JWPR
Journal of World's
Poultry Research

J. World Poult. Res. 6(1): 31-36, March 25, 2016
Review Paper
PII: S2322455X1600006-6

A Review on Effects of Probiotic Supplementation in Poultry Performance and Cholesterol Levels of Egg and Meat

Tarekegn Getachew
Lecturer and researcher, Haramaya University, Ethiopia
Corresponding author`s Email: targech23@gmail.com

Received: 05 Feb. 2016
Accepted: 17 Mar. 2016

ABSTRACT

Probiotics are live microbial food/feed ingredients that have a beneficial effect on health that stimulates the growth of beneficial microorganisms and reduces the amount of pathogens, thus improving the intestinal microbial balance of the host and lowering the risk of gastro-intestinal diseases. Probiotics can be harmful to debilitated and immuno-compromised populations. An accurate dosage of administration has yet to be established despite the wide-use of probiotics. Probiotics have antimutagenic, anticarcinogenic, hypocholesterolemic, antihypertensive, anti-osteoporosis, and immunomodulatory effects. *Lactobacillus, Bifidobacterium, Leuconostoc, Enterococcus, Lactococcus, Bacillus, Saccharomyces, Aspergillus* and *Pediococcus* species are most commonly used probiotics in poultry production. When supplemented to chicken probiotics improve feed-intake, growth performance, meat quality, egg production, egg quality and have cholesterol lowering potential in poultry products. However, some studies reported no significant effect of probiotics on feed-intake, production traits, products' quality and cholesterol level.

Key words: Broiler, Feed intake, Hypocholesterolemic, Layer, Probiotic

INTRODUCTION

A probiotic was defined as a live microbial feed supplement that beneficially affects the host animal by improving its microbial intestinal balance (Fuller, 1989). Probiotics stimulates the growth of beneficial microorganisms and reduces the amount of pathogens thus improving the intestinal microbial balance of the host (Fuller, 1989; Chiang and Pan, 2012). Intake of Probiotic lowers the risk of gastro-intestinal diseases by stimulating the growth of beneficial microorganisms (Fuller, 1989; Chiang and Pan, 2012). Supplementation if probiotics alleviates the problem of lactose intolerance, the enhancement of nutrients bioavailability, and prevention or reduction of allergies in susceptible individuals (Isolauri, 2001; Chiang and Pan, 2012). Probiotics are reported to have also antimutagenic, anticarcinogenic, hypocholesterolemic, antihypertensive, anti-osteoporosis, and immune modulatory effects (Chiang and Pan, 2012).

Moreover, it has been shown that probiotics could protect broilers against pathogens by colonization in the gastrointestinal tract (Nisbet et al., 1993; Hejlicek et al., 1995 andPascual et al., 1999) and stimulation of systemic immune responses (Muir et al., 1998; Que´re´ and Girard, 1999).The World Health Organization (WHO) has predicted that by 2030, cardiovascular diseases will remain to be the leading causes of death. The report indicates hypercholesterolemia contributed to 45% of heart attacks in Western Europe and 35% of heart attacks in central and Eastern Europe from 1999 to 2003. The WHO reported that unhealthy diets lead to increased risk of cardiovascular diseases.

Supplementation of probiotics may avert the use of cholesterol-lowering drugs in people with high cholesterol level profile (WHO, 2008).

There are researches conducted on the effects of supplementation of probiotics, prebiotic and symbiotic on the quality of poultry products in different parts of the world on different breed of hens. Therefore, the objective of present paper is to review the studies on the effects of probiotic supplementation on poultry diet feed intake, growth rate, egg production and products' cholesterol level.

Controversies in probiotics

Probiotics are generally non-pathogenic microorganisms supplemented to both human and animals' diet, but they could be infectious, especially in debilitated and immuno-compromised populations (Peret-Filho et al., 1998).

Some species of *Lactobacillus, Bifidobacterium, Leuconostoc, Enterococcus and Pediococcus* have been isolated from infection sites (Land et al., 2005). Rautio

To cite this paper: Getachew T (2016). A Review on Effects of Probiotic Supplementation in Poultry Performance and Cholesterol Levels of Egg and Meat. *J. World Poult. Res.* 6(1): 31-36.
Journal homepage: http://jwpr.science-line.com/

et al. (1999) reported two probiotic bacterium causing infection.

