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THE EFFECT OF DIETARY SUPPLEMENTATION WITH SACCHAROMYCES CEREVISIAE ON GROWTH PERFORMANCE, SOME SELECTIVE HEMATOLOGICAL, BIOCHEMICAL AND ANTIOXIDANT PARAMETERS IN NEW ZEALAND WHITE RABBITS

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ABSTRACT

The present study was conducted to evaluate the effect of Saccharomyces cerevisiae dietary supplementation on growth performance, some selective hematological, biochemical, oxidative stress marker and antioxidant parameters in New Zealand White (NZW) rabbits. Thirty weaned rabbits were divided into three groups (n=10), C: control fed basal diet, S_1: fed basal diet supplied with Saccharomyces cerevisiae (Sc) 4g/kg diet and S_2: supplied with Sc 10g/kg diet for 6 weeks. The weight gain, feed intake and feed conversion rate (FCR) were calculated at the end of 3rd and 6th week. The blood samples were collected; one with anticoagulant for hematological examination, and other coagulated one for obtain clear serum sample to estimate some selective serum biochemical parameters and serum total antioxidant capacity. One gram of hepatic tissue was collected from each rabbit for preparation of hepatic homogenate which used for analyzing oxidative stress marker and antioxidant parameters (MDA, SOD, Catalase and GSH). At the end of the study, the growth performances were significantly improved in $S_1$and S_2 groups than control one. Serum AST, creatinine, glucose and lipid profile were significantly decreased in $S_1$and S_2 groups than control group. S_1 and S_2 groups showed a marked increase in hepatic GSH compared with control group. Other parameters were insignificantly differed between all experimental groups. Saccharomyces cerevisiae supplementation as a feed additive in rabbits' diet had a desirable effect on weight gain, FCR and antioxidant enzymes activities as well as improved the lipid profile, glucose level, liver and kidney functions.

INTRODUCTION

In the developing countries generally and in Egypt especially, many factors like economic state and population growth influenced the lifestyle and diet pattern that increases the demand on meat consumption, thus rabbit production can be a possible way to solving the problem of meat shortage in Egypt **(Galal and Khalil, 1994; Alboghdady and Alashry, 2010)**. Rabbit meat has a role as functional food which improves the health state and reduces the risk of disease and characterized by white, fine grained muscle, palatable with high good quality protein contents and low fat and caloric contents and high percent of minerals **(Dalle Zotte and Szendrő, 2011)**.

Natural alternatives, non-antibiotic feed additives are added to diet of rabbit to enhance growth performance, decrease post weaning shock, increase reproductive activity and

improve carcass traits and meat production beside disease prevention **(Maertens, 2011)**.

The probiotics is one of the most important feed additives which used in farm animals. They act on maintained the balance of intestinal microorganisms in healthy animals, increase its resistance to diseases, and necessary for efficient digestion and maximum absorption of nutrients **(Shehu et al., 2014)**.

Saccharomyces cerevisiae is a probiotic and consider as a valuable and qualitative growth promoter because of its availability, safety and cheapness. They having positive effects in the treatment and prevention of diseases which originate from either their direct nutritional effect as biologically valuable proteins, vitamin B-complex, important traces minerals and several unique factors or their health promoting effects such as acting as a bioregulator of the intestinal microflora and reinforcing the host's natural defenses **(Hassanein and Soliman, 2010)**

The aim of this study was to evaluate the efficacy of dietary supplementation of *Saccharomyces cerevisiae* on the growth performance, some selective hematological, biochemical, oxidative stress and antioxidant parameters as well as some histopathological studies in NZW rabbits.

MATERIAL AND METHODS

Experimental Animals and Design

The experiment was carried out on 30 male NZW rabbits at weaning age (25-35 days old). After adaptation period (about 2 weeks) in cages condition, rabbits were separated into 3 equal groups, each of 10 rabbits as follow: First group was control group (C) fed only basal diet according to **NRC, (1977),** (Table 1). The second and third groups were supplemented with *Saccharomyces cerevisiae* at two levels 4g/kg and 10g/kg of diet in group S_1 and group S_2 respectively **(Seyidoglu et al., 2013 & Kimse et al., 2012)**. All groups were received their diet for 6 weeks.

Yeast (*Saccharomyces cerevisiae*)

Yeast was purchased from market, as lyophilized powder and stored at 4C°.

Growth performance parameters

The body weight and feed intake of each animal were measured daily to find body weight gain and feed conversion rate (FCR) at 3rd and 6th week post supplementation according to **Al-Dobaib, (2010)**.

Sampling

The blood samples were collected from the ear vein at 3rd and 6th week post supplementation. One sample was taken in eppendorf tubes with anticoagulant (0.5mg Dipotassium salt of EDTA/1ml blood) for hematological examination **(Reinhart et al., 1990)** and other one was taken in clean serum plain centrifuge tubes for serum separation for biochemical parameters analysis. On the other hand, one gram of liver tissue was collected from each animal for preparation of hepatic homogenate and evaluation of some hepatic oxidative stress and antioxidant parameters according to **(Ferdandez-Botran et al., 2002)**.

