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Effect of probiotic supplementation on productive performance of quail chicks.

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Abstract

Six hundred unsexed one day old Japanese quail chicks of a nearly similar live body weight were used in the present study as a trial to improve the productivity of quail chicks applying three probiotic preparations including (pediococcus acidilactici, pediococcus acidilactici plus entrococcus faecium and Bacillus licheniforis plus Bacillus Subtilis) to quail chicks, diet at a level of 0.0, 1.0, 1.5 and 2.0 kg probiotic/ton ration.

The results obtained showed that chicks fed diet supplemented with Bacillus licheniforis plus Bacillus Subtilis had the highest averages of body weight and weight gain compared with different treatment applied. Chicks received 1.5 kg probiotics /ton ration showed the highest averages of body weight and body weight gain at the end of the experimental period followed by chicks received 2 kg/ton, then by those fed diet with 1 kg/ton when compared with the control group. Chicks fed diet supplemented with a mixture of Bacillus licheniforis and Bacillus Subtilis showed the lowest average of feed consumption at all estimated periods compared with those fed pediococcus alone or pediococcus plus entrococcus. The lowest average of feed consumption was observed when Bacillus licheniforis plus Bacillus Subtilis was interacted with either 1.5 or 2.0 kg/ton ration, respectively. Supplementing diet with Bacillus licheniforis plus Bacillus Subtilis had significantly the better efficiency of feed utilization during the whole experimental period followed by those fed diet with pediococcus plus entrococcus and pediococcus alone, respectively. Chicks fed diet supplemented with Bacillus licheniforis plus Bacillus Subtilis had the better performance index and economical efficiency followed by those fed diet with pediococcus plus entrococcus and then by those fed pediococcus alon. In general all levels of feed additives applied had higher performance index and economical efficiency values compared to controls. The higher economical efficiency and performance index values were observed when Bacillus licheniforis plus Bacillus Subtilis was interacted with either 1.5 or 2 kg/ton ration. The lowest average of mortality rate was observed in chicks received 1.5 kg probiotics per ton diet (3.88%) followed by those fed 2 kg/ton (4.99%), then by 1 kg/ton (5.55%)compared to control group(13.33%). Bacillus licheniforis plus Bacillus Subtilis at a level of 1.5 and 2.0 kg ton/ ration seemed to be adequate to achieve the favorable results and could be recommended from the economic point of view.

Key words: "Quail, Probiotic, Body weight, Feed consumption, Feed conversion, Economic efficiency and Mortality"

Introduction

Probiotic microorganisms are inherently present in fermented food products and according to **Kamiya et al., (2008)** they are live microbial feed supplement which beneficially affect the host animals by improving their microbial balance, **(Fuller, 1989)** Probiotics is a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance, helping newly-hatched chicks colonize normal microflora. The species being currently used in probiotic preparations are varied and many. A probiotic preparation may contain one or several different strains of microorganisms. The micro-organisms used in animal feed are mainly gram postive bacterial strains belonging to the species Lactobacillus, Enterococcus, Pediococcus and Bacillus.

Some other probiotics are microscopic fungi such as strains of yeast belonging to the Saccharomyces cerevisiae species. Direct feed microbial product benefit the host animal by stimulating appetite (Nahashon et al., 1992 and Nahashon et al., 1993), improving intestinal microbial (Fuller, 1989) synthesis vitamins (Coates and Fuller., 1977), stimulate the immune system (Saarela et al., 2000), and stimulate lactic acid (Bailey, 1987). So the Probiotics is become a field of science, medicine, growth promoters and business that is growing rapidly.Addition of either pure lactobacillus cultures or mixtures of lactobacilli and other bacteria to poultry diets has produced variable results.The present trial was aimed to study the effect of dietary supplementation of probiotics on productive traits of Japanes quail.

Materials and methods

The present study was carried out at the Poultry Research Farm, Department of Animal Production, Faculty of Agriculture, Benha University. A total number of 600 unsexed one day old Japanese quail chicks of nearly similar live body weights were used in this study. Birds were weighed at hatch and leg banded. All chicks were kept under similar, standard hygienic and environmental condition. Brooding cages with gas heaters were used for brooding chicks. Brooding temperature was maintained at 37^{o}c during the first five days of chick' s age then decreased by 2^{o}c weekly until the end of brooding period. Chicks were vaccinated against Newcastle disease virus. No drugs or antibiotics were used in these experiments. Feed and water were offered ad-libitum. The basal diet (Table 1) was formulated according to the recommended requirements of **NRC, (1994).** Chicks were randomly divided into three groups each of 180 chicks each. Birds of the first, second and third groups were supplemented with *Pediococcs acidilactici; Pediococcs acidilactici* plus *Enterococcus faecium (M74)* and *Bacillus licheniforis* plus *Bacillus Subtilis*, respectively. Each group was then subdivided into three subgroups of 60 chicks each. They were treated with the previously mentioned probiotics at dose of 1.0, 1.5 and 2.0 kg probiotic per ton ration, respectively. Birds of the 10th group was considered as control and fed basal diet without any supplementation.

Live body weight and feed consumption were weekly recorded and body weight gain and feed conversion were then calculated .Performance index was calculated according to **North (1981).**

$$\text{Performance index (\%)} = \frac{\text{Live body weight (kg)}}{\text{Feed conversion X 100}}$$

The economical efficiency (EE) was calculated according to the following equation:

EE= {(price of kg weight gain) – (feed cost/kg gain)/ feed cost/ kg gain)}.

