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EFFECT OF ADDITION OF *Saccharomyces cerevisiae* AND/ OR SODIUM BUTYRATE ON GROWTH PERFORMANCE AND BLOOD BIOCHEMICALS IN GROWING RABBITS.

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A factorial design was conducted to evaluate the effect of live dried yeast (Saccharomyces cerevisiae) (SC) and sodium butyrate (SB) on growth and physiological performance of growing New Zealand White (NZW) rabbits.

Sixty weaned rabbits were specified indiscriminate into six equal groups were fed for eight weeks. All trail groups were fed a uniform rabbit's pelleted diet, (1) basal diet control, (2) basal diet plus 0.3 g sodium butyrate (SB), (3) basal diet plus 0.5g SB, (4) basal diet plus 0.1% Saccharomyces cerevisiae (SC), (5) basal diet plus 0.1g SC plus 0.3g SB and (6) basal diet plus 0.1g SC plus 0.5g SB. Data of growth performance, pH, ammonia-N (NH_3-N) and volatile fatty acid (VFA) production of cecal content, digestibility and nutritive value, nitrogen balance and blood biochemical were analyzed in 2×3 factorial design.

The results revealed that *feed additives as SC and SB used alone improved significantly body weight (BW) and body weight gain (BWG) as compared to the control group. Addition the basal diet with 0.1 SC revealed ($P<0.05$) improved in feed conversion ratio (FCR). Cecum pH did not ($P>0.05$) effect by SC and SB or their mix supplementation. Using mixture of SC and SB or alone gave a positive results on the volatile fatty acids (VFA) concentration vs control group. The opposite trend was noted in NH3-N concentration, which was ($P<0.05$) decreased related to control one. Rabbits fed diets containing 0.1 SC caused ($P<0.05$) to improve in dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF) and Nitrogen free extract) NFE (digestibility and nutritive value of DCP. Growing rabbits fed SB at 0.3 and 0.5g / Kg diet ($P<0.05$) increased the CP digestibility, nutritive value of DCP. Addition SC in rabbits diets initiated observable increased ($P<0.01$) in serum total protein (TP) and Glob vs control. Also, lipid profile as Cholesterol (CHO), TG low and High density lipoprotein (HDL) was decrease ($P<0.01$) vs control. Also, 0.5g SB* *initiated observable increased (P<0.01) in TP vs 0.3 SB and control. CHO, TG and HDL was decrease (P<0.01) vs control. All These results proved that weaning rabbits fed diets have mixed probiotics culture of Saccharomyces cerevisiae and sodium butyrate improved productive performance and economic efficiency.*

Key words: *Saccharomyces cerevisiae*, sodium butyrate, growth performance, rabbit**.**

No doubt that weaned rabbits always suffering from various infectious diseases and high mortality during the 1st four weeks after weaning, however, hinder the development of the rabbit industry. Weanling rabbits often suffer from diarrhoea, which is the major cause of their mortality. Coliform bacteria (mainly *Escherichia coli*) are normal inhabitants of the intestinal tract of rabbits and most of animal species. In the intestine of health rabbits their counts are low, $10^2 – 10^4$ per g intestinal contents. In rabbits with enteritis, however, the concentration of *E. coli* exceeds 10^8 g (Cortez *et al.*, 1992). Digestive problems caused by enter-pathogenic *E. coli* strains are often responsible for high morbidity and mortality of young rabbits after weaning, and consequently for important economic losses in rabbit farms (Licois, 2004). Rabbit breeders widely use antibiotics to control enteritis infections. The use of antibiotics, however, is viewed critically in recent times. Some were banned totally; some received no renewal of their license as a measure of preventive consumer protection. There is a pressing need for harmless antimicrobial substances suitable for rabbits nowadays.

Organic acids and their salts are generally considered as safe and have been approved by most member states of European Union to be used as the feed additives in animal production. Salts organic acids have an antimicrobial activity and can Spear the bacterial cell wall and disorder the normal actions of positive kinds of bacteria including Salmonella Spp, *E. coli*, Clostridia Spp, Listeria Spp. and some coliforms. Therefore, reduction in numbers of some Species of the normal intestinal bacteria as well as pathogenic bacteria can occur in animals fed salts organic acids. It is thought to recover general act by decreasing microbial competition with the weaned rabbits for nutrients, by reducing the risk of subclinical infections, reducing the intestinal immune response and by reducing the production of harmful bacterial compounds. In a nut shell salts organic acids reduces gastric pH (Oh, 2004). Acidification of diets with weak organic acids such as formic, fumaric propionic, lactic and sorbic have been reported to decrease colonization of pathogen and production of toxic metabolites, improved digestibility of protein, Ca, P, Mg, Zn and served as substrate in the intermediary metabolism (Fallah, and Rezaei 2013).

