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A Comprehensive Review on Physiological and Nutritional Properties of Prebiotics as Poultry Feed Supplement

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ABSTRACT

The present article highlights the effect of dietary prebiotics viz., dietary organic acid (OA) supplements, mannan oligosaccharide (MOS) and β-glucan supplementation on different body growth parameters of poultry birds at their various growing stages. The article stresses on the effect on live body weight gain, dressing percentage, weight of vital organs and muscles and mean villus lengths in digestive tract of poultry birds along with their application as growth promoters in commercial poultry feed.

INTRODUCTION

Prebiotics are non-digestible feed ingredients that beneficially affect the host by selectively stimulating the growth or activity of one or a limited number of bacterial species, already resident in colon and thus attempt to improve host health (Gibson and Roberfroid, 1995; Ganguly and Mukhopadhayay, 2011). Mainly prebiotics are small fragments of carbohydrates and commercially available as oligosaccharides of galactose, fructose or mannose.

Paul et al. (2012) revealed the effect of yeast cell wall preparation of Saccharomyces cerevisiae origin as an immunomodulator of the innate immune response. Non-specific immunity was assessed in randomly selected treated and control birds at the end of the experimental feeding period ('0' day) by performing neutrophil, monocyte and lymphocyte functional assay in vitro. In both dose group super oxide anion production by neutrophil was increased gradually up to '10' day post treatment (DPT) and then decreased to '20' DPT. The increase was significant ($P<0.5$) compared to control birds. In vitro nitrite production by monocyte was found to be high in treated birds than control. In 0.4gm treatment group in vitro non-specific lymphocyte proliferation and IL-2 production was first increased and then decreased abruptly. But in 0.8gm treatment group in vitro non-specific lymphocyte proliferation and IL-2 production was increased and then decreased gradually. The findings of the study showed that 15 days oral administration of yeast cell wall preparation on both the doses improve innate immune responses in the broiler chicks.

Paul et al. (2013) studied the effect of purified β-glucan from an edible mushroom (Pleuratus florida) as an immunomodulator on the innate immune responses in broiler chicken (40 No.) , purified mushroom glucan was administered orally to 1 week old broiler chicks (20 No.) @ 20 mg/kg feed for 15 days and then switch back to control diet. Similar number of birds was kept separately as control with normal feeding regime. Non-specific immunity and protective ability were assessed in treated and control birds at the end of the experimental feeding period (0 day) by performing neutrophil, macrophage and lymphocyte functional assay in vitro and challenged with virulent field isolate of Newcastle Disease. Superoxide anion production by neutrophil, in vitro non-specific lymphoproliferation and IL-2 production were increased gradually up to 10 days post treatment and the increase was highly significant ($P<0.05$) compared to control birds. In vitro nitrite production by macrophage was found to be high in treated birds. Also mushroom glucan as a feed supplement significantly provided protection against Newcastle Disease. The result showed the potentiality of β-glucan (mushroom origin) as an immunostimulant in poultry.

Immunomodulation activity of the prebiotics

An immunomodulator is a substance (e.g. a drug) which has an effect on the immune system. Different Immunomodulators stimulate the immune system. Biological activities of immunomodulator are influenced by different physicochemical parameters, such as solubility, primary structure, molecular weight, branching and polymer charge (Bohn and BeMiller, 1995). During the development of immune reactions, immunomodulating the effects of β-glucans have been well established (Vetvicka and Sima, 2004).

Prebiotics have many beneficial effects such as increased disease resistance and improved nutrient availability (De et al., 2009). As such, prebiotics they have the potential to increase the efficiency and sustainability of livestock and poultry production.

Glucans are commercially significant as immunostimulating agents. Different types of β-glucans have been used successfully to increase resistance of poultry, fish and crustaceans against bacterial and viral infections (Paulsen et al., 2001; Bagni et al., 2005; Ganguly et al., 2009; Ganguly and Mukhopadhayay, 2011; Paul et al., 2013; Ganguly, 2013; 2014).

Effect on live body weight gain

It has already been reported that 1% formic acid or 1.45% calcium formate did not affect live weight of broiler chicken (Izat et al., 1990). It was found out that 80% formic acid and 20% propionic acid mixture added at 1% level to broiler chicken ration did not affect live weight (Kaniawati et al., 1992). It has also been reported that formic acid and propionic acid mixture (85% and 15%) added at 1% level to the broiler chicken ration in the initial period did not affect weight gain (Visek, 1978). Reports have also been made about significant increased in body weight gain with the supplementation of 0.5% lactic acid in drinking water (Veeramani et al., 2003). It was also revealed that increased in body weight with supplementation of lactic acid. The mix of organic acids improves performance of birds (Maiorka et al., 2004). From a dose responsive study it was concluded (0-0.33%) that MOS @ 0.11%, maximized weight gain in poultry up to 0-8 weeks of age. The same type of effect was found with supplementation of 0.1% MOS on hybrid Tom's body weight gain (Parks et al., 2001) conducted in turkeys supplemented with MOS that MOS may be utilized as a alternative to AGPs to improve turkey performance (Podolsky, 1995; Pelicano, 2003).

Ganguly et al. (2012) and Ganguly (2014) highlighted the effect of dietary prebiotics on different body growth parameters of fish. However, the application of supplementary prebiotics in aquafeed is now gradually gaining importance in commercial livestock farming practices, the article stresses on the effect of prebiotics on live body weight gain, dressing percentage, weight of vital organs and muscles and mean villus lengths in digestive tract of fish along with their application as growth promoters in commercial poultry and aquafeed (Gatesoupe, 2005, Ganguly et al., 2010; Ganguly, 2014a,b).

It was reported that combined use of MOS and organic acid salts in poultry feed can be used as an alternative to the antimicrobial and antibiotic growth promoters to achieve good health for sustainable and economic poultry production in India (Das et al., 2012).

Antimicrobial properties

Bacteriological studies of intestine of broiler birds revealed reduced E. coli compared with the untreated control group. Salmonellae were not found in any group. No significant difference was observed among control and treatment groups regarding the number of Clostridium sp. present in the intestine. The above result clearly indicated that consumption of prebiotics mixed with poultry feed reduced the load of coliform bacteria in the intestine (Roy et al., 2012).

CONCLUSION

It can therefore be summarized that supplementation of dietary prebiotics in optimum proportions in poultry feed can enhance the immune system of the host by providing increased resistance to infections.

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