Percentage of mortality was calculated by subtreating the number of live birds at the end of experiment from the inithial total number according to the following formula:

Mortality rate (%) = {(I-E) / I} x 100

Whereas:

I=Initial number of birds

E=Number of live birds at the end of the experimental period

Data were statistically analyzed using general linear models procedures of **SAS (1996)**.

The statistical model used was:

$$X_{ijk} = \mu + T_i + L_j + TL_{ij} + e_{ijk}$$

Where;

μ = overall mean

Ti = the effect of the ith treatment applied

Lj = the effect of jth level of probiotics

TLij = the effect of the interaction between the ith treatment and the jth levels of probiotics

eijk = the effect of random residual effect.

Table 1. Composition and calculated analysis of basal diet.

Ingredients	%
Yellow corn	56.00
Soybean meal (44%)	27.90
Corn gluten (60%)	12.00
di-calcium phosphate	1.70
Calcium carbonate	1.35
Common salt	0.25
Hy-mix broiler premix*	0.30
DL.methionine	0.20
Lysine	0.30
Calculated analysis	
ME(kcal/kg)	2948.3
CP (%)	24.39
calcium	0.97
Available phosphorus (%)	0.45

*Each 2.5 kg of vitamins and minerals mixture contains:12000.000 IU vitamin A acetate; 2000.000 IU vitamin D3;10.000 mg vitamin E acetate; 2000 mg vitamin K3; 100 mg vitamin B1; 4000 mg vitamin B2; 1500 mg vitamin B6; 10 mg vitamin B12; 10.000 mg pantothenic acid; 20.000 mg Nicotinic acid; 1000 mg Folic acid; 50 mg Biotin; 500.000 mg chorine; 10.000 mg Copper; 1000 mg Iodine; 300.00 mg Iron; 55.000 mg Manganese; 55.000 mg Zinc ,and 100 mg Selenium.

Results and discussion

1. Body weight

Data concerning the body weight of experimental chicks along the whole period of the study are presented in Table 2. Obtained data showed significant variation in average body weight due to treatments applied at the 2nd ($p<0.05$) and 6th ($p<0.001$) weeks of age. Feeding birds diet supplemented with pediococcus strains as well as those of control group recorded the lowest average of body weight at all periods of estimation. However, birds fed diet supplemented with Bacillus licheniforis plus Bacillus Subtilis had the highest average of body weight that mounted 50.09, 114.74 and 199.20 g at 2nd, 4th and 6th weeks of age, respectively. Chicks treated with pediococcus plus entrococcus recorded intermediate average of body weight estimated at the corresponding intervals. This may lead to conclude that mixture of two probiotics preparation showed efficient effect on improving body weight performance. This may be due to the biological effect of the two microbial preparations towards enhancement of body weight average as birds grew older.

Average body weight increased as the levels of dietary probiotics supplementation increased up to the level of 1.5kg/ton ration. Chicks received 1.5 kg probiotics /ton ration showed the highest average of body weight (201.81g) at the end of the experimental period followed be chicks received 2 kg/ton (201.18 g) then by those fed diet with 1 kg/ton (198.16g) when compared with the control group (183.79 g). This may lead to state that the level of supplementation added to quail diet must not exceed 1.5 kg/ton ration. The interaction effect between treatments applied and the levels of dietary supplementation was found to be of highly significant effect ($p<0.001$) on average body weight at the end of the experimental period only. The highest average of body weight was observed when Bacillus licheniforis plus Bacillus Subtilis interacted with 1.5 and 2.0 kg/ton ration,respectively. The benefit effect of probiotics on live body weight may be attributed to the improvement that may occur in nutrients absorption and suppression of harmful bacteria, maintenance of normal intestinal microflora, increase in digestive enzyme activity, ammonia depletion, inhibition of growth of the entero-pathpgens in the gut by decreasing the intestinal ph and efficient utilization of nutrients by the beneficial microbes. (Fuller, 1989 and Jin et al., 2000).Results obtained go in harmony with the finding of Mountzouris et al., (2007) who reported similar growth-promoting effects among birds fed avilamycin and birds administered a multi-species probiotic product (containing Lactobacillus reuteri, Enterococcus faecium, Bifidobacterium animalis, Pediococcus acidilactici, Lactobacillus salivarius) in feed and water. Also Abaza et al., (2008) reported that, applying either black seed oil, saccharomyce cervisiae or Bacillus licheniforis and Bacillus Subtilis to broiler diet increased body weight at 12 weeks of age as compared with controls.

Table 2. Least squares means and standard error (LSM ± S.E) for body weight (g) of birds of different experimental groups as affected by dietary supplements applied**.**