Lactobacillus rhamnosus strain indistinguishable from *Lactobacillus rhamnosus* GG has been isolated from a liver abscess from an elderly lady with a history of hypertension and diabetes mellitus. Strains of probiotics have also been found to exhibit antibiotic resistance and have raised concerns about horizontal resistant gene transfer to the host and the pool of gastrointestinal pathogenic micro flora (Huys et al., 2006). A low risk probiotics have to be accepted when recommended to immune-compromised individuals, but the risk to benefit ratio needs to be clearly established in such cases.

Mode of inclusion

Although the hypocholesterolemic potential of probiotics and prebiotics has been widely studied, an accurate dosage of administration has yet to be established (Ooi and Liong, 2010). Culture mix indicated a minimum presence of 1.04×10^{8} colony forming unit/gram (*Lactobacillus acidophilus*, *Lactobacillus casei*, *Bifidobacteriumthermophilus* and *Enterococcus faecium*) was used by Ghavidel et al. (2011). According to Mansoub (2010), reported the dosage of basal diet with drinking water containing 0.5– 1%. A study by Ramasamy et al. (2008) used Lyophilized and the concentration of viable *Lactobacillus* cells diluted to 9log colony forming unit/gram with corn starch.

On the other hand, Mahdavi et al. (2005) included four probiotic concentration (0, 400, 1000 and 2000 gram ton^{-1} feed providing 0, 1.28×10^{6}, 3.2×10^{6} and 4.6×10^{6}colony forming unit/gram feed concentration). Bioplus 2B, a commercial probiotic preparation, was used in this study. The product contained 2 strains of bacilli, *Bacillus subtilis* and *Bacillus licheniformis* with a minimum of 3.2×10^{9}colony forming unit/gram of the product. A review of past studies has revealed that the effective administration dosages of probiotics vary greatly and is dependent on the strains used and the clinical characteristics of subjects, such as lipid profiles. Although probiotics have been delivered in the range of 10^{7} to 10^{9} CFU/day in animals (Ha et al., 2006).

Effects on feed intake

Rise in feed and water consumption is recorded in laying hens fed with Liquid Probiotics Mixed Culture (LPMC) containing two type microorganisms, *Lactobacillus* and *Bacillus* species (Raka et al., 2014).Inclusion of probiotic caused no significant increase in feed consumption, egg production and egg weight (P>0.05) (Mahdavi et al., 2005).Ramasamy et al. (2008) reported that supplementation of probiotic *Lactobacillus* cultures did not influence the Feed Intake (FI), egg production or egg mass of hens throughout the 48-week period. Zhang and Kim (2014) reported an increase body in FI in chicken fed with multistrain probiotics compared with that in control group fed basal diet. Saadia and Nagla (2010) reported FI values of different treated groups were approximately similar and lacked significance with layer flock that fed with *Saccharomyces cerevisiae.*

However, feeding viable *Lactobacillus* at 1100 mg kg^{-1} (4.4×10^{7} colony forming units (cfu) kg^{-1}) increased daily feed consumption, egg size, nitrogen and calcium retentions (Nahashon et al., 1996). Yousefi and Karkoodi (2007) reported feed consumption was not affected by the dietary probiotic supplementation. Shareef and Dabbagh (2009) reported that probiotic (*Saccharomyces cervisiae*) supplementation of broilers had significantly increased feed consumption. Results from a study by Babazadeh et al. (2011) indicated that probiotics did not have any significant positive effect on broilers FI, Body Weight (BW) and Feed Conversion Ratio (FCR). Nikpiran et al. (2013) reported that Addition of *Thepax* and *Saccharomyces cerevisiae* significantly increased FI in Japanese quails.