Hematological analysis

The total erythrocytic and leukocytic counts were performed manually via hemocytometer method, while hemoglobin concentration (Hb g/dl) was measured spectrophotometrically, otherwise packed cell volume (PCV %) were estimated by microhematocrit reader. Mean corpuscular volume (MCV fl), mean corpuscular hemoglobin (MCH pg) and mean corpuscular

hemoglobin concentration (MCHC %) were calculated. Also, the differential leukocytic count was considered manually by using Giemsa stain **(Feldman et al., 2000)**

Biochemical analysis

ALT, AST, ALP, total bilirubin, direct, indirect bilirubin, total protein, albumin, cholesterol, triglyceride, HDL, LDL, glucose, urea, creatinine and total antioxidant capacity (TAC) were determined by spectrophotometrically method. The ALT and AST were assayed according to **Reitman and Frankel, (1957)** and ALP measured according to **Walter and Schutt, (1974)**. Total bilirubin was detected according to **Wahlefeld et al., (1972)**. Direct bilirubin was measured according to **Jendrassik, (1938)**. Indirect bilirubin was calculated according to **Coles, (1986)**. Total protein and albumin are measured pursuant to **Dumas and Biggs, (1972)**. Globulin was calculated according to **Kaneko et al., (1997)**. Serum creatinine was determined according to **Henry (1974)** and serum urea was determined according to **Numann et al., (1977)**. Glucose, cholesterol, triglyceride and HDL were determined according to **Young, (2001)** and LDL was calculated according to **Friedewald et al., (1972)**. Finally, Serum TAC was determined according to **Koracevic et al., (2001)**.

Some hepatic oxidative stress marker and antioxidant parameters analysis

Hepatic MDA and Catalase were estimated spectrophotometrically according to **(Ohkawa, 1979) & (Aebi, 1984)**, respectively. Also, GSH and SOD were measured according to **Beulter et al., (1963) & Nishikimi et al., (1972)**, respectively.

Histopathological studies

The animals were sacrificed and then specimen from liver, kidney and intestine were taken and kept in 10% formalin. Later the specimen were placed in paraffin wax and stained by hematoxylin and eosin (H&E) and examined microscopically according to **Bancroft et al., (1990)**.

Statistical analysis

The Statistical software program (SPSS for Windows, version 20, USA) was used to analyzing all data. The results were displayed as the mean ± stander error. A one-way analysis of variance (ANOVA) with Duncan multiple comparison tests were used to analyzing the differences between means of different groups. The variable superscript letter shows the difference if P-value was significantly statistically lower than 0.05 ($P<0.05$).

RESULTS

Growth Performance Parameter Results

As recorded in table (2) we found that at the end of 3rd week of (*Sc*) supplementation, the initial body weight, weight gain, feed intake and feed conversion rate (FCR) were insignificantly changed in all experimental groups, while final body weight was significantly reduced either in S_1or S_2 group in compared with the control one and significantly decreased in S_2 in compared with S_1.

At 6 week post Saccharomyces cerevisiae supplementation, our result revealed that the final body weight was insignificantly differed among all experimental groups. Otherwise the body weight gain in S_2 group was significantly increased in compared with control group. Also, S_2 group had a significant decrease in both feed intake and FCR in compared either with S_1or the control groups.

The cumulative period post *Saccharomyces cerevisiae* supplementation, the initial body weight, final body weight and weight gain were insignificantly varied in

between all experimental groups while Feed intake and FCR are significantly decreased in S_2 group in compared either with S_1 or control groups. Table (2)

Hematological Results

Table (3) illustrated that, RBCs (10^6/µl), Hb (g/dl), PCV (%), MCV, MCH and MCHC were insignificantly varied in *Saccharomyces cerevisiae* supplemented groups compared with control group (C) all over the experimental periods. Also, the same insignificant changes were appeared in leukogram results.

Biochemical Results

- **Liver function biomarker**

As estimated in table (4) the serum activities of ALT and AST were significantly decreased in S_1 and S_2 group when compared with control at the end of 3rd week while at end 6th week serum AST only was significantly decreased in both S_1 and S_2 groups compared with control. Meanwhile serum ALP, Total, direct, indirect bilirubin, total protein, albumin, globulin and (A/G ratio) were insignificantly changed in all experimentally groups, all over the experimental period.

- **Kidney function biomarkers**

The result in table (5) explained that serum creatinine level was significantly decreased in S_1 and S_2 group compared with C group, while serum urea level was insignificantly differed in between all experimental groups at 3rd week post *Saccharomyces cerevisiae* supplementation while at 6th week serum creatinine and urea levels were insignificantly changed between all experimental groups.

- **Serum glucose level**

Table (5) showed that (*Sc*) supplemented groups either at end of 3rd or at end of 6th week had a significantly reduced serum glucose level compared with C group.