Independent variables and interaction		**Body weight (g) at**			
		Hatch	**2nd week**	**4th week**	**6th week**
treatments (T)	(T1)	7.47± 0.29	49.67±0.29[b]	114.07±0.29	192.39±0.29[c]
	(T2)	7.45± 0.29	50.04±0.29[b]	114.35±0.29	197.11±0.29[b]
	(T3)	7.44± 0.29	50.09±0.29[a]	114.74±0.29	199.20±0.29[a]
levels (L)	L0(Control)	7.44± 0.33	48.19±0.33[c]	111.29±0.33[b]	183.79±0.33[c]
	L1(1.0kg/ton)	7.45± 0.33	50.02±0.33[b]	115.08±0.33[a]	198.16±0.33[b]
	L2(1.5 kg/ton)	7.49± 0.33	51.64±0.33[a]	111.80±0.33[a]	201.81±0.33[a]
	L3(2.0kg/ton)	7.43± 0.33	51.01±0.33[a]	115.37±0.33[a]	201.18±0.33[a]
Interaction (**T× L**)	T1× L0	7.44±0.33	48.19±0.33	111.29±0.33	183.79±0.33[c]
	T1× L1	7.47±0.58	49.57±0.58	114.66±0.58	195.78±0.58[e]
	T1× L2	7.52±0.58	50.78±0.58	115.26±0.58	195.60±0.58[e]
	T1× L3	7.45±0.58	50.52±0.58	115.59±0.58	194.40±0.58[e]
	T2× L0	7.44±0.33	48.19±0.33	111.29±0.33	183.79±0.33[c]
	T2× L1	7.42±0.58	49.22±0.58	115.17±0.58	198.43±0.58[d]
	T2× L2	7.50±0.58	51.72±0.58	115.86±0.58	202.93±0.58[b]
	T2× L3	7.43±0.58	51.03±0.58	115.09±0.58	203.28±0.58[b]
	T3× L0	7.44±0.33	48.19±0.33	111.29±0.33	183.79±0.33[c]
	T3× L1	7.44±0.58	51.29±0.58	115.43±0.58	200.26±0.58[a]
	T3× L2	7.46±0.58	52.41±0.58	116.29±0.58	206.90±0.58[a]
	T3× L3	7.42±0.58	51.72±0.58	115.95±0.58	205.86±0.58[c]

(A ,b ,c ,…) Means within the same letter in each column are not significantly different.

(**T1**)*Pediococcus*

(**T2**) *pediococcus* **plus** *entrococcus*

(**T3**) *Bacillus licheniforis* **plus** *Bacillus Subtilis*

2. Body weight gain

Data obtained (Table 3) revealed highly significant variation in average body weight gain due to treatments applied. It was quite true at all intervals of estimation except at the period from (2-4) weeks of age only. On the other hand, the higher body weight gain was observed during the whole period (0-6) in the group of chicks fed *Bacillus licheniforis* plus *Bacillus Subtilis* (191.57g) when compared with those fed *pediococcus* plus *entrococcus* (189.77g) or *pediococcus* (184.93g) (Table 3). However, no significant variation was found in average body weight gain in chicks fed *pediococcus* plus *entrococcus* and those fed *Bacillus licheniforis* plus *Bacillus Subtilis* during the same period. Generally, applying probiotics at different levels increased average body weight gain during all periods of estimation as well as during the whole experimental period compared to the controls. Quail chicks fed diet with 1.5 kg/ton ration showed the highest average of body weight gain (194.18g) followed by those fed 2 kg/ton (193.84g) and 1 kg/ton (190.71g). On the other hand, control group showed the lowest average of body weight gain (176.35g).Average body weight gain increased as the level of dietary supplements increased up to the level of 1.5 kg / ton ration (Table 3) then decreased with insignificant magnitude when supplementation was increased up to 2.0 kg/ton ration. This mean that the biological effect of dietary supplementation applied reach its peak up to the level of 1.5 kg /ton ration then the rate decreased as the level of dietary probiotic increased. These results are in agreement with those obtained by **Jin et al., (1996)** who reported that, using

Bacillus Subtilis as probiotics in the experimental diet increased weight gain as compared to untreated birds. The same results were reported by **Asmita et al., (2001); Tarun,(2008) ; Chimote et al.,(2009) and Al-homidan et al., (2010)** who found that, supplementation of probiotic(*Bacillus .sp, Lactobacillus and Pediococcus*) and enzymes significantly ($P<0.01$) improved live body weights and weight gain as compared to control quails . In contrast, **Namra et al., (2005) and Willis et al., (2007),** reported that using these additives in the broiler ration had no significant effects on growth performance.

3. Feed consumption

Treatments applied were found to have highly significant effect ($p<0.001$) on average of feed consumption during all experimental periods except at the period from (4-6) weeks of age (Table 4).Chicks fed diet supplemented with a mixture of *Bacillus licheniforis* plus *Bacillus Subtilis* showed the lowest average of feed consumption at all estimated periods compared with those fed *Pediococcus* alone or *Pediococcus* plus *entrococcus* (Table 4). Average of feed consumption decreased as the level of feed supplements increased (Table 4). Birds fed diet supplemented with probiotics at a level of 2 kg per ton ration showed the lowest average of feed consumption when compared with controls or those of the other two levels applied (Table, 4). Significant variation was also observed due to the interaction effect between treatments and the level of feed supplementation applied at all experimental intervals**.** The lowest average of feed consumption was observed when *Bacillus licheniforis* plus *Bacillus Subtilis* was interacted with either 1.5 or 2.0 kg/ton ration, respectively. Results obtained agree with those reported by **Santoso et al., (2005) and Hideya and Taku, (2004)** who cleared that diet supplemented with either *Bacillus Subtilis* or *Bacillus cereus toyoi* decreased feed intake. The same findings were obtained by **Asmita *et al.*, (2001)** and **Awad** et al., **(2009)** who stated that feed consumption decreased as result of supplementing birds feed with probiotics preparation. The reduction in feed consumption and improvement in growth performance in treated quail chicks may be attributed to enhancement in the metabolic efficiency and feed utilization rather than to the amount of feed consumed by the chicks.