Effects on growth performance

Song et al. (2014) reported significant increase in body weight gain in broilers fed with probiotics *Lactobacillus*, *Bifidobacterium*, coliforms, and *Clostridium* species. Results from Kabir Rahman et al. (2004) indicated that the live weight gains were significantly (P<0.01) higher in birds supplemented with probiotics as compared to the control group at all levels during the period of 2nd, 4th, 5th and 6th weeks of age, both in vaccinated and non-vaccinated birds. Other studies (Jin et al., 1997; Zulkifli et al., 200; Kalavathy et al., 2003; Santos et al., 2005; Apata, 2008 and Ashayerizadeh et al., 2009) demonstrated increased live weight gain in probiotic fed birds. On the other hand, Lan et al. (2003) found higher (P<0.01) weight gains in broilers subjected to two probiotic species. Shareef and Dabbagh (2009) reported that probiotic (*Saccharomyces cervisiae*) supplementation of broilers, at level of 1, 1.5 and 2%, had significantly increased the body weight gain, feed consumption and feed conversion efficiency. Reports (Banday and Risam, 2002) have suggested that probiotic supplementation improved performance of broilers. Nikpiran et al. (2013) reported that *Thepax* and *Saccharomyces cerevisiae* had positive effects on performance of Japanese quails. Zhang and Kim (2014) reported an overall increase in body weight gain in chicken fed with multistrain probiotics compared with that in control group fed basal diet.

Sherief and Sherief (2011) reported that significantly higher body weight is recorded on broiler flocks that received probiotics. Huang et al. (2004) demonstrated that inactivated probiotics, disrupted by a high-pressure homogenizer, have positive effects on the production performance of broiler chickens when used at certain concentrations. Endens et al. (2003) reported that probiotics improved digestion, absorption and availability of nutrition accompanying with positive effects on intestine activity and increasing digestive enzymes. Mansoub (2010) reported significant increase in body weight of broilers fed with *Lactobacillus acidophilus* and *Lactobacillus casei*. Amer and Khan (2011) showed that the supplementation of probiotic (*Lactobacillus acidophilus, Bacillus subtilis, Saccharomyces cerevisiae and Aspergillus oryzae*) indicated significant increase body weight gain after 6 weeks of experiment. However, some studies show that probiotic supplementation doesn't improve chickens' feed intake (Mansoub, 2010; Jin et al., 1998 and Murry et al., 2006), while Timmerman et al. (2006) found inconsistent results, maybe because of type of diet ingredients which can affect probiotic's growth or their metabolites. Yousefi and Karkoodi (2007) found that body weight changes were not significantly different among treatment groups and feed conversion ratio was not affected by the dietary probiotic supplementation.

Effects on egg production and quality

Raka et al. (2014) reported the highest hen day production and egg weight in layers supplemented with Liquid Probiotics Mixed Culture (LPMC) containing two type microorganisms, *Lactobacillus* and *Bacillus* species. Tortuero and Fernandez (1995) reported that at the end of probiotic bacteria mixed culture to maize basal diet improved hen day egg production. Similarly, in barley based diets, addition of probiotic bacteria increased egg size but there were no differences in feed intake feed conversion ratio and egg specific gravity in layers (Tortuero and Fernandez, 1995). Kurtoglu et al. (2004) reported that supplementation probiotic *Bacillus licheniformis* and *Bacillus subtilis* increased egg production and decreased percentages of damaged egg in Brown-Nick layer hybrids.

Daneshyar et al. (2009) reported that the addition of probiotics did not have significant effect on egg production and egg mass but significant effect was recorded on egg weight. The same result was reported by Ramasamy et al. (2008) supplementation of *Lactobacillus* cultures did not influence the egg production of hens throughout the experimental period and no significant difference in egg weight in hens fed with *Lactobacillus acidophilus.* Davis and Anderson (2002) also found no significant improvement in egg production of hens supplemented with Prima Lac, a commercial product containing *Lactobacillus* species. On the other hand, significant improvement in egg production was observed in hens fed with a mixed culture of *Lactobacillus acidophilus*, *Lactobacillus casei* and *Lactobacillus acidophilus* (Haddadin et al., 1996).

