

ISSN 1682-8356  
ansinet.org/ijps



INTERNATIONAL JOURNAL OF  
**POULTRY SCIENCE**

**ANSI***net*

308 Lasani Town, Sargodha Road, Faisalabad - Pakistan  
Mob: +92 300 3008585, Fax: +92 41 8815544  
E-mail: editorijps@gmail.com

## Probiotic in Quail Nutrition: A Review

Nasrollah Vali

Department of Animal Sciences, Faculty of Agriculture, Islamic Azad University, Shahrekord Branch, Iran

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**Abstract:** The digestive tract must supply the factors necessary for the existence of any micro-organism that finally becomes established. These factors include a favorable temperature, a constant supply of nutrients and essential fluids: In this situation the micro-organisms benefit from the environment and the animal benefits by maintaining a microflora that does not cause any disease state. There are generally two different types of bacterial populations which can become established in the digestive tract. The first is that which exists in close association with the gut epithelium and the second is that which occurs free in the gut lumen. The ideal situation throughout the life of any animal would be to maintain specific numbers of beneficial bacteria in the digestive tract. This would ensure that at all times the animal would have the proper microbial balance. The term "probiotic" has been used to indicate substances or micro-organisms which contribute to an ideal microbial balance. Today probiotics are considered as those viable microorganisms that when administered to man and animal, beneficially affects the host by improving the properties of the indigenous microflora. To maintain the intestinal microflora balance in animals it is important to prevent diseases by controlling the overgrowth of potentially pathogenic bacteria. Although known since a long time, only in the last two decades probiotics have started to receive major attention from researchers, and several studies have been carried out on the effects of probiotics microorganisms, using different formulae and with numerous purposes of preventing or treating diseases.

**Key words:** Coturnix, microflora, nutrition, probiotic, quail

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### INTRODUCTION

In a natural environment the establishment of a microbial population in the digestive tract of all warm blooded animals, soon after birth, is inevitable. The microbial types which first establish, in most cases, are the forerunners of the final organisms which will colonize and persist in the digestive tract throughout the adult life of the animal. It is known that the various types of colonizing bacteria are sensitive to changes which may occur in the digestive tract of the host. The digestive tract must supply the factors necessary for the existence of any micro-organism that finally becomes established. These factors include a favorable temperature, a constant supply of nutrients and essential fluids: In this situation the micro-organisms benefit from the environment and the animal benefits by maintaining a microflora that does not cause any disease state. There are generally two different types of bacterial populations which can become established in the digestive tract. The first is that which exists in close association with the gut epithelium and the second is that which occurs free in the gut lumen. The populations which establish themselves in the digestive tract can be either beneficial or harmful to the host. Not only can certain bacteria produce specific diseases known to be detrimental to the host but they can compete for essential nutrients. If beneficial bacteria establish themselves, the host animal should also benefit accordingly. The ideal situation throughout the life of any animal would be to

maintain specific numbers of beneficial bacteria in the digestive tract. This would ensure that at all times the animal would have the proper microbial balance. This, of course, cannot be guaranteed under natural field conditions. However, if micro-organisms and/or substances which contribute to the proper microbial balance are added to the diet then the animal would continually receive a "boost" to establishing the proper microbial population. The term "probiotic" has been used to indicate substances or micro-organisms which contribute to an ideal microbial balance (Jernigan *et al.*, 1985).

The concept of probiotics rose about more than one hundred years ago, when Döderlein and, subsequently Metchnikoff proposed that bacteria producing lactic acid from sugars should have some beneficial effects (Döderlain, 1892; Metchnikoff, 1907). Originally defined as microorganisms promoting the growth of other microorganisms, their definition has been revised and changed in scope several times. As defined by Crawford (1979) a probiotic is a culture of specific living micro-organisms primarily *Lactobacillus* (sp.) which implants in the animal to which it is fed and ensures the effective establishment of intestinal populations of both beneficial and pathogenic organisms.