4. Feed conversion

Obtained data tabulated in (Table 5) showed that highly significant variation in feed conversion was detected due to the various dietary probiotics applied. Supplementing diet with *Bacillus licheniforis* plus *Bacillus Subtilis* had the better efficiency on feed utilization during the period from(0-2) weeks (1.74),(2-4) weeks (3.03) and(4-6) weeks (3.62 g feed/g gain) as well as during the whole experimental period: (0-6)weeks (2.99 g feed/g gain) followed by those fed diet with *pediococcus* plus *entrococcus* 1.86, 3.05,3.69 and 3.06 g feed /g gain, respectively and when fed *pediococcus* alon 1.89, 3.09, 3.87 and 3.14 g feed /g gain, respectively(Table 5).

It may be concluded that the biological action of the feed supplements applied lowered the amount of feed consumed and increased the average body weight gain with the same rate in all treatments applied. In addition, all dietary supplements act on the metabolic pathway by increasing the enzymatic activity that may improve the feed utilization **Yanbo and Qing (2010)** found significant improvement in feed conversion ($P < 0.05$) due to probiotics applied in birds diet during the experimental period. They attributed this improvement to the higher digestive enzyme activity (protease, amylase and lipase) that may occur. Feed conversion significantly improved as the level of dietary supplementation increased. Chick's received 2 kg/ton ration recorded the better feed efficiency (2.93 g feed /g gain) compared to those received 1.5 kg/ton ration (2.95 g feed /g gain), 1 kg/ton (3.04) and controls (3.34 g feed/g gain) during the whole period of estimation (Table 5). This may lead to recommend applying this level if good feed utilization was aimed. On the other hand, highly significant effect ($P<0.001$) was found due to the interaction between treatments and levels of feed supplementation all over the experimental period. However, this interaction effect differed according to treatments applied. Applying *Bacillus licheniforis* plus *Bacillus Subtilis* at a level of 1.5 or 2.0 kg/ton ration, respectively followed by pediococcus plus *entrococcus* when applied with a level of 2 kg/ton ration were mostly the most favorable level that may be recommended. However, applying *Bacillus licheniforis* plus *Bacillus Subtilis* ration at a level of 1.5 kg/ton was found to be better (Table 5). The positive responses to probiotic may be attributed to more ideal intestinal flora effect that improved feed conversion. Obtained results agree with those of **Sanders and Veld (1999)** who suggested that the use of multistrain and multispecies probiotics might be more effective than monostrain probiotics. **Silva *et al.*, (2000) ;Pelicano *et al.*, (2005); Franco *et al.*, (2005) and Chafai et al., (2007**) demonstrated an improvement in feed conversion in chickens which fed on probiotics such as *Bacillus subtilis, Lactobacillus acidophilus, Saccharomyces cerevisiae , P. acidilactici and Enterococcu*s *faecium..*

Table 3. Least squares means and standard error (LSM ± S.E) for body weight gain (g) of birds of different experimental groups as affected by dietary supplements applied.

Independent variables and interaction		Body weight gain (g) at (0-2) weeks	(2-4) weeks	(4-6) weeks	(0-6) weeks
treatments (T)	(T1)	42.30±0.28^{b}	64.31±0.28	78.32±0.28^{c}	184.93±0.28^{b}
	(T2)	42.59±0.28^{b}	64.42±0.28	82.75±0.28^{b}	189.77±0.28^{a}
	(T3)	43.46±0.28^{a}	63.65±0.28	84.64±0.28^{a}	191.57±0.28^{a}
levels (L)	L0(Control)	40.75±0.33^{c}	63.10±0.33^{c}	72.50±0.33^{c}	176.35±0.33^{c}
	L1(1.0kg/ton)	42.58±0.33^{b}	65.06±0.33^{a}	83.07±0.33^{b}	190.71±0.33^{b}
	L2(1.5 kg/ton)	44.21±0.33^{a}	63.92±0.33^{bc}	86.00±0.33^{a}	194.18±0.33^{a}
	L3(2.0kg/ton)	43.60±0.33^{a}	64.43±0.33^{ba}	85.80±0.33^{a}	193.84±0.33^{a}
Interaction (T× L)	T1× L0	40.75±0.33	63.10±0.33	72.50±0.33^{f}	176.35±0.33^{c}
	T1× L1	40.10 ±0.58	65.09±0.58	81.12±0.58^{d}	188.31±0.58^{cd}
	T1× L2	43.36 ±0.58	64.48±0.58	80.35±0.58^{de}	188.19±0.58^{cd}
	T1× L3	43.00 ±0.58	64.57±0.58	79.31±0.58^{e}	186.88±0.58^{d}
	T2× L0	40.75±0.33	63.10±0.33	72.50±0.33^{f}	176.35±0.33^{c}
	T2× L1	41.78±0.58	65.95±0.58	83.26±0.58^{c}	190.99±0.58^{bcd}
	T2× L2	44.30±0.58	64.14±0.58	87.07±0.58^{b}	195.51±0.58^{ab}
	T2× L3	43.53±0.58	64.52±0.58	88.19±0.58^{b}	196.24±0.58^{ab}
	T3× L0	40.75±0.33	63.10±0.33	72.50±0.33^{f}	176.35±0.33^{c}
	T3× L1	43.86±0.58	64.14±0.58	84.83±0.58^{c}	192.83±0.58^{bc}
	T3× L2	44.97±0.58	63.14±0.58	90.60±0.58^{a}	198.71±0.58^{a}
	T3× L3	44.27±0.58	64.22±0.58	89.91±0.58^{a}	198.41±0.58^{a}

(A ,b ,c ,…) Means within the same letter in each column are not significantly different
(**T1**)*Pediococcus*
(**T2**) *pediococcus* **plus** *entrococcus*
(**T3**) *Bacillus licheniforis* **plus** *Bacillus Subtilis*

Table 4. Least squares means and standard error (LSM ± S.E) for feed consumption (g) of birds of different experimental groups as affected by dietary supplements applied.