Yörük et al. (2004) reported that egg production in Hisex Brown layers fed with probiotics contained *Lactobacillus plantarum*, *Lactobacillus delbrueckii* subsp. *bulgaricus*, *Lactobacillus acidophilus*, *Lactobacillus rhamnosus*, *Bifidobacterium bifidum*, *Streptococcus salivarius* subsp. *thermophilus*, *Enterococcus faecium*, *Aspergillus oryza* and *Candida pintolopesii* showed greater egg production than the group fed with basal diet. Moreover, there were linear increases in egg production with increased supplemental probiotic. Haddadin et al. (1996) reported that egg quality had improved by the addition of a liquid culture of probiotic bacteria to the basal diet. However, the egg weight was significantly greater in *Lactobacillus* Culture fed hens (58.77 gram) from 20 to 68 weeks of age. Addition of probiotic had no significant effect (P>0.05) on shell hardness and shell thickness and these were expected which have already been reported (Haddadin et al., 1996 and Mohan et al., 1995). On the other hand, Saadia and Nagla (2010) indicated that significant higher egg production was recorded in Hy-line layers supplemented with probiotic *Saccharomyces cerevisiae.*

Hypocholesterolemic Potential

Mansoub (2010) reported that the cholesterol level of serum significantly decreased in groups supplemented with probiotics in assimilation of cholesterol by *Lactobacillus* compared to control group fed with basal diet. The same study also reported that there is a significant decrease in the serum level of triglycerides between control group and groups treated with *Lactobacillus acidophilus* and *Lactobacillus casei* supplemented in broiler diet in combination with water or alone. Kurtoglu et al. (2004) reported that supplementation probiotic *Bacillus licheniformis* and *Bacillus subtilis* decreased egg yolk cholesterol and serum cholesterol levels in Brown-Nick layer hybrids.

Corcoran et al. (2005) reported that fat digestion rate is linked to the rate of gallbladder acids in digestion latex and subsequently the lipid concentration. *Lactobacillus acidophilus* and *Lactobacillus casei* in diet or water cause a decrease in gallbladder acids in digestion latex and this resulted in a reduction in the ability of fat digestion and therefore decreasing lipid level of blood (Corcoran et al., 2005). *L. acidophilus* can absorb cholesterol in vitro, and this phenomenon can decrease the cholesterol level of medium (Gilliland et al., 1985).

Ashayerizadeh et al. (2011) reported that dietary supplementation with probiotic decrease cholesterol concentration when compared with birds fed basal diet, prebiotic and antibiotic diets. The cholesterol content of eggs produced by probiotic (*Lactobacillus* culture) fed hens was significantly lower by 15.3% and 10.4% when compared to those of the control hens at 24 and 28 weeks of age, respectively (Ramasamy et al., 2008). Mahdavi et al. (2005) also reported that probiotic *Bacillus subtilis* and *Bacillus licheniformis* supplementation reduced the plasma cholesterol and triglyceride significantly. *Saccharomyces cerevisiae* probiotic supplementation has been shown to reduce the cholesterol concentration in egg yolk which was reported by Abdulrahim et al. (1996) and serum concentration in chicken (Mohan et al., 1996). A study by Amer and Khan (2011) showed that the supplementation of probiotic (*Lactobacillus acidophilus, Bacillus subtilis, Saccharomyces cerevisiae* and *Aspergillus oryzae*) indicated significant decrease in serum cholesterol concentration after 6 weeks of experiment with probiotic treatment.

CONCLUSION

Probiotics have a number of beneficial effects in poultry production. According to different studies, provision of probiotics improves feed intake, feed conversation ratio, stimulates growth rate, increases egg production and have hypocholesteronemic effects on poultry products. However, some studies reported no significant effect of feeding probiotics on feed intake, growth performance and egg production. Despite the wide use of probiotics in poultry production, an accurate dosage of administration has yet to be established. It can be mixed into water and feed with different dosages.

Competing interests

The authors have no competing interests to declare.

REFERENCES

Abdulrahim SM, Haddadin SY, Hashlamoun EA and Robinson RK (1996). The influence of *Lactobacillus acidophilus* and bacitracin on layer performance of chickens and cholesterol content of plasma and egg yolk. British Poultry Science, 37(2): 341–6.

Apata D (2008). Growth performance, nutrient digestibility and immune response of broiler chicks fed diets supplemented with a culture of *Lactobacillus bulgaricus*. Journal of the Science of Food and Agriculture, 88(7): 1253–1258.