Today they are considered as those viable microorganisms that when administered to man and animal, beneficially affects the host by improving the properties of the indigenous microflora (Lilly and

Stillwell, 1965; Fuller, 1989; Guarner and Schaafsma, 1998). More recently probiotics have been defined as mono- or mixed cultures of "live microorganisms which, when administered in adequate amounts, confer a health benefit on the host" (FAO/WHO, 2002). Probiotics were defined as "living microorganisms that upon ingestion in certain numbers exert health effects beyond inherent basic nutrition" (Guarner and Schaafsma, 1998). Probiotics have been defined as "live microbial food supplements which beneficially affect the host by improving the intestinal microbial balance" (Fuller, 1989; Pal, 1999; Salminen *et al.*, 1999).

To maintain the intestinal microflora balance in animals it is important to prevent diseases by controlling the overgrowth of potentially pathogenic bacteria. The control of infections through a nonantibiotic approach is urgently requested. The natural bacterial flora (e.g. probiotic bacteria) represents a promising alternative therapy (Strompfova *et al.*, 2005). Among these microorganisms, lactic acid bacteria are regarded as a major group of probiotic bacteria (Mourad and Nour-Eddine, 2006). Although known since a long time, only in the last two decades probiotics have started to receive major attention from researchers and several studies have been carried out on the effects of probiotics microorganisms, using different formulae and with numerous purposes of preventing or treating diseases (Mercenier *et al.*, 2002; Sartor, 2005; Vecchi and Drago, 2006).

The use of probiotics in poultry was pioneered by Tortuero (1973) who reported an increase in growth rate in chicks given a *Lactobacillus acidophilus* culture in drinking water for 11 days from hatching. Similar results on the beneficial effects of *Lactobacillus* cultures on the growth of chickens were also reported by several researchers (Kalbane *et al.*, 1992; Jin *et al.*, 1998). One of the probiotics used in poultry feed is Protexin. Protexin is a multi-strain probiotic containing live microbes to establish, enhance or re-establish essential microflora in the gut. Protexin is a highly concentrated pre-mix containing seven strains of bacteria and two yeasts (*Lactobacillus plantarum*  $1.89 \times 10^{10}$  cfu/kg (colony forming unit per kilo gram), *Lactobacillus delbrueckii* subsp. *Bulgarius*  $3.09 \times 10^{10}$  cfu/kg, *Lactobacillus acidophilus*  $3.09 \times 10^{10}$  cfu/kg, *Lactobacillus rhamnosus*  $3.09 \times 10^{10}$  cfu/kg, *Bifidobacterium bifidum*  $3.00 \times 10^{10}$  cfu/kg, *Streptococcus salivarius* subsp. *Thermophilus*  $6.15 \times 10^{10}$  cfu/kg, *Enterococcus faecium*  $8.85 \times 10^{10}$  cfu/kg, *Aspergillus oryza*  $7.98 \times 10^9$  cfu/kg, *Candida pintolopesii*  $7.98 \times 10^9$  cfu/kg). All the micro-organisms in the protexin are naturally occurring and have been isolated from a wide range of feed, plant, animal, bird and human sources (Ayasan *et al.*, 2006).

## RESULTS AND DISCUSSION

Miles *et al.* (1981a) conducted two experiments in which 4800 Bobwhite quail were fed a corn-soybean meal

starter diet supplemented with a probiotic culture containing *L. acidophilus* and other lactobacilli. In experiment 1, three diets were fed in each of two trials to four replicate pens of 200 chicks per pen from hatch to 5 weeks of age. The three experimental diets contained probiotic at levels of 0, 250 and 625 mg per kilogram respectively. Diets were mixed each 2 weeks to insure a viable culture during the experimental period. In experiment 2, the same design was used as in experiment 1 except levels of 0, 125, 250 and 375 mg probiotic per kilogram were fed. Results indicated that no significant differences existed in growth, feed efficiency or mortality when quail fed the probiotic were compared to those fed the unsupplemented control diet. Mortality of quails was higher than normal in all treatments but was not treatment related.

