mg/dl	36.97	41.74	36.54	42.95	1.89	0.4083
Uric acid mg/dl	2.97	2.93	4.17	3.10	1.37	0.6371
Creatinine g/dl	0.79	0.88	1.09	0.64	0.34	0.3770
AST U/l	30.89	29.31	22.93	29.73	1.79	0.2171
ALT U/l	63.42	72.07	73.41	71.85	3.62	0.4646

$^{a, b}$.. Means significantly different on the same raw with the different super scripts (p<0.05).

This could be attributed to the fact that animals in T3 exhibited the most significant feed intake, resulting in an increased supply of nutrients to the body, which was then transformed into more body proteins. Regarding this matter, the serum total protein level indicates the animal's nutritional condition and is directly related to the amount of protein consumed in the meal (Kumar *et al.*, 1980). In addition, these results align with the research carried out by Abu El-Ella and Kommonna (2013), who demonstrated that Damascus goats supplemented with 2.5g SC/head/day exhibited the most significant ($P<0.05$) elevation in blood total protein levels. In a similar vein, Ismaeel *et al.* (2010) found a noteworthy ($p\leq 0.05$) rise in the overall protein concentration when the yeast levels added to the diet of Awassi lambs were increased (3, 5, 7 g / head/ day). No statistically significant differences ($p>0.05$) were seen for serum albumin, triglycerides, and glucose.

These results align with the research conducted by Al-Rikabi (2013), who indicated that the addition of yeast at a rate of 3 g SC/kg of feed did not result in a substantial rise in serum glucose levels in local goat youngsters. Supplementing goats' feed with various doses of ACTISAC did not impact renal function, as indicated by serum urea, creatinine, and uric acid levels. Feeding ACTISAC did not impact the liver's functionality and well-being, as indicated by the levels of alanine amino transaminase and aspartate transaminase. Bush (1991) determined that liver injury, drug induction, and myocarditis are factors that lead to an elevation in AST levels. In addition, liver injury, skeletal muscle damage, cardiac muscle problems, and intense physical effort lead to an elevation in ALT levels.

Growth performance:

The data shown in Table (5) indicates that the group fed a diet supplemented with 5.5 g of yeast culture (T3) exhibited considerably greater final weight, total weight growth, and average daily gain compared to the other experimental groups (T1, T2, and T4). However, no significant differences were seen among T1, T2, and T4. This might be attributed to the fact that T3 exhibited a notably greater feed intake level than the other groups, as indicated in Table 5. This trend was observed alongside the absence of any substantial impact on nutritional digestibility across all groups.

The findings are consistent with the study conducted by Tripathi and Karim (2011), which revealed that including yeast in lamb diets resulted in a noteworthy ($P<0.05$) rise in average daily gain (ADG) for yeast-treated lambs compared to the control group. In a similar vein, Cai *et al.* (2021) demonstrated a statistically significant ($P<0.05$) enhancement in the daily weight gain of goats when the basal meal was supplemented with yeast at a rate of 0.60%.

Table (5): Effect of ACTISAC supplementation on growth performance of Baladi male goats

Item	Experimental rations					p value
	T1	**T2**	**T3**	**T4**	SEM	
Initial wt. (kg)	17.97	18.33	19.53	17.3	0.57	0.8042
Final wt. (kg)	27.3^{ab}	26.35^{ab}	29^{a}	23.95^{b}	1.82	<0.0001
Total wt. gain (kg)	9.33^{ab}	8.01^{ab}	9.47^{a}	6.65^{b}	0.61	<0.0001
Average daily gain (g)	77.78^{ab}	66.87^{ab}	78.89^{a}	55.41^{b}	5.07	<0.0001

$^{a, b}$.. Means significantly different on the same raw with the different super scripts ($p<0.05$)..

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تأثير مكملات البروبيوتيك المعتمدة على الخميرة على الأداء الإنتاجي لذكور الماعز البلدي تحت ظروف أسوان

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أجريت هذه الدراسة لتقييم تأثير إضافة مستويات مختلفة من خميرة Saccharomyces cerevisiae (ACTISAC) في علائق الماعز البلدي على استهلاك العلف، وتخمر الكرش، ومؤشرات الدم، والهضم، وأداء النمو تحت ظروف أسوان .تم تقسيم ستة عشر ذكرماعز بلدي، تتراوح أعمارها بين 10 و 12 شهرًا ومتوسط وزن الجسم 18.28 ± 0.8 كجم، إلى أربع مجموعات، بواقع أربعة ماعز في كل مجموعة .تم تغذية المجموعات التجريبية بعليقة أساسية تحتوي على 50% علف مصنع مركز و 50% دريس البرسيم بالإضافة إلى 0، 2.5، 5.5، و 7.5 جرام خميرة للمجموعاتT1 ، T2، T3، وT4 ، على التوالي، لفترة تجريبية قدرها 155 أيام .أظهرت النتائج أن الماعز في المجموعات المعالجة زادت (P <0.05) درجة حموضة الكرش بينما لم تتأثر الأمونيا N-والأحماض الدهنية الكلية المتطايرة (P < 0.05)بـ .ACTISAC لم تتأثر مستويات الألبومين في سيرم الدم، الدهون الثلاثية، الجلوكوز، ALT، ASTاليوريا، الكرياتينين، وحمض اليوريك (P>0.05) بإضافة الخميرة، في حين ارتفعت مستويات البروتين الكلي والجلوبيولين والكوليسترول .(P<0.05) للماعز التي تتغذى على .ACTISAC علاوة على ذلك، زاد تناول المادة الجافة (P<0.05) مقارنة بمجموعة المقارنة (T1) ، وسجلت أعلى القيم للحيوانات التي تم تغذيتها بـ 5.5 جم أكتيساك (506.94 جم/يوم .(لم ينتج عن مكملات أكتيساك أي تأثير كبير على هضم العناصر الغذائية . تأثر أداء نمو الماعز بمكملات أكتيساك؛ كانت قيم النموالكلي (TG) ومتوسط النمو اليومي (ADG) أعلى (P <0.05) في المجموعة الثالثة(T3) مقارنة بالمجموعة الضابطة .في الختام، أدت مكملات أكتيساك إلى تحسين استهلاك العلف ومعامل الدم للماعز النامية وتحسين أداء نموها.