Butyric acid is one of the short chain fatty acids that are created by microbial fermentation in the gastrointestinal tract of non- ruminant (Mallo *et al.,* 2012). Especially, the propionic and butyric acids produced in the gastrointestinal tract are looking substantial metabolites that have antibacterial good on pathogenic bacteria (Stecher and Hardt, 2011). Supplementation of butyric acid directly to rabbit diet possibly limited on account of its highly volatile and corrosive advantage (Piva *et al.,* 2002). Subsequently, some products of butyric acid have been used in mixed forms with Ca and Na. Butyrate is recognized as the most effective source of energy for epithelial cells proliferation (Mroz *et al.,* 2006), where Na-butyrate has been reported to be helpful in maintenance of intestinal villi structure (Leeson *et al.,* 2005). Recently, dietary sodium butyrate decreased diarrhea scores of weanling rabbit and improved growth performance (Viliene *et al.,* 2018; Hassanin *et al.,* 2015). In addition, sodium butyrate supplementation to rabbit diets (Romero *et al.,* (2011) was reported to have a positive effect on pH, NH3-N concentration.

It was consequently assumed that the chelating compounds formed by organic salts combined with the probiotic effects promoted by live dried yeast (*Saccharomyces cerevisiae*) (SC) would, by their synergism, prevent the growth of pathogenic bacteria, thereby avoiding the widespread of disease specially weaned rabbits diaherria. High (%) mortality is considered as one of the main problem that the rabbit's production faces today. Therefore, the request for additives that improve the product and the conflict of the environment organisms against unlike infections is growing. The use of probiotics along with organic salts, such as additives for prevention of pathogens, can be a very useful tool to be careful for rabbit's production thus avoiding the avoidable use of antibiotics and accordingly producing a positive impact in the productive sector. Since few studies on the combined use of probiotics and organic salts have been reported (Bolivar *et al.,* 2018) who evaluate the effect of linking a probiotic with organic salts presents synergistic in vitro suppression against aquaculture bacterial pathogens.

Therefore, the goal of this work was to explore the effectiveness sodium butyrate (SB) and probiotic (*Saccharomyces cerevisiae*) (SC) in rabbit's diets on productive performance of rabbits.

MATERIALS AND METHODS

1. *Experimental animals and management*

This study was conducted in 2018–2019 in the individual rabbit breeding farm, which had about 400 of rabbits, in Borg El-Arab Poultry Research Station belonging to Animal Production Research Institute, Agriculture Research Center, Ministry of Agriculture, and Egypt.

Rabbits were housed in well ventilated block building (three per cage in the fattening trials and individually during the digestibility trial). The batteries were arranged in rows in a windowed house naturally ventilated and the fresh air circulated in the house using exhaust fans. The rabbits were kept with a cycle of 16 h light and 8 h dark using artificial light sources. No heating was applied in the rearing pen. Fresh water was automatically available at all time by stainless steel nipples for each cage. The experimental diets were offered to rabbits *ad libitum* in pelleted form from 5 to 13 weeks of age. Pellets were offered twice daily at 8 am and 4 pm. The experimental rabbits were kept under the same managerial and hygienic conditions.

2. *Experimental diets*

A 2 x 3 factorial arrangement was conducted. Feeding trial was conducted with weaning New Zealand White (NZW) rabbits of 5 Wks old. The rabbit's weight was 522 g at start of the study. All the experimental diets were formulated to be *iso-nitrogenous*, *iso-caloric*, and to meet all the essential nutrient requirements of growing rabbits according to Lebas (2013) as shown in Table 1. Chemical analysis of basal diet was carried out according (AOAC, 1996). The feeding period was extended for 8 Wks. During the study, 60 rabbits were divided into 6 treatment groups, 10 rabbits in each as follow: (1) basal diet control, (2) basal diet plus 0.3 g sodium butyrate (SB), (3) basal diet plus 0.5g SB, (4) basal diet plus 0.1% *Saccharomyces cerevisiae* (SC), (5) basal diet plus 0.1g SC plus 0.3g SB and (6) basal diet plus 0.1g SC plus 0.5g SB.

3. *Growth response, apparent nutrient digestibility and nitrogen balance*

The rabbits were weighted at 5 week old, initial body weight (BW) and final body weight (FBW) at 13weeks of age. The weight gain (BWG) was calculated by subtracting BW at beginning of period and at the end of the period. Feed intake (FI) was calculated as the difference between the weight of the feed offered and the weight of the remained at same day of weighing the animals. Feed conversion ratio (FCR) was computed as the ratio between FI and weight gain per period.

Table (1): Feed ingredients and chemical composition of experimental diets (% DM basis).

Feed Ingredients (%)	Basal diet Kg	Chemical composition (%DM basis)	%
Soybean meal (44%CP)	20.9	DM	91.00
Barley	32.0	OM	83.38
Wheat bran	9.2	CP	17.20
berseem hay	31.0	CF	12.90
Molasses	3.0	EE	2.60
Limestone	0.7	NFE	58.30
Di- Ca- phosphate	2.2	Ash	7.62
DL-Methionine	0.4	NDF	37.27
NaCl	0.3	Digestible energy (Kcal/Kg DM)	2530
Vit. -Min. premix*	0.3		
Total	**100**		
Price of kg diet, LE	**480**		

*__Mineral and vitamin mixture supplied per kg of diet__: Vitamin A 10,000 IU, Vitamin D3,1,800 UI; Vitamin E, 15 mg; Vitamin K3, 4.5 mg; Vitamin B1, 0.5 mg; Vitamin B2, 4 mg; Vitamin B12, 0.001 mg; Folic acid, 0.1 mg; Pantothenic acid, 7 mg; Nicotinic acid, 20 mg; I, 1 mg; Mn, 60 mg; Cu, 5.5 mg, Zn, 75 mg; Fe, 40 mg; Co, 0.3 mg; Se, 0.08 mg; Robenidine, 52.8 mg, Antioxidant, 0.250 mg.