- **Lipid profile**

As declared in table (5) at 3rd week and 6th week post *Saccharomyces cerevisiae* supplementation, total cholesterol and LDL were markedly decreased in S_1 and S_2 groups compared with C group while triglysceride and HDL were insignificantly varied between all experimental groups. Table (5)

Some hepatic antioxidant and oxidative stress parameters

At the end of 3rd week MDA level was markedly reduced in S_1 and S_2 groups compared with control one (C). Furthermore, hepatic SOD, Catalase and GSH activities as well as serum TAC were insignificantly varied between all experimental groups. While at the end of 6th week only hepatic GSH activity was markedly increased in S_1 and S_2 groups in compared with C group. Table (6)

Histopathological Results

Microscopically examination of Intestinal tissue in S_1 and S_2 groups noticed normal intestinal villi lined by normal enetrocytes, intestinal crypts, normal submucosa and muscular layer and normal proportion of goblet cells filled with faint basophilic mucin in their cytoplasm and normal supporting stroma like control group (C) either at the end of 3rd or 6th week(Photo1). Also, liver is showing normal hepatocyte and normal radial arrangement around central vein and portal vein (PV), either at the end of 3rd or 6th week in both S_1 and S_2 groups(Photo2). Normal renal glomeruli, normal renal tubules with normal lining renal tubular epithelium were noticed microscopically in cross section in kidney of control group as well as both S_1 and S_2 groups either at the end of 3rd or 6th week(Photo3).

Table (1): basic diet structure and chemical composition of diet:

Ingredients	Kg/ ton	Chemical composition	%
Driss Hegazy	245	Digestible Energy	2.6
Caraway Hay	70	Protein	16.3
Yellow Corn	127	Calcium	0.8
Barley	110	Phosphorus	0.62
Soy bean meal	174	Crud fiber	13
Bran	250		
Minerals and vitamins(premix)	3		
Salt or NaCl	4		
Lime stone	10		
Anti coccida	0.2		
Anti-myotoxin	1		

Table (2): Some growth performance parameters (Mean ± SE) post *Saccharomyces cerevisiae* supplementation in rabbits:

Intervals	Parameters	C	S_1	S_2
At end of 3rd week	Initial body weight (g)	759±7.14^a	750±4.18^a	745±3.53^a
	Final body weight(g)	1609±1.8^a	1596±1.8^b	1579±2.9^c
	Weight gain(g)	850±7.07^a	846±4.84^a	834±2.9^a
	Feed intake(g)	1506±3.6^a	1496±2.4^a	1503±7.6^a
	Feed conversion rate (FCR)	1.77±0.016^a	1.76±0.008^a	1.80±0.11^a
From 3rd week to end of 6th week	Initial body weight (g)	1609±1.8^a	1596±1.8^b	1579±2.9^c
	Final body weight(g)	2309±2.91^a	2303±3.39^a	2300±4.18^a
	Weight gain(g)	700±4.18^b	707±2.54^{ab}	721±6.59^a
	Feed intake(g)	2296±4.3^a	2288±3.0^a	2227±3.39^b
	Feed conversion rate (FCR)	3.28±0.02^a	3.23±0.009^a	3.08±0.028^b
Cumulative period from 0 day to end of 6th week	Initial body weight (g)	759±7.14^a	750±4.18^a	745±3.53^a
	Final body weight(g)	2309±2.91^a	2303±3.39^a	2300±4.18^a
	Weight gain(g)	1550±7.07^a	1553±6.24^a	1555±6.12^a
	Feed intake(g)	3802±6.04^a	3784±5.09^a	3730±10.36^b
	Feed conversion rate (FCR)	2.45±0.009^a	2.43±0.006^a	2.39±0.014^b

C: control free diet, S_1: supplied with 4g *Saccharomyces cerevisiae*/kg diet, S_2: supplied with 10g *Saccharomyces cerevisiae*/kg diet.

The different letters show significant difference between groups at ($p<0.05$).

Table (3): Some selective hematological parameters (Mean ± SE) post *Saccharomyces cerevisiae* supplementation in rabbit:

Intervals	Group	RBCs $10^6/\mu L$	Hb g/dl	PCV %	MCV fl	MCH pg	MCHC %	TLC $10^3/\mu L$	Lymph. $10^3/\mu L$	Neutroph. $10^3/\mu L$	Monocyt. $10^3/\mu L$
At 3rd week	C	5.46±0.13^a	10.82±0.23^a	37.88±0.77^a	69.47±1.27^a	19.84±0.27^a	28.60±0.75^a	5.13±0.34^a	2.76±0.27^a	2.26±0.10^a	0.10±0.006^a
	S_1	5.45±0.14^a	10.96±0.12^a	38.04±0.53^a	69.94±1.69^a	20.16±0.32^a	28.84±0.37^a	4.80±0.56^a	2.82±0.33^a	1.88±0.22^a	0.096±0.011^a
	S_2	5.35±.002^a	10.50±0.001^a	36.40±0.50^a	68.01±0.95^a	19.62±0.01^a	28.87±0.40^a	4.97±0.24^a	2.79±0.12^a	2.07±0.10^a	0.10±0.019^a
At 6th week	C	5.04±0.15^a	11.49±0.34^a	38.40±0.81^a	76.35±1.5^a	22.84±0.61^a	30.01±0.70^a	4.68±0.20^a	2.81±0.13^a	1.76±0.08^a	0.10±0.008^a
	S_1	5.19±0.05^a	11.67±0.10^a	39.40±0.50^a	75.95±0.87^a	22.50±0.22^a	29.63±0.41^a	4.52±0.13^a	2.67±0.07^a	1.70±0.05^a	0.10±.007^a
	S_2	4.94±0.03^a	11.34±0.12^a	37.60±0.51^a	76.11±0.93^a	22.96±0.25^a	30.18±0.54^a	4.64±0.04^a	2.73±0.03^a	1.82±0.02^a	0.09±0.004^a

Table (4): Some selective serum biochemical parameters (Mean ± SE) post *Saccharomyces cerevisiae* supplementation in rabbit:

Intervals	Group	ALT U/L	AST U/L	ALP U/L	T.BIL mg/dl	Dir.BIL mg/dl	Indir.BIL mg/dl	T.Protein mg/dl	Albumin mg/dl	Globulin mg/dl	A/G Ratio
At 3rd week	C	32.87±0.78^a	41.35±0.68^a	342.10±23.25^a	0.500±0.022^a	0.184±0.028^a	0.314±0.02^a	9.60±0.19^a	4.26±0.13^a	5.34±0.25^a	0.808±0.059^a
	S_1	27.35±0.48^b	33.33±0.59^b	347.12±18.69^a	0.516±0.018^a	0.168±0.035^a	0.348±0.05^a	9.74±0.32^a	4.26±0.093^a	5.48±0.37^a	0.792±0.057^a
	S_2	27.92±0.89^b	32.38±0.71^b	357.06±22.10^a	0.528±0.083^a	0.192±0.065^a	0.336±0.03^a	9.74±0.23^a	4.28±0.116^a	5.46±0.34^a	0.804±0.073^a
At 6th week	C	32.3±0.50^a	41.15±0.45^a	436.00±4.30^a	0.348±0.06^a	0.162±0.018^a	0.186±0.055^a	8.86±0.10^a	4.62±0.16^a	4.24±0.14^a	1.10±0.072^a
	S_1	30.63±0.62^a	38.25±0.35^b	442.41±2.87^a	0.370±0.07^a	0.148±0.033^a	0.224±0.047^a	8.64±0.17^a	4.56±0.10^a	4.08±0.2^a	1.13±0.074^a
	S_2	30.44±0.74^a	38.13±0.28^b	439.00±4.62^a	0.340±0.04^a	0.102±0.019^a	0.236±0.47^a	8.66±0.11^a	4.30±0.16^a	4.36±0.16^a	0.998±0.072^a

C: control free diet, S_1: supply with 4g *Saccharomyces cerevisiae*/kg diet, S_2: supply with 10g *Saccharomyces cerevisiae*/kg diet.

- The different letters show significant difference between groups at ($p<0.05$).

Table (5): Some selective serum biochemical parameters (Mean ± SE) post *Saccharomyces cerevisiae* supplementation in rabbit:

Intervals	Group	Creatinine mg/dl	Urea mg/dl	Glucose mg/dl	Cholesterol mg/dl	Triglyceride mg/dl	HDL mg/dl	LDL mg/dl
At 3rd week	C	1.22±0.07^a	53.8±0.83^a	105.18±0.43^a	102.16±0.33^a	71.90±0.98^a	43.14±0.26^a	44.64±0.1^a
	S_1	0.95±0.09^b	50.7±0.50^a	90.62±0.22^b	97.80±0.49^b	71.90±0.18^a	43.44±0.16^a	39.98±0.44^b
	S_2	0.88±0.09^b	52.10±0.46^a	89.36±1.32^b	97.14±0.68^b	71.58±0.33^a	43.90±0.5^a	38.92±0.5^b
At 6th week	C	1.75±0.044^a	47.00±0.42^a	116.10±0.98^a	104.44±0.35^a	86.55±0.75^a	47.69±0.33^a	39.44±0.27^a
	S_1	1.72±0.086^a	46.66±0.39^a	108.82±0.74^b	92.71±0.45^b	85.01±0.46^a	47.34±0.30^a	28.37±0.39^b
	S_2	1.74±0.050^a	47.99±0.47^a	109.58±0.64^b	93.73±0.60^b	85.17±0.28^a	47.28±0.34^a	29.42±0.51^b

