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

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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 of 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; Hejlíček et al., 1995 and Pascual 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
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 1.04×10⁸ colony forming unit/gram (*Lactobacillus acidophilus, Lactobacillus casei, Bifidobacterium thermophilus* 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, 1.28×10⁶, 3.2×10⁶ and 4.6×10⁶ colony forming unit/gram feed concentration). Biplus 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 3.2×10⁵ 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 10⁷ to 10⁹ 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 (4.4×10⁵ 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 cerevisiae*) 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., 2000; 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 cerevisiae*) 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).

Yörü 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 pintoopesii 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 hypcholesteronemic 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