Rabbits were housed in individual metabolic cages and fed the experimental diets for a period of 7 days for adaptation, and then feces were collected every 24 hours for 5 consecutive days. Total digestible nutrients (TDN) were calculated according to Cheeke *et al.*, (1982). Digestible energy (DE) of the experimental diets was calculated according to the equation described by Cheeke *et al.(*1987) as follows:

$$DE\ (Kcal) = 4.36 - 0.0491 \times NDF\%$$
$$NDF\% = 28.924 + 0.657 \times CF\%.$$

Chemical analysis was performed as recommended by A.O.A.C (2007) for determining moisture, crude protein (CP), crude fiber (CF), ether extract (EE), ash and minerals for the diets and feces. The urine of each animal was collected in a glass recipient, containing 10 ml of a 1:1 HCl: H2O solution, to avoid bacterial production and possible losses by volatilization. The values of nitrogen intake (NI), nitrogen excreted in feces (NF) and nitrogen excreted in urine (NU) were obtained by the amounts of feed ingested and excreted nitrogen of feces and urine, respectively.

Retained nitrogen was calculated as RN = NI – (NF + NU).

4. *Blood samples and determination of biochemical parameters:*

For determining blood biochemical components, five blood samples (5ml from each rabbit) were taken during slaughter from five animals per treatment. Serum was separated from blood by centrifugation at 1000 g for 20 min and stored at −20°C till assayed. Serum total protein (TP), albumin (ALB), globulin (GLOB), Cholesterol (CHO), Triglyceride (TG), High Density lipoprotein (HDL), Low Density Lipoprotein (LDL), serum glutamic pyruvic transaminase (GPT) and serum glutamic oxaloacetic transaminase (GOT) were measured calorimetrically using commercial kits (purchased from Bio-diagnostic, Cairo, Egypt) according to the manufacturers' instructions Plasma globulin concentration was calculated by the difference between total protein and albumin.

5. *Economic efficiency*

To determine the economic efficiency of the experimental diets for body weight gain, the costs of feed required for producing one kg of body weight gain was calculated. The cost of the experimental diets was calculated according to the price of different ingredients prevailing at local market, as well as, the price of tested materials at the time of experimentation.

Economic efficiency (%) was calculated as a ratio between the return of weight gain and the cost of consumed feed.

6. *Statistical analysis*:

Data were statistically analyzed using the General Linear Model procedure of the Statistical Analysis System **(SAS, 2001)**. Data obtained were tested by analysis of variance with one-way design to test the treatment, sub treatment and interaction group differences at each sampling according to the following model:

$$Y_{ijk}=\mu+T_i+\delta_j+(T\delta)_{ij}+E_{ijk}$$

Where: μ represents the overall mean effect, T_i is the effect of the i th level of factor A ($i=1,2,\ldots\ldots n_b$), δ_j is the effect of the j th level of factor B ($j= 1,2, \ldots\ldots n_b$), $T\delta)_{ij}$ represents the interaction effect between A and B, E_{ijk} represents the random

error terms (which are assumed to be normally distributed with a mean of zero and variance of $\boldsymbol{\delta}$) and the subscript ***K*** denotes the *m* replicates (k = 1, 2, ..m).
Values were given as mean. The significant differences among groups were subjected to Duncan's Multiple Range Test (Duncan, 1955).

RESULT AND DISCUSSION

1. *Growth performance*

Table 2 present the results of the effect of feeding different levels of live dried yeast (*Saccharomyces cerevisiae*) (SC) , sodium butyrate (SB) and their interactions on body weight (BW), body weight gain (BWG), feed intake (FI) and feed conversion (FCR) of New Zealand White (NZW) rabbits.

Initial body weight (IBW) of NZW rabbits ranged from 518 to 524 g with no (P>0.05) differences among treatments, which means a random distribution of the rabbits on the different treatments. Irrespective of sodium butyrate supplementation, the results showed that the incorporation of SC in rabbit diets at the levels of 0.1 % resulted in (2111g/h, 1586.5g/h and 2.52 ratio, P=0.01) improvement in BW, BWG and FCR *vs* control group at the end of trial, respectively. Optional FI wasn't significantly influenced by live yeast (*Saccharomyces cerevisiae*) or sodium butyrate supplementation as El-Badawi *et al.,* (2017) who definite that FI did not change by using bacteria (*Bacillus subtilis*) or live yeast (*Saccharomyces cerevisiae*) to male rabbits diets. This improvement in final BW, BWG and FCR back to that yeasts may straight digest fiber components and/or recover gut environments by the formation of favorable pH, supply of micronutrients and scavenging of oxygen derived radicals, which is conducive for the growth of cellulolytic bacteria, (Robinson and Erasmus 2009). Shehu *et al.*, (2014) observed that rabbits fed diet increment with baker's yeast (*Saccharomyces cerevisiae*) at 20, 40, 60 and 80 g/ kg of basal diet, corresponding to 2 x $10^{9,}$ 4 x 10^9, 6 x 10^9 and 8 x 10^9 CFU/kg of control diet, respectively in five therapy groups had highest BW and increment had (P < 0.05) influence on BW between groups. Also, El-Badawi *et al*., (2017) confirmed that BWG or average daily gain (ADG) of rabbits fed only bacteria and yeast or their mixture added diets were (P<0.05) advanced than those control.