Miles *et al.* (1981b) conducted an experiment with Bobwhite quail breeders 80 weeks of age. The experiment was conducted for 56 days and a total of 96 caged pairs of male and female birds were fed a corn-soybean meal breeder diet containing 0 or 625 mg probiotic per kilogram. No significant differences were found between treatments in egg production, feed consumption, fertility, hatchability of fertile eggs or mortality.

Bamba and Miyakawa (1994) reported prevention of Salmonella disease by in laying Japanese quails additives in feed containing propionic acid, egg white product, mannose lactose and probiotics. At 4 weeks of age, quails were inoculated with *Salmonella typhimurium* L-417NR (ST) strain and were fed with the above additional feed for 4 weeks after inoculation. Effects of prevention of ST colonization in the bowel were significantly with propionic acid and egg white product. Additives in feed containing probiotics, mannose and lactose tended to prevent ST colonization, but these effects were lower than those with propionic acid and egg white product. Depressive synergism with propionic acid and egg white product were not observed.

Siriken *et al.* (2003) investigated the effects of two commercially available probiotics, alone and in combination with an antibiotic, on the caecal flora of Japanese quail (*Coturnix coturnix japonica*) reared under unstressed conditions. Thirty-four 90-day-old Japanese quail were selected for their study. The birds were divided into four groups, two groups of nine birds and two groups of eight birds. The animals in these groups were given feed containing 0.5 kg per tonne of probiotics alone (Protexin or Biosacc), a mixture of probiotic plus antibiotic (Biosacc plus *Zinc Bacitracin* at 0.5 and 0.0525 ppm, respectively) and a group where no supplement was added to be used as controls. The total count of aerobic bacteria, *lactobacilli*, *enterobacteriaceae*, *coliforms*, *enterococci*, *salmonellae*, sulphite-reducing anaerobic bacteria (*clostridia*) and pH values in the caecal content of the birds were examined.

No significant differences were detected among the four groups for pH values and bacterial number ( $p>0.05$ ) except for sulphite-reducing anaerobic bacteria ( $p<0.001$ ). These results suggest that the use of probiotics alone and/or a mixture of a probiotic plus antibiotic as a feed supplement does not have a major suppressing effect on the majority of bacterial groups in the caecal flora of mature, healthy Japanese quail reared in unstressed conditions.

Homma and Shinohara (2004) reported the effects of a commercial probiotic, *Bacillus cereus toyoi* on abdominal fat accumulation in the Japanese quail fed either a commercial control diet Crude Protein (CP) 23.5%; Metabolizable Energy (ME) 11.7 MJ/kg (mega joule per kilogram) or a high-energy diet (CP, 23.0%; ME, 13.8 MJ/kg) were investigated. Four-week-old male birds ( $n = 108$ ) were divided into four diet groups: control diet, control with probiotic, high-energy diet and high-energy diet with probiotic. At 8 weeks and 12 weeks of age (4 and 8 weeks of probiotic supplementation period, respectively) abdominal fat, muscles and the liver were weighed. The weight of total fat and protein in the muscles and liver were also determined. A rectal temperature was recorded weekly. Bodyweight and feed intake in both diets were not affected by probiotic supplementation. At 8 weeks of age, birds fed the control diet with probiotic had significantly less abdominal fat than those fed without the probiotic and a similar tendency was seen for both diet groups at 12 weeks of age. The decrease in abdominal fat coincided with an increase in rectal temperature. These results suggest that greater metabolizable energy was consumed through elevation of heat production by supplementation of *B. cereus toyoi*, with hardly any energy stored as body fat. Probiotic supplementation appears to induce greater muscle weight, higher protein and lower lipid content in muscles by 8 weeks of age and lower lipid content in muscles and greater liver weight by 12 weeks of age, in the Japanese quail.