Independent variables and interaction		Average feed consumption (g/bird/day) at (0-2) weeks	(2-4) weeks	(4-6) weeks	(0-6)weeks
treatments (T)	(T1)	5.72±0.04^{a}	14.22±0.04^{a}	21.59±0.04	581.76±1.73^{a}
	(T2)	5.66±0.04^{a}	14.05±0.04^{b}	21.67±0.04	579.46±1.73^{a}
	(T3)	5.41±0.04^{b}	13.80±0.04^{c}	21.64±0.04	572.08±1.73^{b}
levels (L)	L0(Control)	5.71±0.04^{a}	14.32±0.04^{a}	22.05±0.04^{a}	589.20±2.00^{a}
	L1(1.0kg/ton)	5.61±0.04^{ab}	14.13±0.04^{b}	21.66±0.04^{b}	579.77±2.00^{b}
	L2(1.5 kg/ton)	5.54±0.04^{b}	13.91±0.04^{c}	21.47±0.04^{c}	573.12±2.00^{c}
	L3(2.0kg/ton)	5.53±0.04^{b}	13.74±0.04^{d}	21.36±0.04^{c}	568.97±2.00^{c}
Interaction (T× L)	T1× L0	5.71±0.08^{ab}	14.32±0.08^{a}	22.05±0.08^{a}	589.20±3.46^{a}
	T1× L1	5.91±0.08^{a}	14.39±0.08^{a}	21.43±0.08^{cd}	584.32±3.46^{ab}
	T1× L2	5.7±10.08^{ab}	14.48±0.08^{a}	21.49±30.08^{cd}	582.72±3.46^{ab}
	T1× L3	5.57±0.08^{bc}	13.71±0.08^{b}	21.48±0.08^{c}	570.80±3.46^{cd}
	T2× L0	5.71±0.08^{ab}	14.32±0.08^{a}	22.05±0.08^{a}	589.20±3.46^{a}
	T2× L1	5.57±0.08^{bc}	14.28±0.08^{a}	21.57±0.08^{bc}	580.00±3.46^{abc}
	T2× L2	5.65±0.08a^{b}	13.90±0.08^{b}	21.74±0.08^{b}	578.20±3.46^{abc}
	T2× L3	5.71±0.08a^{b}	13.71±0.08^{b}	21.31±0.08^{cd}	570.44±3.46^{cd}
	T3× L0	5.71±0.08^{ab}	14.32±0.08^{a}	22.05±0.08^{a}	589.20±3.46^{a}
	T3× L1	5.35±0.08^{cd}	13.71±0.08^{b}	22.00±0.08^{a}	575.00±3.46^{bcd}
	T3× L2	5.25±0.08^{d}	13.37±0.08^{c}	21.26±0.08^{d}	558.44±3.46e
	T3× L3	5.31±0.08^{cd}	13.80±0.08^{d}	21.28±0.08^{d}	565.68±3.46^{ed}

(A ,b ,c ,…) Means within the same letter in each column are not significantly different
(**T1**)*Pediococcus*
(**T2**) *pediococcus* **plus** *entrococcus*
(**T3**) *Bacillus licheniforis* **plus** *Bacillus Subtilis*

Table 5. Least squares means and standard error (LSM ± S.E) for feed conversion of birds of different experimental groups as affected by dietary supplements applied.

Independent variables and interaction		Average feed conversion (g feed / g gain) at			
		(0-2) weeks	**(2-4) weeks**	**(4-6) weeks**	**(0-6) weeks**
treatments (T)	(T1)	1.89±0.01[a]	3.09±0.01[a]	3.87±0.01[a]	3.14±0.01[a]
	(T2)	1.86±0.01[b]	3.05±0.01[b]	3.69±0.01[b]	3.06±0.01[b]
	(T3)	1.74±0.01[c]	3.03±0.01[c]	3.62±0.01[c]	2.99±0.01[c]
levels (L)	L0(Control)	1.96±0.01[a]	3.18±0.01[a]	4.26±0.01[a]	3.34±0.01[a]
	L1(1.0kg/ton)	1.84±0.01[b]	3.04±0.01[b]	3.65±0.01[b]	3.04±0.01[b]
	L2(1.5 kg/ton)	1.75±0.01[c]	3.04±0.01[b]	3.50±0.01[c]	2.95±0.01[c]
	L3(2.0kg/ton)	1.77±0.01[d]	2.98±0.01[d]	3.49±0.01[c]	2.93±0.01[d]
Interaction **(TX L)**	T1× L0	1.96±0.01[a]	3.18±0.01[a]	4.26±0.01[a]	3.34±0.01[a]
	T1× L1	1.97±0.01[a]	3.09±0.01[c]	3.70±0.01[c]	3.10±0.01[b]
	T1× L2	1.84±0.01[c]	3.14±0.01[b]	3.73±0.01[c]	3.09±0.01[b]
	T1× L3	1.81±0.01[d]	2.97±0.01[f]	3.79±0.01[b]	3.05±0.01[c]
	T2× L0	1.96±0.01[a]	3.18±0.01[a]	4.26±0.01[a]	3.34±0.01[a]
	T2× L1	1.86±0.01[b]	3.03±0.01[d]	3.63±0.01[d]	3.03±0.01[c]
	T2× L2	1.78±0.01[e]	3.03±0.01[d]	3.49±0.01[e]	2.95±0.01[d]
	T2× L3	1.83±0.01[c]	2.97±0.01[f]	3.38±0.01[f]	2.90±0.01[e]
	T3× L0	1.96±0.01[a]	3.18±0.01[a]	4.26±0.01[a]	3.34±0.01[a]
	T3× L1	1.71±0.01[f]	2.99±0.01[ef]	3.63±0.01[d]	2.98±0.01[d]
	T3× L2	1.63±0.01[h]	2.96±0.01[f]	3.28±0.01[g]	2.81±0.01[g]
	T3× L3	1.68±0.01[g]	3.01±0.01[ed]	3.31±0.01[g]	2.85±0.01[f]

