ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF

POULTRY SCIENCE

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

International Journal of Poultry Science 5 (1): 01-03, 2006
ISSN 1682-8356

Aspergillus oryzae as Probiotic in Poultry - A Review

KyungWoo Lee, Soo Kee Lee and Bong Duk Lee
Department of Animal Science, College of Agriculture, Chungnam National University, 220, Gungdong, Yusung, 305-724, Daejeon, South Korea

Abstract: Probiotics are widely accepted as an alternative to in-feed antibiotics in poultry production. So far, the frequently used microorganisms in probiotics are strains of lactic acid producing bacteria having specificity of adhering to the intestinal epithelium. Recently, a probiotic containing novel strain such as *Aspergillus oryzae* is also in practice, but its effect on performance of poultry is limited. The present review explored *Aspergillus oryzae* as the potential candidate for probiotic.

Key words: *Aspergillus oryzae*, probiotics, poultry

Introduction

In the modern intensive poultry production, newly-hatched chicks have little chance to contact with their mother, thereby normal microflora is slow to colonize in the intestine (Fuller, 1989). This situation makes chicks likely to be affected by a small number of pathogenic bacteria due to sterile condition of intestine, then subsequently causing food-borne disease to human-beings (Pivnick and Nurmi, 1982). Probiotic, which is a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance, has been used for the alternative tools for helping newly-hatched chicks colonize normal microflora as conventionally hatched chicks do (Fuller, 1989). Due to their several negative effects, antibiotics have gradually been replaced by probiotics in controlling intestinal pathogenic bacteria (Fuller, 1992).

Probiotic has been used as feed additives to improve the performance of poultry and many workers have done outstanding jobs in reviewing the literature in this field (Jernigan *et al*., 1985; Barrow, 1992; Stavric and Kornegay, 1995; Jin *et al*., 1997). *Aspergillus oryzae* and yeasts, particularly *Saccharomyces cerevisiae*, have been used as probiotics by many workers (Fox, 1988; Montes and Pugh, 1993; Kautz and Arens, 1998). Both *Aspergillus* spp. and *Saccharomyces* belong to the Ascomycoyina subdivision (Boyd, 1988), and have many industrial applications, involving brewing, distilling and baking industries (Raper *et al*., 1965). Until recently, information on an *Aspergillus oryzae*-based probiotic is lacking although its application into poultry production is on the increase. The present review will explore *Aspergillus oryzae* as a possible probiotic strain.

History and development of probiotics: Mechinicoff (1908) demonstrated that consumption of fermented milk was closely related with Bugarian's longevity. He believed that beneficial bacteria could balance the intestinal environment, prevent the growth of pathogen, and therefore improve health and prolong life. Probiotic based on Metchinicoff's observation is defined as a live microbial supplement which beneficially affects the host animal by balancing its intestinal microbial ecosystem (Fuller, 1989). Due to the possible hazards and risks of antibiotics in poultry production, the importance of probiotics as an alternative has increased more than ever (Fuller, 1992). The *Salmonella* contamination of poultry products is primarily originated from the intestinal tract of poultry, especially ceca where microbial activity is greatest (Snoeyenbos *et al*., 1982). To produce *Salmonella*-free products in poultry industry, recent research has been focused on reducing *Salmonella* contamination by concept of competitive exclusion (CE) first introduced by Nurmi and Rantala (1973). The frequently used microorganisms in probiotics are strains of lactic acid producing bacteria having specificity of adhering to the intestinal epithelium. Besides lactic acid bacteria, other microbial products that contain *Bacillus*, yeasts, *Aspergillus oryzae*, and other agents are also classified as probiotics (Fox, 1988).

Biological properties of *Aspergillus oryzae*: Although *Aspergillus oryzae* has many industrial applications, involving brewing, distilling and baking industries (Raper *et al*., 1965), until recently information with regards to an *Aspergillus oryzae*-based probiotic is limited in farm animal production. The roles of *Aspergillus oryzae* with emphasis on practical relevance are discussed with the published reported so far.

Antimicrobial effect: As Kim *et al*. (2003) reported, *Aspergillus oryzae* might act as substrates for favorable

Corresponding Author: KyungWoo Lee, Animal Disease Diagnostic Division, National Veterinary Research and Quarantine Service, 480, Anyang-6, Manan, Anyang, 430-824, Kyunggi, South Korea

bacteria such as *Lactobacillus* in intestinal microbial system that subsequently affects to lower *Salmonella* or *E. coli* concentrations. In line with study of Kim *et al.* (2003), Han *et al.* (1999) also observed the *Aspergillus-oryzae*-mediated increase in *Lactobacillus* and concomitant decrease in *E. Coli* in layers' fecal droppings. Interestingly, *Aspergillus oryzae* was recovered from birds fed the diet containing the Aspergillus-oryzae-based probiotic, but could not be detected from those fed the control diet (Han *et al.*, 1999). It was postulated (Han *et al.*, 1999) that livability *per se* of *Aspergillus oryzae* may in part play a role by affecting microflora in intestine. Although the impact of *Aspergillus oryzae* on intestinal microflora seems indirect as suggested by Kim *et al.* (2003), a possible synergistic interaction between exogenous *Aspergillus oryzae* and endogenous microbials in GIT should not be excluded.