Strompfova *et al.* (2005) investigated the effect of *Lactobacillus fermentum* AD1-canine isolate on selected intestinal microbial groups, weight gain, organic acids, haematology, glutathione peroxidase and phagocytosis of leucocytes in 2-days-old Japanese quail (*Coturnix coturnix japonica*). The results demonstrated that the 4-day application of this strain significantly increased the population of lactic acid bacteria-*lactobacilli* and *enterococci* in faeces ( $p<0.01$  and/or  $p<0.001$ ) and caecum of quail ( $p<0.001$ ) and significantly decreased the counts of *E. coli* in faeces ( $p<0.05$ ). The daily weight gain was increased by 14%. Although intestinal pH of both groups of birds was similar, the concentration of lactic acid was significantly increased in the experimental group ( $p<0.05$ ). The concentration of other organic acids (acetic, acetoacetic, formic, succinic, valeric, propionic, butyric) as well as

blood glutathione peroxidase was not influenced. The index of phagocytic activity of *leucocytes* was significantly improved ( $p<0.01$ ).

Ayasan *et al.* (2005) determined whether dietary *Yucca schidigera* powder would affect egg yield parameters and egg shell quality of laying Japanese quail (*Coturnix coturnix japonica*). In this study, 30 female Japanese quails were used. The experimental quails were divided into two dietary treatment groups of similar mean weight comprising 30 birds each, which was divided into 3 subgroups of birds each. A standard layer feed, basal diet of the trial was supplemented with 0 or 120 ppm *Yucca schidigera* powder. Feed and water were supplied ad libitum and light was provided 16 h (from 8:00-24:00) each day. Laying performance was determined daily by measuring feed intake, feed conversion efficiency (feed intake/egg weight) and egg production (number and weight). Egg quality, length, width, shape index (width/length) shell weight, shell thickness of each egg obtained on the sixth days of every week were recorded. After measuring width and length, the egg was broken was then separated and then weighted. Shell samples from top, middle and bottom sites of the egg were measured for thickness using a micrometer and the mean was calculated prior to statistical analysis. The results obtained in this experiment showed that *Yucca schidigera* supplementation to the diet tended to improve feed conversion efficiency, egg weight ( $p<0.05$ ) while reducing egg shell thickness but not affected on feed intake, egg production, egg shell weight, egg shape index, number of eggs (42 days) ( $p>0.05$ ).

Ayasan *et al.* (2006) investigated the effects of grower diets, dietary three different levels of probiotic (protexin) in grower diet on egg production parameters and egg shell quality 225 female of Japanese quail (*Coturnix coturnix japonica*). The experimental quails were divided into three dietary groups of similar mean weight comprising 75 birds each, consisted of 3 subgroup containing 25 birds each. Treatment groups were assigned control Group A (unsupplemented diet) Group B (0.5 kg per tonne "Protexin" supplemented diet) and Group C (1.0 kg per tonne "Protexin" supplemented diet) for 5 weeks. After 5 weeks, probiotic treatment was ceased and then all groups were allowed to nourish standard layer diet. Results showed that age and body live weight of quails at the first laying was found significant ( $p<0.05$ ) but the first 10 eggs weight and shape index of the first 10 eggs were not found significant ( $p>0.05$ ) different between groups. Ages at sexual maturity in groups were 47-57, 51-53 and 51-57 days for quails, respectively. Mean live weights at sexual maturity were found 271.30, 291.48 and 300.00 g in groups. During the egg production period, probiotic supplementation to the diet did not affect feed intake, feed conversion efficiency, average egg weight, egg