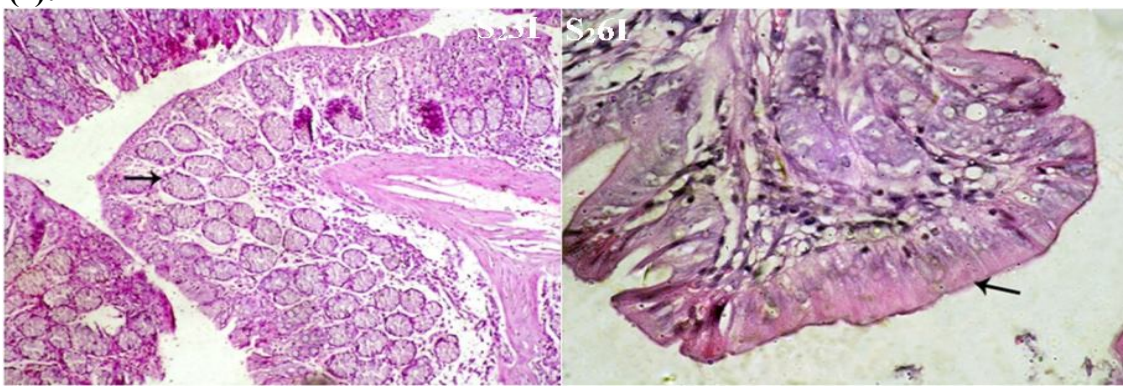
Table (6): Some oxidative stress marker and antioxidant enzymes in liver homogenate and serum TAC (Mean ± SE) post *Saccharomyces cerevisiae* supplementation in rabbit:

Intervals	Group	MDA nmol/g tissue	SOD U/g tissue	Catalase nmol/g tissue	GSH mmol/g tissue	TAC mM/L
At 3rd week	C	8.59±0.52^a	247.59±2.55^a	0.812±0.028^a	4.65±0.12^a	1.50±0.042^a
	S_1	4.97±0.50^b	251.59±2.00^a	0.739±0.020^a	4.57±0.11^a	1.52±0.026^a
	S_2	4.84±0.29^b	245.66±1.56^a	0.786±0.023^a	4.50±0.10^a	1.66±0.078^a
At 6th week	C	4.24±0.38^a	281.66±5.81^a	0.592±0.07^a	5.42±0.29^b	1.51±0.09^a
	S1	3.40±0.43^a	285.61±4.18^a	0.586±0.06^a	6.52±0.28^a	1.52±0.09^a
	S2	3.13±0.55^a	284.66±5.09^a	0.578±0.03^a	6.38±0.22^a	1.38±0.01^a

C: control diet, S_1: supply with 4g *Saccharomyces cerevisiae*/kg diet, S_2: supply with10g *Saccharomyces cerevisiae*/kg diet.

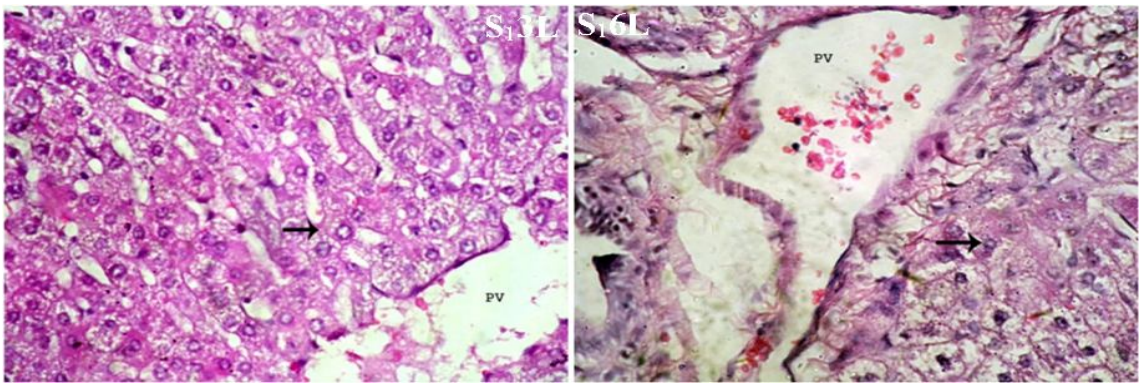
- The different letters show significant difference between groups at ($p<0.05$)

Photo (1):



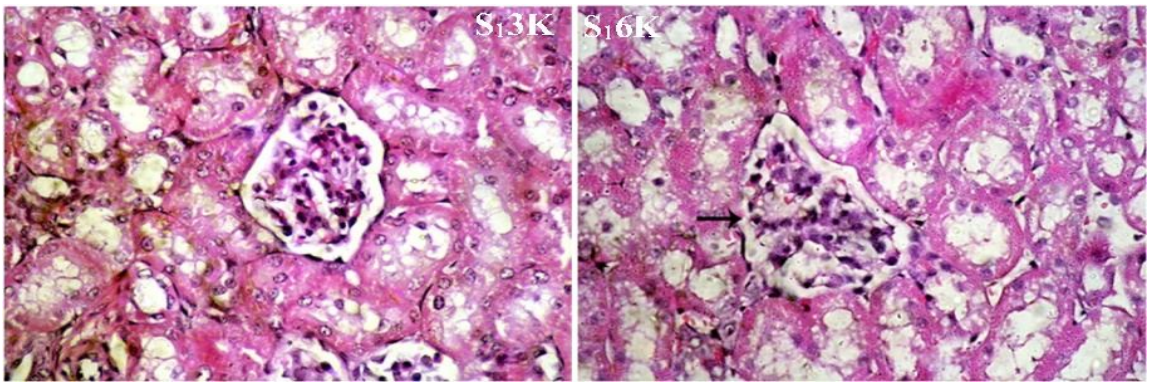
At 3rd week post supplementation At 6th week post supplementation