Feed intake and weight gain were currently reflected on values of the feed conversion efficiency (g intake/g gain), where it was better for SC being 2.52 than 2.82 for control. Bhatt *et al.* (2017) told that fed diets added with *Lactobacillus acidophilus* and *Lacto coccus lactis* able to enhanced BEG and FCR ratio without (P>0.05) effect on FI. Similar inference was also eminent by Thanh and Uttra (2017) on rabbits aging 5Wk fed diet have *Bacillus subtilis* and *Lactobacillus*

Table (2): Live body weights of growing rabbits as affected by feeding diets supplemented with *Saccharomyces cerevisiae* (SC) and/ or sodium butyrate (SB) from 5 to 13 weeks.

Treatment Groups	Body weight (g), Wks				
	IBW(g)	**FBW(g)**	**BWG(g)**	**FI(g)**	**FCR**
Main effect of SC:					
SC 0.0	518.8	1934.7^{b}	1415.8^{b}	3991.8	2.82^{a}
SC 0.1	524.5	2111.0^{a}	1586.5^{a}	3980.7	2.52^{b}
SEM	17.21	14.76	18.62	44.38	0.032
P- value	**NS**	**0.01**	**0.01**	**NS**	**0.01**
Main effect of SB supplements					
SB 0.0	520.8	2027.1	1509.5	3954.5	2.63
SB 0.3	520..0	2029.3	1509.3	4028.4	2.69
SB 0.5	524.3	2016.8	1492.5	4027.8	2.72
SEM	21.25	27.01	29.77	54.06	0.055
***P*- value**	**NS**	**NS**	**NS**	**NS**	**NS**
Interaction effect SC × SB					
***P*- value**	**NS**	**NS**	**NS**	**NS**	**NS**

a, b, c, d : different superscripts within a column indicate significant differences.
Initial body weight (IBW), final body weight (FBW), body weight gain (BWG), feed intake (FI) and feed conversion (FCR),
NS: Not significant, $^{**}P \leq 0.01$

acidophilus. Seyidoglu and Galip (2014) observed that final BW and BWG did not vary (P>0.05) when male NZW rabbits (aged 5- 6 weeks) were keep on basal diet or added with SC (3.0 g/kg diet) for a period of 90 days. When the effect of SC was over looked, the results indicated that the supplementation of SB at different levels 0.0, 0.3 and 0.5% did not elicit detectable changes in BW (2029.3g/h), BWG (1509.5g/h), FI (4028.4g/h) and FCR (2.72 ratio) during the trial periods. In this connect, Agboola *et al*., (2018) told that sole organic acid salt added to broiler chicks diets did not recover BW, BWG and FI. Ribeiro *et al*., (2012) recorded that rabbits fed on diet containing SB consumed less (98.8 vs. 104.1 g/d; P=0.05) and grew the same (42.7 vs. 42.9 g/d) than their control.

Data in the same Table showed that the effect of interaction between the SC and SB levels supplementation was not significant for BW, BWG, FI and FCR ratio), respectively. Similar results were confirmed by Dousa *et al*., (2016) who reported that addition probiotics (*bacillus subtilis*) 0.05%, acidifiers 0.20% and their combination in broiler feed had no adverse effects on broiler performance and FI (P<0.05). Also, Sherif (2018) found that rabbits received cocktail of enzymes, organic acids and β-probiotic in their diets BW had not (P>0.05) changes during the experimental period from 7 to 12 wks.' of age; however in 13^{th} and 14^{th} wks.' of age there were ($P<0.05$) improvement related to control. Hassanin *et al*., (2015) showed that live body weight was gradually ($P < 0.05$) improved at the end of the experiment in the following order mixture of SB plus Synbiotic > SB > Synbiotic > control (2468, 2350, 2300 and 2011 g/rabbit, respectively). In piglets, Suryanarayana *et al*., (2012) recorded that addition citric acid and probiotic only or combination tend to improve BW BWG, FI and therefore FCR ($P<0.05$) beside the incidence of diarrhoea can be reduced. In conflict Kliševičiūtė *et al.,* (2016) indicated that inclusion of butyrate and mixture of organic acid salt in the rabbit feeds increased the body weight and growth rate of rabbits. Ribeiro *et al.,* (2012) told that using coated Na-butyrate (23-63 days of age) found that dietary supplementation with organic acids did not affect growth rate of fattening rabbits. In contrast to our results Viliene *et al.,* (2018) found that the implication of butyric acid, medium chain fatty acids and yeast cell walls (*Saccharomyces cerevisiae*) in the composition feeds raised the rabbit's body weight, weight gain, growth rate and decreased feed intake.