Digestive simulation effect: The effect of *Aspergillus oryzae* on macronutrients metabolizabilities in laying hens was observed (Han *et al.*, 1999), of which findings might be of practical relevance. They postulated that active amylolytic and proteolytic enzymes residing in *Aspergillus oryzae* may have effect on the digested nutrients. Similarly, it was reported that an increase in the digestibility of dry matter was closely related to the enzymes released by yeast (Jonvel, 1993). At this moment, endogenous digestive enzyme activities by feeding *Aspergillus oryzae* were not measured, of which could explain the mechanisms of the probiotic with respect to digestion process.

Cholesterol-lowering effect: In the recent study (Kim *et al.*, 2003), *Aspergillus oryzae* at 0.1% in diet significantly lowered serum cholesterol of broiler chickens that were fed for 5 weeks of age. However, serum cholesterol was not affected in birds that were fed probiotic-containing diet for 3 weeks of age. The reasons for age dependence of *Aspergillus oryzae* on cholesterol metabolism were not explored further. On the other hand, mechanism (s) underlying the cholesterol-lowering effect of *Aspergillus oryzae* has been recently proposed. The hypocholesterolemic effect by *Aspergillus oryzae* could be related to compounds in *Aspergillus oryzae* that is known to inhibit cholesterol biosynthesis (Hajjaj *et al.*, 2005). After all, conclusive remarks on hypocholesterolemic effect by *Aspergillus oryzae* can be made by monitoring key enzyme, i.e., 3-hydroxyl-3-methylglutaryl-coenzyme A reductase in cholesterol synthesis in poultry.

Effect of *Aspergillus Oryzae* on Performance of Poultry : Grimes *et al.* (1997) conducted an experiment to determine the efficacy of Fermacto® (commercially available fermentation product from *Aspergillus oryzae* and *niger*) as a nutritional aid in alleviating protein insufficiency caused by a decrease in protein quality in diets for laying hens. It was shown that no differences were found on egg production, egg weight, and shell weight except for the production of extra large eggs. Digestibilities of nutrients were not significantly affected by dietary treatment, though laying hens fed Fermacto® showed increase in protein and lipid digestibilities. Similarly, positive effect of Fermacto® on the performance of laying hens fed diets with different levels of methionine was also reported (Harms and Miles, 1988). Recently, the effects of feeding *Aspergillus oryzae* on fecal micrflora populations, pH and moisture contents, egg quality and macronutrients metabolizabilities in laying hens have been studied (Han *et al.*, 1999). Interestingly, fecal moisture contents tended to be reduced by the addition of *Aspergillus oryzae*, of which finding was of practical relevance in poultry production. Metabolizabilities of gross energy and dry matter were increased by the *Aspergillus oryzae* supplementation. However, metabolizabilities of crude protein and crude fat were not affected (Han *et al.*, 1999). In study with yeast culture, Thayer *et al.* (1978) reported an improvement in egg production, egg weight, and egg specific gravity for turkey breeder hens fed diet containing low phosphorus level.

Aspergillus oryzae in broiler chickens is focused on growth performance, serum cholesterol and ammonia gas production. Kim *et al.* (2003) reported that feeding *Aspergillus oryzae* to broiler chickens significantly enhanced performance indices such as body weight gain, feed intake, but failed to affect feed:gain ratios. In addition, *Aspergillus oryzae* significantly lowered ammonia gas production and serum cholesterol concentration in broilers. *Aspergillus oryzae* feeding also influenced microflora population in a beneficial manner. Contrary to study by Kim *et al.* (2003), *Aspergillus oryzae* at 0.5, 0.7 and 1.0% in diet significantly effected on the feed:gain ratios, but not on weight gains and feed intakes, of broiler chicken (Goh and Hwang, 1999).

Multiple probiotic containing *Bacillus* sp., *Lactobacillus* sp., *Rhdobacter* sp., and *Aspergillus oryzae* did not affect growth performance, and ileal and cecal microflora, but lowered serum cholesterol and ammonia gas production of beddings in broiler chickens (Yoon *et al.*, 2004). Thus, *Aspergillus oryzae* alone or in combination with *Lactobacillus* spp. could improve performance of poultry and favorably lower gas production in broiler house, of which remarks need to be further tested

Conclusions: In conclusion, the effects of *Aspergillus oryzae* on performance of laying hens and broiler chickens are observed as seen in this review. *Aspergillus oryzae* has also effects on mancronutrients

digestion, cholesterol metabolism, modulating intestinal microflora, and lowering ammonia gas production. The optimal inclusion level can be on average 0.1% in diets.