- **Photo (2):**



At 3rd week post supplementation At 6th week post supplementation

- **Photo (3):**



At 3rd week post supplementation At 6th week post supplementation

DISCUSSION

The growth performance results in the present study clarified the positive effect of *Saccharomyces cerevisiae* supplementation on the growth performance as FCR and weight gain. This result may be reflected the activity of *Saccharomyces cerevisiae* which targeting the hind gut (caecum and colon) of rabbit to antagonize the bacterial colonization **(Chaucheyras-Durand and Durand, 2009; Hassan et al., 2012)** and improve the growth and healthy state of rabbits along the experiment, decrease the incidence of diarrhea and present of mortality **(Ezema and Eze, 2012; Shehu et al., 2014)**. Also, **Paryad and Mohamoudi,(2008) & Shareef and Al-Dabbagh,(2009)** observed a significant increase in body weight gain, feed intake and improved feed conversion rate in chicks dietary supplemented with different levels of *Saccharomyces cerevisiae*. Moreover, **Al-Mansour et al., (2011)** confirmed that yeast culture supplementation to diet of broiler chicks for 42 days improve the growth performance. The presence of B-glucan and mannanoligosaccharide in the yeast culture and its wall extract considered the important natural growth promoters for livestock and poultry production and play trophic effect on the intestinal mucosa and increases the villus height **(Shareef and Al-Dabbagh, 2009)**

In the existing study, the rabbit supplemented with *Saccharomyces cerevisiae* either with S_1or S_2 groups respectively, has insignificant effect on the erythrogram result either at 3rd or 6th week post supplementation. This finding agreed with **Galip and Seyidoglu, (2012) & Seyidoglu et al., (2013)** who noted insignificant changes in hematological parameters of rabbit dietary supplemented with yeast. Also, pervious researches like, **Al-Mansour et al., (2011)** detected that dietary supplementation with *Saccharomyces cerevisiae* in broiler chicken insignificantly changed the erythrogram. Meanwhile, **Shareef and Al-Dabbagh,(2009)** partially agreed with our finding as found that hematological parameters in male broilers were insignificant changed with different levels of yeast (0.5, 1 & 1.5%, of diet) for 21 days except at level 2% of diet the hematological parameters were significantly increased in compared with control group. In contrast, **Onifade et al., (1999) & Ezema and Eze, (2012)** observed a significant elevation in the hematological parameters of rabbits fed *Saccharomyces cerevisiae* especially at levels 3g/kg or/and 0.12g/kg, respectively. This difference may be due to the different concentration of *Saccharomyces cerevisiae* **(Seyidoglu et al., 2013)**.

The leukocyte picture in this study revealed that the *Saccharomyces cerevisiae* dietary supplementation either in S_1 or S_2 groups, respectively has insignificant effect on leukogram either at 3rd or 6th week post supplementation. In the same way, **Galip and Seyidoglu, (2012) & Seyidoglu et al., (2013)** recorded that rabbits which supplied with dietary yeast for 12 weeks had the insignificant effect on leukocyte count in compared with control group. Likewise, **Shareef and Al-Dabbagh,(2009)** recorded that leukocyte counts were insignificantly changed in broiler chicks supplied with live yeast (*S.cerevisiae*) or fed with dietary yeast supplementation at different levels. This result referring that the *S.cerevisiae* had no adverse effect on the total leukocytic count or the immune system of the animal. Although *S.cerevisiae* may had a stimulating and supporting effect as reported in many other researches like **Onifade et al., (1999); Ezema and Eze, (2012)** who observed a significant elevation in the TL counts and the population of lymphocytes with dietary *S.cerevisiae* supplementation in rabbits,

poultry, quails and fish. In contrast, **Al-Mansour et al, (2011) & Adebowale et al., (2014)** who reported that the dietary yeast supplementation had a significant reduction on leukocyte counts and lymphocyte counts in poultry and turkey.

The result of current study demonstrated that the dietary supplementation of rabbit with *Saccharomyces cerevisiae* either at S_1 or S_2 groups induced a significant reduction in both serum ALT and AST activities than control group at 3rd week post dietary supplementation but at 6th week AST only significantly reduced. The reduction of the liver enzymes even with normal range as a result of dietary yeast supplementation or its byproducts indicated that yeast has a hepatoprotective effect which reflecting the better health of animal, represent the non-pathological metabolism of liver and heart, decrease the rate of enzymes leakage from hepatic tissues, decrease the processes of tearing and wearing and protect against hepatic injuries **(Onifade et al., 1999; Aluwong et al., 2013[b])**. Others researches, **Seyidoglu et al., (2013) & Seyidoglu and Galip, (2014)** reported that serum ALT and AST levels were insignificantly changed in rabbits and poultry nourished on dietary yeast and that partially agreed with our result at 6th week post supplementation.