2. *Values of PH, ammonia-N (NH_3-N) and volatile fatty acid (VFA) production of cecal content.*

Table (3) presents the impact of SC and SB addition on cecum activity, irrespective of sodium butyrate supplementation, the results showed that the supplementation of SC did not cause any changes in pH (6.31 vs 5.7). Nevertheless, NH_3-N was (21.13%, P=0.01) lower than control which recorded (26.86%). Meanwhile, VFA % was (6.88%, P=0.01) higher in rabbits fed diets including 0.1% SC than those received no SC (6.82%). Gut microflora changes actively by adding prebiotics and significantly reduces gut pH which improve rabbit's performance through influencing gut microbial population (Rahmani and Speer, 2005). These results are contract with those reported by Al-Dabeeb and Ahmed (2002), Ali (2005) and Komonna (2007) who reported that yeast culture or commercial probiotic had no effect on animal pH. Also, El-Shaer (2003) stated that yeast culture in feed lead to decline of cecum NH3-N related to control. Individual decrease in the cecum NH3-N in reaction to YC addition may be due to the increase of ammonia transportation into microbial protein (Harrison *et al*., 1988).

Newbold *et al*., (1995) recommended that the reduction in rumen NH3-N due to yeast is not due to a reduction in the proteolytic, peptidolytic or deamination activity of rumen microorganisms, but it is more likely to be due to the increase of bacterial growth. Williams and Newbold (1990) specified that rumen NH_3 decrease looks to be the consequences of increased incorporation of NH_3 into microbial protein and it may be the direct result of stimulated microbial activity.

Table (3): Values of PH, Ammonia concentration and Volatile fatty acids (VFA) of growing rabbits as affected by feeding diets supplemented with *Saccharomyces cerevisiae* (SC) and/ or sodium butyrate (SB).

Treatment Groups	**Cecum activity**		
	pH	**NH3-N %**	**VFA %**
Main effect of SC:			
SC 0.0	6.31	26.86[a]	6.82[b]
SC 0.1	5.97	21.13[b]	6.88[a]
SEM	0.10	0.77	0.02
***P*- value**	**NS**	**0.01**	**0.01**
Main effect of SB supplements			
SB 0.0	6.37	27.42[a]	6.58[c]
SB 0.3	6.34	24.60[ab]	6.62[b]
SB 0.5	6.14	21.09[b]	6.84[a]
SEM	0.11	2.04	0.05
***P*- value**	**NS**	**0.01**	**0.01**
Interaction effect SC × SB			
SC 0.0 ×SB 0.0	6.37	33.40[a]	6.40[c]
SC 0.0× SB 0.3	6.39	28.82[ab]	6.66[b]
SC 0.0× SB 0.5	6.31	26.86[b]	6.82[ab]
SC 0.1× SB 0.0	6.37	21.44[c]	6.76[ab]
SC 0.1× SB 0.3	6.29	20.39[c]	6.57[b]
SC 0.1× SB 0.5	5.97	21.13[c]	6.88[a]
SEM	0.12	0.91	0.03
***P*- value**	**NS**	**0.05**	**0.01**

a, b, c, d : different superscripts within a column indicate significant differences.
NS: Not significant, * P≤ 0.05, **P ≤ 0.01.

These results showed rabbits fed diets including 0.1%SC in their feed had a greater total VFA concentration in the cecum of these rabbits. VFA offer a controlling energetic force for the movement of water and sodium out of the colonic lumen, which leads to reduce moisture content in the feces and then a lower fecal score, (Cummings and Macfarlane 1991). Addition animal feed with *Saccharomyces boulardii* caused a lower incidence of diarrhea and lower faecal score, (Giang *et al*., 2012). An increase of the total cecal VFA concentration in the rabbits supplemented with SC was expected to reduce cecal pH, which might exert adverse effect to the intestinal pathogens, (Högberg and Lindberg 2006).

When the effect of SC was passed, the results indicated that the supplementation of SB at different levels 0.0, 0.3 and 0.5% did not produce noticeable changes in pH. While, NH_3-N was (P=0.01) decreased gradually with increased the dose of NB. The opposite trends was noted in VFA (P=0.01). Same results was conducted by Ribeiro *et al.,* (2012) who detected that addition SB in rabbits diets did not significant difference in pH and VFA between control or treated group, respectively. Romero *et al.,* (2011) found in their study that organic acid did not effect on the caecum pH compared with control group. This trend suggests in part that organic acids of the digestive tract of rabbits are not working as expected. A degree of specificity of the rabbit gastrointestinal tract (small gastric motility and prolonged retention in the stomach feed time) and cecotrophy distinguish them from other animals. Perhaps this was due to the fact that in a number of studies the expected results in relation to the pH of the digestive tract were not obtained. Nevertheless, several studies have clearly confirmed organic acids effect on gastrointestinal pH. A recent study with butyric acid (sodium butyrate) has proved that if inserted into the feed it reduced ceacal pH.