Ashayerizadeh A, Dabiri N, Mirzadeh KH and Ghorbani MR (2011). Effect of dietary supplementation of probiotic and prebiotic on growth indices and serum biochemical parameters of broiler chickens. Journal of Cell and Animal Biology, 5(8): 152-156.

Ashayerizadeh O, Dastar B, Shargh MS, Ashayerizadeh A and Mamooee M (2009). Influence of antibiotic, prebiotic and probiotic supplementation to diets on carcass characteristics, hematological indices and internal organ size of young broiler chickens. Journal of Animal and Veterinary Advances, 8(9): 1772–1776.

Babazadeh D, Vahdatpour T, Nikpiran H, Jafargholipour MA and Vahdatpour S (2011). .Effects of probiotic, prebiotic and synbiotic intake on blood enzymes and performance of Japanese quails (*Coturnix japonica*). Indian Journal of Animal Sciences, 81(8): 870–874.

Banday MT and Risam KS (2002). Growth performance and carcass/ characteristics of broiler chicken fed with probiotics. Poultry Abstracts, 28: 388.

Chiang SS and Pan TM (2012). Beneficial effects of *Lactobacillus paracasei* subsp. paracasei NTU 101 and its fermented products. Applied Microbiology and Biotechnology, 93(3): 903–16.

Corcoran BM, Stanton C, Fitzgerald GF and Ross RP (2005). Survival of probiotic lactobacilli in acidic environments is enhanced in the presence of metabolizable sugars. Applied and Environmental Microbiology, 71 (6): 3060–3067.

Daneshyar M, Kermanshahi H and Golian A (2009). Changes of biochemical parameters and enzyme activities in broiler chickens with cold-induced ascites. Poultry Science, 88(1): 106–10.

Davis GS and Anderson KE (2002). The effects of feeding the direct-fed microbial, PrimaLac, on growth parameters and egg productionin single white leghorn hens.Poultry Sciences, 81: 755–759.

Edens F (2003). An alternative for antibiotic se in poultry: probiotics. RevistaBrasileira de CiênciaAvícola, 5(2): 75–97.

Fuller R (1989). Probiotics in man and animals. The Journal of Applied Bacteriology, 66(5): 365–378.

Ghavidel SZ, Kambiz NA, Naser MS, Saeed A, Afshar M, Masoud M and Seyed AS (2012). Effects of *lactobacillus*-based probiotic on growth performance, mortality rate and carcass yield in broiler chickens. Annals of Biological Research, 2 (2): 325-331.

Gil de los Santos JR, Storch OB and Gil-Turnes C (2005). Bacillus cereus var. toyoii and *Saccharomyces boulardii* increased feed efficiency in broilers infected with *Salmonella enteritidis*. British Poultry Science, 46(4): 494–7.

Gilliland SE, Nelson CR and Maxwell C (1985). Assimilation of cholesterol by *Lactobacillus acidophilus*. Applied and Environmental Microbiology, 49(49): 377–385.

Ha CG, Cho JK, Lee CH, Chai YG, Ha YA and Shin SH (2006). Cholesterol Lowering Effect of *Lactobacillus plantarum* isolated from Human Feces. Journal of Molecular Microbiology and Biotechnology, 16: 1201–1209.

Haddadin MSY, Abdulrahim SM, Hashlamoun EAR and Robinson RK (1996). The Effect of *Lactobacillus acidophilus*on the Production and Chemical Composition of Hen's Eggs. Poultry Science, 75(4): 491–494.

Hejlicek K, Soukupova A and Moltasova M (1995). Salmonellosis in 1-day-old chicks caused by *Salmonella enteritidis*. Veterinarstvi, 45:16–18.

Huang Choi YJ, Houde R, Lee JW, Lee B and Zhao XMK (2004). Effects of Lactobacilli and Acidophilic fungus on the production performance and\immune responses in broiler chickens. Poultry Science, 83:788–795.

Huys G, Vancanneyt M, D'Haene K, VankerckhovenV, Goossens H and Swings J (2006). Accuracy of species identity of commercial bacterial cultures intended for probiotic or nutritional use. Research in Microbiology, 157(9): 803–10.