(A, b, c,…) Means within the same letter in each column are not significantly different.
(**T1**)*Pediococcus*
(**T2**) *pediococcus* **plus** *entrococcus*
(**T3**) *Bacillus licheniforis* **plus** *Bacillus Subtilis*

5. Performance index

Results obtained that listed in Table 6 showed that treatments applied had no significant effect on the value of performance index at the first 2 weeks of age, however, highly significant variation due to treatments applied was observed when estimated at 2-4 and 4-6 weeks and during the whole experimental period 0-6 weeks.Supplementing diet with *Bacillus licheniforis* plus *Bacillus Subtilis* had the better performance index during the period from 0-2weeks (4.27%), 2-4 weeks (16.79%), 4-6 weeks (32.07%) as well as during the whole experimental period 0-6weeks (66.99%) followed by those fed diet with *pediococcus* plus *entrococcus* 4.00, 16.40, 31.26 and 64.72%, respectively and then by those fed *pediococcus* alon 3.93, 16.08, 29.58and 61.22%, respectively(Table 6).On the other hand, level of dietary supplementation showed highly significant effect ($p<0.001$) on performance index during the period from (2-4), (4-6) and (0-6) weeks of age. In general all levels of feed additives had the superiority of the performance index values compared to controls (Table 6). Performance index increased in its magnitude as the level of dietary supplements increased reaching its maximum effect when birds fed diet supplemented with 2.0 kg probiotic /ton ration. Significant variation was detected due to the interaction effect between treatments applied and levels of dietary supplementation at all periods of estimation, except at the period from 0-2 weeks of age only. This effect differed within treatments applied. The higher values of performance index were found in birds fed diet supplemented with *Bacillus licheniforis* plus *Bacillus Subtilis* when interacted with either 1.5 or 2.0 kg/ton ration. Obtained results agree with those obtained by **El-Gendi et al., (2000); Salim (2004); Namra et al., (2005); Awad et al., (2009)** and **Hegab, (2010)** who concluded that synbiotic or probiotic displayed a greater efficacy as growth promoters for broilers.

6. Economical efficiency

From the results obtained in (Table 7), it could be concluded that, dietary probiotic supplementation applied showed highly significant effect on the value of economical efficiency. This may be attributed to the significant differences that were found in body weight gain and feed conversion. Supplementeing birds diet with *Bacillus licheniforis* plus *Bacillus Subtilis* had the highest values of economical efficiency (115.33%) compared with those supplemented with *pediococcus* plus *Entrococcus* treatment (112.50%) or *pediococcus* alone (108.33%).Highly significant variation ($p<0.001$) was found in the economical efficiency due to the level of feed additives applied. Generally all levels of feed additives had the superiority of the economical efficiency values compared to control group.

Table 6. Least squares means and standard error (LSM ± S.E) for performance index of birds of different experimental groups as affected by dietary supplements applied.