Data in the similar Table showed that the effect of interaction between the SC and SB levels supplementation was significant effect on NH3-N and VFA. It could be noticed that rabbits fed diets including 0.1% SC and 0.5% SB gave a low NH_3-N concentration (21.13%, P=0.05) vs control (33.40%), meanwhile, VFA take the opposite way (6.88 vs 6.4%, P=0.01). The decreased in caecal pH, the decreased in ammonia-N concentration and the higher VFA concentration suggest high fermentation activity, caecal microbial synthesis, gut health and high nitrogen retention. This observation is consistent with Viliene *et al.,* (2018) who found that the rabbits fed on diets including butyric acid, medium chain fatty acids and SC tendency to a lower pH in the content of duodenum, caecum, ileum and colon was observed in the trail group (P>0.05). Hassanin *et al.,* (2015) confirmed that the caecal NH3-N concentrations in rabbits fed diets added with either SB or nixture of SB plus Synbiotic explained (P<0.05) decreased related to control group. Award to Macfarlane and Gibson (1995) a round of agent could effect NH_3-N concentrations in the caecum, including H2 pressure, chyme reaction, and carbohydrates availability. Compared with ruminants, proteolytic activity in the rabbit caecum is relatively higher (Gidenne, 1997).

The lower recorded NH_3 concentration in SC and SB or SC×SB treat could be attributed to either increased nitrogen retention by enterocytes and colonocytes in these treats which may be connected with greater epithelial cell proliferation in gastrointestinal tract as suggested by Smulikowska *et al.,* (2009) or better ammonia utilization in liver for protein production, this seems true since albumen concentrations were not significant in SC and SB or SC×SB treats.

3. *Digestibility and nutritive values*

Results in Table (4) showed the impact of SC and SB addition on digestible coefficient and nutritive value, irrespective of sodium butyrate supplementation, the results showed that the addition of SC caused a visible improvement in DM (75.78%, P=0.01), OM (76.24%, P=0.01), CP (75.49%, P=0.01) and CF (47.74%, P=0.01). However, nutritive value as DCP was (12.98 %, P=0.01) higher than those received no SC (12.29%).

Digestible coefficients of DM, OM, CP, NDF, and GE were advanced (P<0.05) in rabbits fed diet containing 1×107 cfu/g *Lactobacillus acidophilus* and 0.5×10^7 cfu/g *Lactobacillus acidophilus* in their feed than those in the control, (Phuoc and Jamikorn 2017). Chandra *et al.,* (2014) attributed the improvement in growth performance back to feeding the probiotic-supplemented diets to improved nutrient digestibility and absorption in the ileum.

When the effect of SC was wink, the results indicated that the supplementation of 0.5% SB high level gave CP (75.11%, P=0.05) and DCP (12.92%, P=0.05) high than 0.3% SB low level (72.76% and 12.52%) or control (72.58% and 12.48%), respectively.

The effect of interaction between the SC and SB levels supplementation was not significant effect on digestible coefficient and nutritive value of growing rabbits.

4. *Nitrogen balance*

Table (5) presents the influence of SC and SB supplementation on nitrogen balance, irrespective of sodium butyrate supplementation, the results showed that the addition SC in rabbits diets caused visible difference in FN (0.66g/d *vs* control 0.77g/d, P=0.01), DN/IN (75.49% *vs* control 71.48, P=0.01) and RN/IN (55.23% vs control 50.90%, P=0.01), respectively. As well as, El-Badawi *et al.,* (2017) from studied on rabbits summarized that the alone supplements at 0.1% of *bacillus subtilis* or *Saccharomyces cerevisiae* diets of growing NZW rabbits had clear positive effects on dietary N utilization. Also, weaned Chinchilla rabbits Bhatt *et al.,* (2017) found that addition probiotics (107 CFU/g concentrate) *Lactobacillus acidophilus* and *Lactococcus lactis*. In rabbits diets caused an improvement in nitrogen utilization with reduced faecal excretion.

When the effect of SC was look over, the results indicated that the supplementation of 0.5% SB high level produce noticeable changes in DN/IN (75.11%, P=0.05) compared with low 0.3% SB level and control (72.76% and 72.58%), respectively. Data in the similar Table presented that the effect of interaction between the SC and SB levels supplementation was not significant

effect on IN, g/d; FN, g/d; UN, g/d; DN, g/d; RN, g/d; DN/IN %; RN/IN % and RN/DN %, respectively.

5. *Blood Biochemical*

Table (6) presents the influence of SC and SB supplementation on serum total protein profile, irrespective of sodium butyrate supplementation, the results showed that the addition SC in rabbits diets initiated observable difference in TP (6.37 mg/d *vs* control 5.80 mg/dl, P=0.01) and GLOB (2.77mg/dl *vs* control 2.24 mg/dl, P=0.01), respectively. However, lipid profile as CHO was (79.67mg/dl vs control 103.68 mg/dl, P=0.01), TG (46.70 mg/dl vs control 51.16 mg/dl, P=0.01) low and HDL (29.29 mg/dl vs control 35.06 mg/dl, P=0.01), respectively. Seyidoglu and Galip (2014) recorded that there were (P>0.05) effects on blood glucose, TG and CHO values of rabbits when fed with the SC complements (3 g/kg diet). Galip and Seyidoolu (2012) observed that serum CHO value tended to be lower (P<0.05) in rabbit fed 2 g SC. Sarat Chandra *et al.* (2015) supervised that there were (P>0.05) variance in the blood CHO content of rabbits when fed with probiotics (*Saccharomyces boulardi* 50% and *Pediococcus acidilacticii* 50%, 109 CFU/g of feed) and enzymes (Kemzyme HF at 500 g/Ton of feed).