Isolauri E, Sütas Y, Kankaanpää P, Arvilommi H and Salminen S (2001). Probiotics: Effects on immunity. In American Journal of Clinical Nutrition, 73: 444-450.

Jin LZ, Ho YW, Abdullah N and Jalaludin S (1998). Growth performance, intestinal microbial populations, and serum cholesterol of broilers fed diets containing *Lactobacillus* cultures. Poultry Science, 77 (9): 1259–1265.

Jin LZ, Ho YW, Abdullah N and Jalaludin S (1997). Probiotics in poultry: Modes of action. World's Poultry Science Journal, 53(4): 351–368.

Kabir Rahman MM, Rahman MB, Rahman MM, Ahmed SU and Sani ML (2004). The dynamics of probiotics on growth performance and immune response in broilers. International Journal of Poultry Science, 3(5): 361–364.

Kalavathy R, AbdullahN, Jalaludin S and Ho YW (2003). Effects of *Lactobacillus* cultures on growth performance, abdominal fat deposition, serum lipids and weight of organs of broiler chickens. British Poultry Science, 44(1): 139–144.

Kurtoglu V, Kurtoglu F, Seker E, Coskun B and Balevi T (2004). Effect of probiotic supplementation on laying hen diets on yield performance and serum and egg yolk cholesterol. Food Additives and Contaminants, 21(9): 817-823.

Land MH, Rouster-Stevens K, Woods CR, Cannon ML, Cnota J and Shetty AK (2005). *Lactobacillus* sepsis associated with probiotic therapy. Pediatrics, 115(1): 178–81.

Amer MY and Khan SH (2012). A comparison between the effects of a probiotic and an antibiotic on the performance of Desi chickens. Veterinary World, 5(3): 160–165.

Mahdavi AH, Rahman HR and Pourreza J (2005). Effect of probiotic supplements on egg quality and laying hen's performance. International Journal of Poultry Science, 4(7): 488–492.

Mansoub NH (2010). Effect of Probiotic Bacteria Utilization on Serum Cholesterol and Triglycrides Contents and Performance of Broiler Chickens. Global Veterinaria, 5(3): 184–186.

Mohan B, Kadirvel R, Bhaskaran M and Natarajan A (1995). Effect of probiotic supplementation on serum/yolk cholesterol and on egg shell thickness in layers. British Poultry Science, 36(5): 799–803.

Mohan B, Kadirvel R, Natarajan A and Bhaskaran M (2007). Effect of probiotic supplementation on growth, nitrogen utilisation and serum cholesterol in broilers. British Poultry Science, 5: 799-803.

Muir WI, Bryden WL and Husband AJ (1998). Evaluation of the efficacy of intraperitoneal immunization in reducing Salmonella typhimurium infection in chickens. Poultry Sciences, 77:1874–1883.

Murry AC, Hinton A and Buhr RJ (2006). Effect of botanical probiotic containing Lactobacilli on growth performance and populations of bacteria in the ceca, cloaca, and carcass rinse of broiler chickens. International Journal of Poultry Science, 5(4): 344–350.

Nahashon SN, Nakaue HS and Mirosh LW (1996). Performance of Single Comb White Leghorn fed a diet supplemented with a live microbial during the growth and egg laying phases. Animal Feed Science and Technology, 57(1-2): 25–38.

Ngoc Lan PT, Binh LT and Benno Y (2003). Impact of two probiotic *Lactobacillus* strains feeding on fecal lactobacilli and weight gains in chicken. The Journal of General and Applied Microbiology, 49(1): 29–36.

Nikpiran H, VahdatpourT, Babazadeh D and Vahdatpour S (2013). Effects of *Saccharomyces Cere*visiae, *Thepax* and Their Combination on Blood Enzymes and Performance of Japanese Quails (Coturnix Japonica).Journal of animal and plant sciences, 23(2): 369–375.

Nisbet DJ, Corrier DE, Scanlan CM, Hollister AG, Beier RC and Deloach JR (1993). Effect of a defined continuous flow derived bacterial culture and dietary lactose on Salmonella colonization in broiler chickens. Avian Disease, 37: 1017–1025.