Independent variables and interaction		Performance index(%) at			
		0-2 Weeks	2-4 Weeks	4-6 Weeks	0-6 Weeks
treatments (T)	**(T1)**	3.93± 0.15	16.08 ±0.12[b]	29.58 ±0.12[c]	61.22 ±0.19[c]
	(T2)	4.00± 0.15	16.40 ±0.12[b]	31.26± 0.12[b]	64.72 ±0.19[b]
	(T3)	4.27± 0.15	16.79±0.12[a]	32.07± 0.12[a]	66.99± 0.19[a]
levels (L)	**L0(Control)**	3.78± 0.18	15.17 ±0.31[c]	26.13± 0.14[c]	55.00± 0.22[c]
	L1(1.0kg/ton)	4.04± 0.18	16.45 ±0.31[b]	31.51± 0.14[b]	65.19± 0.22[b]
	L2(1.5 kg/ton)	4.27 ±0.18	16.96± 0.13[a]	33.13± 0.14[a]	68.47± 0.22[a]
	L3(2.0kg/ton)	4.29 ±0.18	17.11± 0.31[a]	33.15 ±0.14[a]	68.59± 0.22[a]
Interaction (T× L)	**T1× L0**	3.78± 0.31	15.17± 0.24[c]	26.13 ±0.25[f]	55.00± 0.39[h]
	T1× L1	3.79± 0.31	16.01 ±0.24[a]	31.00 ±0.25[e]	63.09± 0.39[g]
	T1× L2	4.07± 0.31	16.15± 0.24[b]	30.26± 0.25[e]	63.17± 0.39[g]
	T1× L3	4.10± 0.31	16.99± 0.24[a]	30.34 ±0.25[e]	63.64 ±0.39[a]
	T2× L0	3.79± 0.31	15.17 ±0.24[c]	26.13 ±0.25[f]	55.00± 0.39[h]
	T2× L1	3.97 ±0.31	16.23 ±0.24[b]	31.75 ±0.25[d]	65.34± 0.39[f]
	T2× L2	4.10 ±0.31	17.05± 0.24[a]	33.14± 0.25[c]	68.62± 0.39[d]
	T2× L3	4.14± 0.31	17.15 ±0.24[a]	34.01± 0.25[b]	69.93± 0.39[c]
	T3× L0	3.79 ±0.31	15.17 ±0.24[c]	26.13± 0.25 [f]	55.00± 0.39[h]
	T3× L1	4.35 ±0.31	17.13 ±0.24[c]	31.79 ±0.25[d]	67.15± 0.39[e]
	T3× L2	4.55 ±0.31	17.68± 0.24[a]	35.40± 0.25[a]	73.62± 0.39[a]
	T3× L3	4.42± 0.31	17.19 ±0.24[a]	34.98± 0.25[a]	72.20± 0.39[b]

(A ,b ,c ,…) Means within the same letter in each column are not significantly different.
(**T1**)*Pediococcus*
(**T2**) *pediococcus* **plus** *entrococcus*
(**T3**) *Bacillus licheniforis* **plus** *Bacillus Subtilis*

Table 7. Least squares means and standard error (LSM ± S.E) for economical efficiency (%) of birds of different experimental groups as affected by dietary supplements applied.

Independent variables and interaction		Economical efficiency(%) at 6 weeks
treatments (T)	(T1)	108.33±1.47[b]
	(T2)	112.50±1.47[ab]
	(T3)	115.33±1.47[a]
levels (L)	L0(Control)	100.00±1.70[b]
	L1(1.0kg/ton)	113.11±1.70[a]
	L2(1.5 kg/ton)	117.77±1.70[a]
	L3(2.0kg/ton)	117.33±1.70[a]
Interaction (T× L)	T1× L0	100.00±1.70
	T1× L1	111.00±2.94
	T1× L2	111.33±2.94
	T1× L3	111.00±2.94
	T2× L0	100.00±1.70
	T2× L1	112.00±2.94
	T2× L2	118.66±2.94
	T2× L3	119.33±2.94
	T3× L0	100.00±1.70
	T3× L1	116.33±2.94
	T3× L2	123.33±2.94
	T3× L3	121.66±2.94

(A ,b ,c ,…) Means within the same letter in each column are not significantly different
(**T1**)*Pediococcus*
(**T2**) *pediococcus* **plus** *entrococcus*
(**T3**) *Bacillus licheniforis* **plus** *Bacillus Subtilis*

Economical efficiency value increased as the level of dietary supplementation increased reaching its maximum value at 1.5 kg probiotic/ton ration (117.77%) then it decreased with increasing the level of dietary supplementation.On the other hand, no significant variation in the average of economical efficiency due to the interaction effect between treatments and level of dietary supplementations. The higher economical efficiency values were observed when *Bacillus licheniforis* plus *Bacillus Subtilis* applied at the level of either 2 or 3 (1.5 or 2 kg/ton ration), respectively. This improvement could be attributed to improving the feed utilization or reducing the amount of feed required for unit of body weight gain.Obtained results agree with those found by **Abdel-Azeem et al., (2001); Anjum et al., (2005); Ghazalah, et al, (2006); Abaza et al., (2008), Tollba and Mahmoud (2009) and Hegab (2010)** who all reported that , probiotic improved economic efficiency in broilers and quail diets.

7. Mortality rate percentage

Inspection of data (Table 8) revealed that, highly significant variation ($p<0.001$) in mortality rate during the whole experimental period was found due to treatments applied.Chicks received *pediococcus* plus *entrococcus* strains recorded the lowest average of mortality rate (6.24 %) as compared with either *Bacillus licheniforis* plus *Bacillus Subtilis* (6.66%) or *pediococcus* alone (7.91%). Highly significant effect was observed in the average mortality rate due to the level of feed supplementation. All levels applied lowered average of mortality rate. The lowest average of mortality rate was observed in chicks received probiotics at a level of 1.5 kg probiotics per ton diet (3.88%) followed by those fed 2 kg/ton (4.99%) then by 1 kg/ton (5.55%).No significant effect on average mortality rate was found due to the interaction between treatments and level of dietary supplementations. The lowest average of mortality rate was observed when *Bacillus licheniforis* plus *Bacillus Subtilis* was applied at a level of either 1.5 or 2.0 kg/ton ration, respectively follwed by pediococcus plus *entrococcus* when applied with a level of 2 kg/ton ration, respectively. The significant decrease in mortality percentage due to treatment could be attributed to a reduction in colonization of enterpathogens in the gastrointestinal tract. Studies of **Drake *et al*., (2003) and Higgins *et al*., (2007)** demonstrated that administration of probiotic culture for 1 or 3 consecutive days was able to reduce *Salmonella* colonization in one day-old broiler chicks**.**

Conclusion

Bacillus licheniformis plus *bacillus subtilis* at alevel of 1.5 and 2.0 kg ton\ ration seemed to achieve the favorable results and bing recommended from the economic point of view.