When the effect of SC was over looked, the results indicated that the supplementation of 0.5% SB high level produce noticeable changes in TP (6.31 mg, P=0.01) vs low control (5.89 mg/dl). Lipid profile as CHO was (77.83 mg/dl vs control 109.02 mg/dl, P=0.01), TG (46.45 mg/dl vs control 53.1 mg/dl, P=0.01) low and HDL (30.25 mg/dl vs control 33.65 mg/dl, P=0.05), when rabbits fed diets including different levels 0.3 and 0.5 % SB, respectively. Dorra *et al.*, (2013) reported that blood parameters of rabbits were not affected by dietary organic acids. Radwan and Abdel-Khalek (2007) found that dietary organic acids (0.5% acetic or lactic acids) did not affect blood plasma parameters (TP, ALB, GLOB and total lipids) of rabbits. In addition, Kamal *et al.*, (2008) fed male NZW rabbits on diets added with organic acids (citric, fumaric and malic acids, singly or in combination) and found (P<0.05) reductions in serum levels of CHO, total lipid and LDL cholesterol. El-Sawy *et al.*, (2014) found that chicks treated with SB (0.49 mg or 0.98 mg/ ml. drinking water/day each alone) showed (P<0.05) increase in serum TP, ALB and CHO in comparison with those did not received SB. However, AST was (P<0.05) increased in comparison with the untreated group. Data in the similar Table presented that the effect of interaction between the SC and SB levels supplementation was (P>0.05) effect on TP, ALB, GLOB, A/G ratio, CHO, TG, HDL, LDL, GPT and GOT. The values of studied

parameters were in the physiological range of rabbits. Same results was showed by Sherif *et al.,* (2018) who revealed that blood TP, ALB, GLOB, TG, HDL, CHO and glucose and the activity of AST and ALT enzymes) for 14 wks.' old NZW rabbits did not affected by addition cocktail of enzymes, organic acids and β-probiotic in their diets (P>0.05). The obtained results showed that the experimental treatments did not have (P<0.05) effect on studied blood parameters. The values of studied parameters were in the physiological range of rabbits. Viliene *et al*., (2018) told that the blood parameters of the rabbits received butyric acid, medium chain fatty acids and SC in the composition feeds caused a decreased AST − by 105.30 U/l (P<0.05), ALT – by 33.53 U/l (P>0.05) *vs* control group. In broiler chicks, Dousa *et al.,* (2016) found that blood serum parameters as glucose, TP, ALB, CHO, and TG, at 3rd week of age were (P>0.05) effect by inclusion of probiotics, acidifiers and their combination compare to control.

6. *Economic evaluation:*

Final body weight, length of the growing period and feeding cost are generally among the most important factors involved in achievement of maximum efficiency values of meat production. The relative economic efficiency (REE) of the different formulated diets as affected by different treatments is shown in Table 7. It should be pointed that the Relative economic efficiency values were calculated according to the prevailing market selling price of 1 kg LBW.

Results indicated that feeding weaning rabbits including sodium butyrate and *Saccharomyces cerevisiae* individually or mixture improved slightly the net revenue and reduced the total feed cost. The low total feed cost / rabbit (18.58, 19.35 and 19.46 LE) was observed with rabbits fed the diets (0.3SB, 0.5SB and 0.1SC+0.3SB), respectively. Ezema and Eze (2015) said that cost of rabbit's diet/Kg of live weight gain was cheapest (x69.68) in rabbits fed diet containing 0.12 g yeast/kg diet than control, therefore the optimum economic benefit in this group of rabbits.

The same trends were found in the economic efficiency (4.08, 3.90 and 3.88), respectively. The results indicated that addition sodium butyrate at 0.3g/Kg and 0.1g/Kg of *Saccharomyces cerevisiae* alone or mixture at the same dose improved the REE of diets by 116.9, 111.8 and 110.9%, respectively when compared with the rabbits fed on basal diet without supplementation or including high dose of SB 0.5g/Kg, as well as containing mixture of 0.5SB 0.1SC tend to reduce the REE. In this connect, El-Adawy *et al.,* (2000) recorded the highest economic efficiency value with the addition of 0.1 or 0.2% probiotic or 0.05, 0.1

Table (7): Economical efficiency as affected by dietary treatments.

Items	Treatment groups					
	Cont rol	**0.3 SB**	**0.5 SB**	**0.1 SC**	**0.1 SC +0.3 SB**	**0.1 SC +0.5 SB**
Total average weight gain (Kg)	1.95	2.10	1.93	2.13	2.11	1.93
Price of 1kg body weight	45	45	45	45	45	45
Selling price/rabbit (LE) (A)	87.67	94.41	86.92	95.72	94.86	86.65
Total feed intake (Kg)	4.07	3.86	4.00	4.1	4.03	4.03
Price/kg feed(LE)	4.8	4.82	4.84	4.81	4.83	4.85
Total feed cost/ rabbit (LE) (B)	19.52	18.58	19.35	19.52	19.46	19.53
Net revenue(LE)[1]	68.16	75.83	67.57	76.19	75.40	67.12
Economic efficiency[2]	3.49	4.08	3.49	3.90	3.88	3.44
Relative Econ. Eff.[3]	100	116.9	100	111.8	110.9	98.40

(1) Net revenue = A – B.
(2) Economic efficiency = (A-B/B).
(3) Relative Economic Efficiency= Economic efficiency of treatments other than the control/ Economic efficiency of the control group.

or 0.2% antibiotic. Abdel-Azeem *et al.,* (2009) observed the best net return, percentage of economic efficiency; relative economic efficiency and performance index due to supplementing probiotic on rabbit diets. El-Katcha *et al.*, (2011) recorded that dietary supplementation of probiotic at 0.1 or 0.15 g/kg diet improve economic efficiency by about 64.9% and 49.7% in two different groups.