shell thickness and egg shape index ( $p>0.05$ ), but affected egg production and egg shell weight ( $p<0.05$ ). Badr *et al.* (2006) evaluated the efficacy of different treatment trials in controlling *Pseudomonas aeruginosa* infection in quail chicks. Two probiotics (*Lactobacilli* and active dry yeast) and two fluoroquinolone antibiotics (*Ciprofloxacin* and *ofloxacin*) were used. Four-days old quail chicks were infected orally with 0.2 ml containing  $3 \times 10^9$  cfu/ml (colony forming unit per milliliter) of *Pseudomonas aeruginosa* strain which proved to be highly pathogenic for quails and sensitive to both antibiotics mentioned above. After three days, infected quails were sorted out into treated and control groups. The fluoroquinolone treated groups were given either of the antibiotics in the drinking water at a dose level of 10 mg/kg BW every 12 h for five successive days, while the probiotic treated groups received either and both of the probiotics at a dose level of 0.5 gm/liter daily till the end of the experiment. The results revealed that fluoroquinolones were highly effective in destroying the infectious agent. On the other hand, the general health condition and body functions were negatively affected. Histopathological changes in fluoroquinolone and probiotic treated groups were similar. Bacteriologically, the probiotics failed to remove pseudomonas from the infected internal organs. Probiotics proved to be effective in reducing mortalities, severity of infection, enhancement of liver and kidney functions up to almost normal values and improving quail immunity. Probiotics resulted in improvement of the haematological and biochemical parameters as well as total serum proteins and serum globulins. Dual administration of the *lactobacilli* and *saccharomyces* justified their synergistic probiotics effect against quail chick pseudomoniasis. Sahin *et al.* (2008) determined the effect of dietary supplementation of combiotics (probiotic + prebiotic, Makroton) on Body Weight Gain (BWG) Feed Conversion Rate (FCR) carcass quality and serum biochemical parameters. A total of 264 daily Japanese quail chicks (*Coturnix coturnix japonica*) were used in this experiment. They divided into 1 and 3 treatment group each containing 66 chicks. Each group was divided into 3 subgroups each containing 22 chicks. The experimental period lasted 35 days. Control group was fed with unsupplemented basal diets. 0.5, 1.0 and 1.5 g  $\text{kg}^{-1}$  combiotic was added to diets of treatment group 1, 2 and 3 respectively. At the end of the experiment, the effect of combiotic supplementation to diet on the BWG, FCR, carcass yield of and serum biochemical parameters of quail were not statistically significant among the groups ( $p>0.05$ ). FCR rate was determined as 3.19, 3.15, 3.14 and 2.87, respectively. Body weight of quail chicks was not significantly influenced by the addition combiotic. Body weight of quails at 5 weeks of age in 4 groups (control group, group 1, group 2 and group 3) were respectively  $148.72 \pm 1.97$ ,  $151.68 \pm 1.71$ ,  $152.30 \pm 1.89$  and  $153.32 \pm 1.80$  g.

Zeweil *et al.* (without of date) compared the response of laying Japanese quail hens to dietary supplementation with probiotic (*Lacto-Sacc*) and medicinal plant Thyme flowers (*Thymus vulgaris*) through three-months experimental period. The response was measured in terms of productive performance, egg quality and chemical composition of the edible parts of egg, blood constituents, and digestibility of nutrients. A total of 150 laying Japanese quail hens which had been in production for 12 weeks were, randomly, allocated in a completely randomized design considering five treatments with three replicates and 10 samples in each. A group of them received a layer basal diet with no supplementation and served as control. The second and third groups were fed the control diet supplemented with 1.0 or 2.0 g of probiotic/kg diet, respectively. The fourth and fifth groups were fed the same control diet with a supplement of 1.0 or 2.0 g of Thyme flowers/kg diet, respectively. The results showed that the supplementation of 1.0 or 2.0 g probiotic/kg diet resulted in significant effect ( $p \leq 0.01$ ) on the improvements of egg production, eggs mass/hen/day, egg weight and feed conversion ratio as compared to control laying hens. However, only slight numerical improvements, but not significant, were observed for means egg production, egg weight, egg mass and feed conversion ratio when birds were fed with 1.0 g Thyme flowers supplemented diet compared with control. Egg quality measurements were not affected by the dietary treatments. However, yolk cholesterol was significantly ( $p \leq 0.01$ ) decreased by adding 1 g of *lacto-Sacc* or 1 g Thyme flowers/kg diet. Neither digestibility of ether extract, nitrogen free extract, crude fiber and organic matter nor energy utilization were affected by dietary treatments. However, probiotic supplementation to diets at 1.0 or 2.0 g/kg diet caused a pronounced increase in protein digestibility as compared to control. Notably, using 2.0 g probiotic Kg diet and 1.0 g Thyme flowers/Kg diet caused significant ( $p \leq 0.05$ ) decrease in plasma cholesterol and plasma total lipids, but they had no significant effects on other blood constituents.

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