References

Barrow, P.A., 1992. Probiotics for chickens. In Fuller R. (Ed), Probiotics. The Scientific Basis. Chapman and Hall, London, pp: 225-257.

Boyd, R.F., 1988. General microbiology. 2nd ed. Times Mirror/Mosby College Publishing, St. Louis, Mo.

Fox, S.M., 1988. Probiotics: Intestinal inoculants for production animals. Vet. Med., 83: 806-830.

Fuller, R., 1989. Probiotics in man and animals. J. Appl. Bacteriol., 66: 365-378.

Fuller, R., 1992. History and development of probiotics. In Fuller R. (Ed), Probiotics. The Scientific Basis. Chapman and Hall, London, pp: 1-8.

Goh, Y.G. and Y. H. Hwang, 1999. Effects of feeding yeast culture fermented with *Aspergillus oryzae* on performance of broiler chicks. Kor. J. Anim. Sci., 41: 15-22.

Grimes, J.L., D.V. Maurice, S.F. Lightsey and J.G. Lopez, 1997. The effect of dietary Fermacto® on layer hen performance. J. Appl. Poult. Res., 6: 399-403.

Hajjaj, H., P. Duboc, L.B. Fay, I. Zbinden, K. Mace and P. Niederberger, 2005. *Aspergillus oryzae* produces compounds inhibiting cholesterol biosynthesis downstream of dihydrolanosterol. FEMS Microbiol. Letters, 242: 155-159.

Han, S.W., K.W. Lee, B.D. Lee and C.G. Sung, 1999. Effect of feeding *Aspergillus oryzae* culture on fecal microflora, egg qualities, and nutrient metabolizabilities in laying hens. Asian Aust. J. Anim. Sci., 12: 417-421.

Harms, R.H. and R.D. Miles, 1988. Influence of Fermacto® on the performance of laying hens when fed diets with different levels of methionine. Poult. Sci., 67: 842-844.

Jernigan, M.A., R.D. Miles and A.S. Arafa, 1985. Probiotics in poultry nutrition – A Review. World's Poult. Sci. J., 41: 99-107.

Jin, L.Z., Y.W. Ho, N. Abdullah and S. Jalaudin, 1997. Probiotics in poultry: Modes of action. World's Poult. Sci. J., 53: 351-368.

Jonvel, S., 1993. Use of yeast in monogastrics. Feed Mix, Vol. 1. Num. 4.

Kautz, W. and M. Arens, 1998. What questions should feed manufacturers ask?: Choosing the right microbes. Feed Management, 49: 43-46.

Kim, S.H., S.Y. Park, D.J. Yu, S.J. Lee, K.S. Ryu and D.G. Lee, 2003. Effects of feeding *Aspergillus oryzae* ferments on performance, intestinal microflora, blood serum components and environmental factors in broiler. Kor. J. Poult. Sci., 30: 151-159.

Mechinicoff, E., 1908. Prologation of life. G.P. Putman and Sons, New York.

Montes, A.J. and D.G. Pugh, 1993. The use of probiotics in food - Animal practice. Vet. Med., 88: 282-289.

Nurmi, E. and M. Rantala, 1973. New aspects of Salmonella infection in broiler production. Nature, 241: 210-211.

Pivnick, H. and E. Nurmi, 1982. The Nurmi concepts and its role in the control of Salmonella in poultry. In: Davis, I.R. (Ed), Developments in food microbiology. Applied Science Publishers, Essex, pp: 41-70.

Raper, K.B., D.I. Fennell and P.K.C. Austwick, 1965. The Genus *Aspergillus*. R.E. Krieger Publishing company, Huntington. New York.

Snoeyenbos, G.H., A.S. Soerjadi and O.M. Weinack, 1982. Gastrointestinal colonization by Salmonella and pathogenic *Escherichia coli* in monzenic and holoxenic chicks and poults. Avian Dis., 26: 566-575.

Stavric, S. and E.T. Kornegay, 1995. Microbial probiotic for pigs and poultry. In: R.J. Wallace, R.J., Chesson, A. (Eds), Biotechnology in animal feeds and animal feeding. VCH. Weinheim, pp: 205-231.

Thayer, R.H., R.F. Burkitt, R.D. Morrison and E.E. Murray, 1978. Efficiency of utilization of dietary phosphorus by caged turkey breeder hens when fed rations supplemented with live yeast culture. Anim. Sci. Res. Rep. MP-103. Oklahoma State Univ., Stillwater, OK.

Yoon, C., C.S. Na, J.H. Park, S.K. Han, Y.M. Nam and J.T. Kwon, 2004. Effect of feeding multiple probiotics on performance and fecal noxious gas emission in broiler chicks. Kor. J. Poult. Sci., 3: 229-235.