In conclusion, adding growing rabbits diets with either *Saccharomyces cerevisiae* or sodium butyrate showed ($P<0.05$) improvement of Productive parameters however, the most beneficial effect was observed when both probiotics were combined in diet with 0.3 and 0.5 g sodium butyrate.

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تأثير إضافة *Saccharomyces cerevisiae* و / أو الصوديوم بيوتيرات على أداء النمو والكيمياء الحيوية في الدم في الأرانب النامية.

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أجريت هذه الدراسة لتقييم تأثير الخميرة المجففة الحية (*Saccharomyces cerevisiae*) و الصوديوم بيوتيرات على الأداء الإنتاجي والفسيولوجي لفطام الأرانب النيوزلاندى الأبيض. تم التوزيع العشوائي لعدد 60 أرنب مفطوم إلى ست مجموعات متساوية تم تغذية لمدة ثمانية أسابيع. تم تغذية جميع مجموعات الأرانب على نظام غذائي موحد وكانت المعاملات كالأتي:

(1) الكنترول (العليقة الأساسية).

(2) العليقة الأساسية + 0.3 جم الصوديوم بيوتيرات.

(3) العليقة الأساسية + 0.5 جم الصوديوم بيوتيرات.

(4) العليقة الأساسية + 0.1 جم (*Saccharomyces cerevisiae*).

(5) العليقة الأساسية + 0.1 جم (*Saccharomyces cerevisiae*)+ 0.3 جم الصوديوم بيوتيرات.

(6) العليقة الأساسية + 0.1 جم (*Saccharomyces cerevisiae*)+ 0.5 جم الصوديوم بيوتيرات.

وقد تم اجراء تحليل بيانات الأداء الأنتاجى ، ودرجة الحموضة (PH)، والأمونيا ، وإنتاج الأحماض الدهنية الطيارة (VFA) من محتوى الأعور ، ومعاملات الهضم والقيمة الغذائية ، وتوازن النيتروجين والكيمياء الحيوية في الدم.

وتتلخص النتائج في الأتى :

- إضافة (*Saccharomyces cerevisiae*) و الصوديوم بيوتيرات أدت إلى تحسن معنوي فى وزن الجسم ومعدل الزيادة فى وزن الجسم بالمقارنة بالكنترول.

- إضافة (*Saccharomyces cerevisiae*) بمعدل 0.1 جم أدت إلى تحسن معنوى فى معامل التحويل الغذائي مقارنة بالمجموعات التجريبية الأخرى.
- إضافة خليط من(*Saccharomyces cerevisiae*)و الصوديوم بيوتيرات أو منفردا أدى إلى تحسن معنوى في تركيز ألاحماض الدهنية الطيارة مقارنة بالكنترول.
- إضافة (*Saccharomyces cerevisiae*)بمعدل 0.1 جم وكذلك إضافة الصوديوم بيوتيرات بمعدل 0.3 و0.5 جم أدت إلى تحسن معنوى فى معاملات هضم الغذاء مقارنة بالكنترول.
- إضافة (*Saccharomyces cerevisiae*) بمعدل 0.1 جم وكذلك إضافة الصوديوم بيوتيرات بمعدل 0.3 و0.5 جم أدت إلى تحسن معنوى ملحوظ البروتين الكلى والجلوبيولين في بلازما الدم و كذلك أقل تركيز للكوليسترول والتراي جليسريد و HDL مقارنة بالكنترول.
- إضافة ((*Saccharomyces cerevisiae*) بمعدل 0.1 جم وكذلك إضافة الصوديوم بيوتيرات بمعدل 0.3 و0.5 جم أدت إلى تحسن فى الكفاءة الأقتصادية والعائد مقارنة بالكنترول.

كل هذه النتائج أثبتت أن أرانب الفطام التي تتغذى على العلائق التي تم اضافة خليط من (*Saccharomyces cerevisiae*) و الصوديوم بيوتيرات أدت إلى تحسن الأداء الإنتاجي والكفاءة الاقتصادية.

التوصية: من خلال هذه التجربه فأنه تم التوصل الى ان اضافة (*Saccharomyces cerevisiae*) مع الصوديوم بيوتيرات فى علائق الارانب الناميه اظهرت تحسن معنوى على الاداء الانتاجى للارانب. والتأثير الامثل هو اضافة (*Saccharomyces cerevisiae*) بمعدل 0.1 جم مع كل من المستوى 0.3 و0.5 جرام من الصوديوم بيوتيرات الى علائق الارانب.