In the current study, the addition of dietary *Saccharomyces cerevisiae* either in S_1 or S_2 groups have no side effect on the liver function as the serum ALP, total bilirubin, direct and indirect bilirubin as well as total protein, albumin, globulin and A/G ratio were insignificantly differ all over the experiment. Our data in agreement with **Seyidoglu et al., (2013); Seyidoglu and Galip, (2014)** who found that the serum ALP activity, total protein, albumin and globulin were insignificantly changed in rabbit fed diet supplied with *Saccharomyces cerevisiae*. Also, **Matur et al., (2010); Yalcin et al., (2014)** concluded that serum total protein and albumin were insignificantly changed in broiler chicks or laying hens were supplied with dietary live yeast (*S.cerevisiae*), yeast culture or *S.cerevisiae* extract, respectively. Likewise, **Abdalla et al., (2013)** observed that the serum total protein, albumin, globulin and A/G ratio were insignificantly affected in calves fed on diet supplied with (*S.cerevisiae*) dried yeast. This result may clarify that the dietary yeast supplementation had no adverse effect on the immune system or the osmoregulatory system of animal body as the most important role of albumin is control osmotic pressures in the blood. However, **Onifade et al., (1999) & Yalcin et al., (2014)** reported a significant elevation of serum protein, albumin, and globulin either in rabbits or poultry fed on dietary yeast as result of direct response to increase protein intake and protein quality enhancing the circulating immunoglobulin levels.

The kidney function and its health state were evaluated through measuring serum urea and creatinine levels. From our finding, serum creatinine and urea levels were insignificantly changed either at 3rd and 6th week post *S.cerevisiae* supplementation except creatinine was significantly reduced at 3rd week post supplementation. Our result clarified that no toxic effect on kidney tissue with dietary yeast supplementation and it may protect the kidney from renal injuries. **Seyidoglu et al., (2013) & Seyidoglu and Galip, (2014)** found that the addition of *Saccharomyces cerevisiae* to rabbit diet had insignificant effect on serum creatinine and urea levels. Also, **Matuer et al., (2010)** noted that creatinine and urea levels were insignificantly varied in hen fed diet supplied with *Saccharomyces cerevisiae* extract (1g/kg for 30 days).

Our study showed a significant decrease in the serum glucose level in both S_1 and S_2 groups. This result observed by **Aluwong et al., (2013[a])** with dietary supplementation of yeast at level 1.5% of diet for 6 weeks in

broiler chicken that may due to the suppressive effect of the probiotic on glucagon (source of blood glucose in chicken), and maintaining blood glucose homeostasis. Also, the yeast may be impaired glucose absorption through the intestinal lumen during its growth which may be decreased the glucose in blood pool. Unlike our result, **Galip and Seyidoglu, (2012); Seyidoglu and Galip,(2014)** reported that serum glucose was significantly increased either in rabbit supplied with dietary *S.cerevisiae* supplementation respectively, while **Seyidoglu et al., (2013)** reported that serum glucose was insignificantly changed in rabbit was supplied with yeast.

Our data indicated that serum cholesterol and LDL levels were significantly decreased in both S_1 and S_2 groups either at 3rd and 6th week post supplementation. These results confirmed by **Onifade et al.,(1999) & Galip and Seyidoglu, (2012)** who noted that rabbit fed *Saccharomyces cerevisiae* for 56 days a significantly decrease serum cholesterol. Additionally, **Paryad and Mahmoudi, (2008) & Shareef and Al-Dabbagh, (2009)** found that serum total cholesterol level was significantly decreased in broiler chicken fed variable levels of *Saccharomyces cerevisiae*. The hypocholesterolemic activity of *Saccharomyces cerevisiae* could be explained by its ability as a probiotics to regulate the serum cholesterol level by deconjunction of bile acid **(Klaver and Van Der Meer, 1993)**. Also, the reduction of cholesterol concentrations may be attributed to the integration of cholesterol into the cellular membrane of the probiotic microorganism. Probiotics may also influence the cholesterol blood levels by mitigating cholesterol synthesis **(Krasowska et al. 2007)**.

The serum triglyceride and HDL in this study are insignificantly affected either at 3rd week or at 6th week post *Saccharomyces cerevisiae* supplementation. This result agreed with **Seyidoglu et al., (2013); Seyidoglu and Galip, (2014)** who found insignificant changes of serum HDL in rabbit fed *S.cerevisiae*. Also, **Matur et al., (2010)** noticed that serum triglyceride was insignificantly affected in the hen fed extract of *S.cerevisiae* for 30 days.