Ooi LG and Liong MT (2010). Cholesterol-lowering effects of probiotics and prebiotics: A review of in Vivo and in Vitro Findings. International Journal of Molecular Sciences, 6: 2499-522.

Pascual M, Hugas M, Badiola JI, Monfort JM and Garriga M (1999). *Lactobacillus salivarius* CTC2197 prevents *Salmonella enteritidis* colonization in chickens. Applied Environmental Microbiology, 65: 4981–4986.

Peret-Filho LA, Penna FJ, Bambirra EA and Nicoli JR (1998). Dose effect of oral Saccharomyces boulardii treatments on morbidity and mortality in immunosuppressed mice. Journal of Medical Microbiology, 47(2): 111–6.

Prado FC, Parada JL, Pandey A and Soccol CR (2008). Trends in non-dairy probiotic beverages. Food Research International, 41(2): 111–123.

Que´re´ P and Girard F (1999). Systemic adjuvant effect of cholera toxin in the chicken. Veterinary Immunology and Immunopathology, 70:135–141.

Ramasamy K, Abdullah N, Wong MC, Karuthan C and Ho YW (2010). Bile salt deconjugation and cholesterol removal from media by *Lactobacillus* strains used as probiotics in chickens. Journal of the Science of Food and Agriculture, 90(1): 65–69.

Raka Pambuka S, Sjofjan O and Eka Radiati L (2014). Effect of Liquid Probiotics Mixed Culture Supplements through Drinking Water on Laying Hens Performance and Yolk Cholesterol. Journal of World's Poultry Research, 4(1): 05-09.

Saadia MH and Nagla KS (2010). Effect of Probiotic (*Saccharomyces cerevisiae*) Adding to Diets on Intestinal Microflora and Performance of Hy-Line Layers Hens. Journal of American Science, 6 (11): 159-169.

Shareef AM (2009). Effect of probiotic (*Saccharomyces cerevisiae*) on performance of broiler chicks. Iraqi Journal of Veterinary Sciences, 23: 23–29.

Sherief MA and Sherief MSA (2011). The Effect of Single or Combined Dietary Supplementation of Mannan Oligosacharide and Probiotics on Performance and Slaughter Characteristics of Broilers. International Journal of Poultry Science, 10 (11): 854-862.

Song J (2014). Effect of a probiotic mixture on intestinal microflora, morphology and barrier integrity of broilers subjected to heat stress. American Historical Review, 119(2): 581–588.

Timmerman HM, Veldman A, van den, Elsen E, Rombouts FM and Beynen AC (2006). Mortality and Growth Performance of

Broilers Given Drinking Water Supplemented with Chicken-Specific Probiotics. Poultry Science, 85(8): 1383–1388.

Tortuero F and Fernández E (1995). Effects of inclusion of microbial cultures in barley-based diets fed to laying hens. Animal Feed Science and Technology, 53(3-4): 255–265.

World Health Organization (WHO) (2008). 2008-2013Action Plan for the Global Strategy for the Prevention and Control of Noncommunicable Diseases the six objectives of the 2008-2013 Action Plan are. Blood.1:48ISBN: 9789241597418.

Yörük MA, Gül M, Hayirli A and Macit M (2004). The effects of supplementation of humate and probiotic on egg production and quality parameters during the late laying period in hens. Poultry Science, 83(1): 84-88.

Yousefi M and Karkoodi K (2007). Effect of Probiotic *Thepax* and *Saccharomyces cerevisiae* Supplementation on Performance and Egg Quality of Laying Hens.International Journal of Poultry Science, 6(1): 52-54.

Zhang ZF and Kim IH (2014). Effects of multistrain probiotics on growth performance, apparent ileal nutrient digestibility, blood characteristics, cecal microbial shedding, and excreta odor contents in broilers.Poultry science, 93(2): 364–370.

Zulkifli I, Al-Aqil A, Omar AR, Sazili AQ and Rajion MA (2009). Crating and heat stress influence blood parameters and heat shock protein 70 expression in broiler chickens showing short or long tonic immobility reactions. Poultry Science, 88(3): 471–6.