Table 8. Least squares means and standard error (LSM ± S.E) for mortality rate (%) of birds of different experimental groups as affected by dietary supplements applied.

Independent variables and interaction		**Mortality rate(%) at 6 weeks**
treatments (T)	(T1)	7.91±0.29[a]
	T2)	6.24±0.29[b]
	(T3)	6.66±0.29[b]
levels (L)	L0(Control)	13.33±0.33[a]
	L1(1.0kg/ton)	5.55±0.33[b]
	L2(1.5 kg/ton)	3.88±0.33[c]
	L3(2.0kg/ton)	4.99±0.33[b]
Interaction (**T× L**)	T1× L0	13.33±0.33
	T1× L1	6.66±0.58
	T1× L2	5.00±0.58
	T1× L3	6.66±0.58
	T2× L0	13.33±0.33
	T2× L1	5.00±0.58
	T2× L2	3.33±0.58
	T2× L3	3.33±0.58
	T3× L0	13.33±0.33
	T3× L1	5.00±0.58
	T3× L2	3.33±0.58
	T3× L3	5.00±0.58

(A, b, c) Means within the same letter in each column are not significantly different

(**T1**)*Pediococcus*

(**T2)** *pediococcus* **plus** *entrococcus*

(**T3**) *Bacillus licheniforis* **plus** *Bacillus Subtilis*

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"تأثير اضافة البروبيوتيك على الاداء الانتاجى لكتاكيت السمان"

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الملخص العربى

استخدم فى هذه الدراسة عدد 600 كتكوت سمان يابانى عمر يوم متماثلة فى الوزن تقريبا بهدف دراسه مدى امكان تحسين الاداء الانتاجى للسمان اليابانى نتيجة المعاملة بثلاث مركبات مختلفة من مستحضرات البروبيوتك وهى بيديوكوكس اسيديلاكتيسي (المعاملة الاولى), بيديوكوكس اسيديلاكتيسي+ انتيروكوكس فاسيم (المعاملة الثانية), باسيلاس ستيلاس + باسيلاس ليشينيفورميس(المعاملة الثالثة) وذلك بمستويات صفر, 1 , 1.5 , 2 كجم بروبيوتك / طن عليقة.

اظهرت النتائج المتحصل عليها ان الكتاكيت التى تم تغذيتها على علائق مضاف اليها باسيلاس ستيلاس + باسيلاس ليشينيفورميس اظهرت اعلى متوسط لوزن الجسم والزيادة المكتسبه فى وزن الجسم مقارنة بالمعاملات الاخرى بينما اظهرت الكتاكيت المغذاه على 1.5 كجم بروبيوتيك/ طن عليقة اعلى متوسط لوزن الجسم الزيادة المكتسبه فى وزن الجسم عند نهاية التجربة (6 اسابيع) يليها الكتاكيت المغذاه على 2 كجم بروبيوتيك/ طن عليقة ثم تلك المغذاه على 1 كجم بروبيوتيك/ طن عليقة مقارنة بمجموعة الكنترول. اظهرت الكتاكيت المغذاه على عليقة مضاف اليها باسيلاس ستيلاس + باسيلاس ليشينيفورميس اقل متوسط لمعدل استهلاك الغذاء مقارنة بتلك المغذاه على بيديوكوكس اسيديلاكتيسي فقط او تلك المغذاه على بيديوكوكس اسيديلاكتيسي+ انتيروكوكس فاسيم كما ادى التداخل بين المعاملة الثالثة(باسيلاس ستيلاس + باسيلاس ليشينيفورميس) و المستوى 1.5 و 2 كجم بروبيوتيك/ طن الى الحصول على اقل متوسطات لمعدل استهلاك العليقة.اظهرت الكتاكيت المغذاه على علائق مضاف اليها (باسيلاس ستيلاس + باسيلاس ليشينيفورميس) تحسن معنوى فى معدل كفاءة التحويل الغذائى يليها الكتاكيت المغذاه على علائق مضاف اليها بيديوكوكس اسيديلاكتيسي+ انتيروكوكس فاسيم ثم تلك المغذاه على علائق مضاف اليها بيديوكوكس اسيديلاكتيسي فقط .

وعموما ادى اضافة باسيلاس سبتيلاس+ باسيلاس ليشينيفورميس الى علائق كتاكيت السمان الى الحصول على افضل اداء انتاجى وكذلك افضل كفاءة اقتصادية يليها تلك المغذاة على علائق مضاف اليها بيديوكوكس اسيديلاكتيسي+ انتيروكوكس فاسيم ثم المجموعة التى غذيت على علائق مضاف اليها بيديوكوكس اسيديلاكتيسي ومن جهه اخرى لوحظت اقل معدلات لنسبة النفوق فى المجاميع التى تم اضافة البروبيوتك الى علائقها وكان اقل المستويات فى معدل النفوق هو 1.5 كجم بروبيوتك / طن عليقة (3.88 %) يليها المستوى 2 كجم / طن عليقة (4.99%) ثم المستوى 1 كجم / طن عليقة (5.55%). هذا ويمكن التوصيه من وجهة النظر الاقتصاديه باضافة الباسلس ستيلاس+ الباسلس ليشينوفورميس بمعدل 1.5 و2 كجم/ طن عليقة