In this work, the *Saccharomyces cerevisiae* supplementation induce a significant reduction in the hepatic MDA level at 3rd week post treatment that agreed with **Abdalla et al.,(2013)** who clarified that MDA level was significantly decreased in calves fed with *Saccharomyces cerevisiae* groups. Meanwhile at 6th week post supplementation, hepatic MDA was insignificantly changed. This in accordance with **Shehu et al.,(2016) & Aluwong et al.,(2013[c])** who found insignificant variation in the level of serum MDA of either rabbits and broiler chicken supplied with yeast, respectively.

In the present study, the hepatic SOD and Catalase activities were insignificantly changed either at 3rd or at 6th week post *Saccharomyces cerevisiae* supplementation in both S_1 and S_2 groups. These results was confirmed previously through **Abdalla et al., (2013)** who recorded that SOD and Catalase activities were insignificantly changed at 8th and 12th week post treatment with *Saccharomyces cerevisiae* in calves. Also, **Shehu et al., (2016) & Aluwong et al.,(2013[c])** found insignificant variation in the activity of serum SOD of rabbits or broiler chicken respectively supplied with yeast, while found that serum Catalase activity was significantly elevated with *Saccharomyces cerevisiae* supplementation. The hepatic GSH activity was insignificantly affected at 3rd week post supplementation with *Saccharomyces cerevisiae* while at 6th week post supplementation hepatic GSH activity is significantly increased in compared with control. This finding is agreed with **Abdalla et al.,(2013)** who found a significant elevation of GSH level in calves supplemented with *S.cerevisiae*. Also, **Darwish et al.,(2011)** observed a significant increase in the GSH

level in the mice received *S.cerevisiae* alone especially in kidney tissue rather than liver tissue in compared with the control group. Serum total antioxidant capacity (TAC) is one of oxidative stress biomarker. In our study the supplementation of *S.cerevisiae* in rabbit diet did not affected the level of serum TAC either at 3rd or 6th week post supplementation. This result agree with **Pengkumsri et al.,(2017)** who noticed that serum TAC level was insignificantly changed in compared between yeast b-glucan treated rat group and negative control.

The histopathological examination of rabbits intestine all over the experiment, recorded insignificant changes between all experimental groups. Our finding agree with those of **Peker et al.,(2014) & Seyidoglu and Peker,(2015)** who reported insignificant changes in between rabbits supplied with *S.cerevisiae* and control unsupplied one. Additionally, rabbit's liver and kidney were showing normal histological architecture in compared with control group. In same context to our finding, **Ahmed et al., (2013)** watched insignificant histological alteration in liver tissue of male rats and in kidney tissue of both male and female rats treated orally with *S.cerevisiae* in comparison with control rats.

CONCLUSION

Natural alternatives, non-antibiotic feed additives such as *Saccharomyces cerevisiae* was added to the ration of rabbit to enhance its performances; as it improve FCR, increase the weight gain and increase the final body weight. *Saccharomyces cerevisiae* does not have any side effect on the selective hematological parameters of rabbits and no toxic effect on the liver and kidney functions. Additionally, *Saccharomyces cerevisiae* has great antioxidant effect through elevation of GSH levels.

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الملخص العربي

تأثير إضافات الأعلاف كالخميرة على معدل النمو، و بعض التغيرات الدموية، والبيوكيميائية، ومضادات الاكسدة في الأرانب النيوزلاندية البيضاء

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أجريت الدراسة الحالية لتقييم تأثير إضافات الأعلاف كالخميرة على معدل النمو وبعض معايير الدم وبعض المعاملات البيوكيميائية ومضادات الاكسدة في الأرانب النيوزلاندية البيضاء.

تم تقسيم عدد ثلاثين من الأرانب المفطومة حديثا إلى ثلاثة مجموعات متساوية؛ حيث تغذت المجموعة الأولى على العليقة الأساسية بدون إضافات بينما زودت المجموعة الثانية ب ٤جم من الخميرة لكل كجم من العليقة الأساسية(٤جم/كجم)، وزودت المجموعة الثالثة ب١٠ جم من الخميرة لكل كجم من العليقة الاساسية(١٠جم/كجم)، لمدة ستة أسابيع، ثم أخذت العينات في نهاية الاسبوع الثالث والاسبوع السادس على التوالي من التجربة.

وأظهرت النتائج في نهاية الدراسة تحسن في معدل النمو في المجموعتين المزودتين بالخميرة؛ حيث لوحظ التأثير الإيجابي للخميرة على زيادة الوزن ومعدل النمو. كما لوحظ عدم وجود أي آثار سلبية على وظائف الكبد والكلى. ووجد تغير ملحوظ في معدل السكر والدهون الثلاثية في المجموعتان المزودتان بالخميرة. وسجل تأثير الخميرة على بعض مضادات الأكسدة. بخلاف ذلك لم يشاهد أي تغيرات مرضية في أنسجة الامعاء والكبد والكلى.