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Review Article

PREBIOTICS AND SYNBIOTICS AS FEED ADDITIVES ON PERFORMANCE AND HEALTH OF COMMERCIAL CHICKEN

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PREBIOTICS

Introduction

A prebiotic is a non-digestible food ingredient that beneficially affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon, that can improve the host health.

Characteristics of Prebiotic:

(a) Prebiotics must neither be hydrolysed nor absorbed in the upper part of the gastrointestinal tract.

(b) It should be a selective substrate for one or a limited number of potentially beneficial bacteria commensal to the colon, which are stimulated to grow and/or are metabolically activated.

(c) It must consequently be able to alter the colonic microflora towards a healthier composition.

(d) It must induce systemic effect that is beneficial to the host health.

❖ First, prebiotics are always feed ingredients that are not digested by the host, not or little used and/or metabolised as they pass through the upper portion of the intestinal tract, so they can reach the flora of the large intestine.

❖ Secondly, they have to be able to serve as a substrate for one or more bacterial species with a potentially beneficial effect on the host.

❖ Finally they have to be able to cause a shift in the microflora that improves the health of the host.

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Classes of prebiotics

I. Monosaccharide prebiotics

1. Hexoses : glucose, fructose, galactose, mannose
2. Pentoses : Ribose, Xylose, Arabinose.

❖ Galactose is available mostly under the disaccharide form of lactose.

❖ Mannose is the most commonly used monosaccharide feed additive (Allen *et al.*, 1997). These monosaccharides can form the basis for enzymatically constructed oligo- or polysaccharides.

II. Natural disaccharides

1. Sucrose,
2. Lactose,
3. Maltose

Isomerization products of these compounds can be used as prebiotics. Eg. Lactulose (based on lactose)

Lactose and lactosucrose have prebiotic effects in chickens.

III. Oligosaccharides

Are usually defined as glycosides that contain a limited number of hexose or pentose units. Sometimes they are used in their natural form but mostly they are obtained through enzymatic synthesis or hydrolysis.

Synthetic oligosaccharides can be based on different hexose monosaccharides, for example glucose, fructose, galactose and mannose (Iji and Tivey, 1998). The synthetic route varies, depending on the direct polymerization of disaccharides or the fractionation of microbial cells to obtain the material from the cell wall.

Polysaccharides, when fermented, also yield oligosaccharides.

❖ Fructo-oligosaccharides (FOS) - produced commercially by hydrolysis of inulin.

❖ Fructo-oligosaccharides (FOS) are short-chain polymers of β 1-2-linked fructose units, which are produced commercially by hydrolysis of inulin or by enzymatic synthesis from sucrose or lactose (Le Blay *et al.*, 1999).

- FOS is known for their ability to stimulate the growth of bifido bacteria and to inhibit that of potentially pathogenic bacteria such as entero bacteria, Clostridia and Salmonella.
- FOS has been shown to resistant to intestinal glycolytic enzymes and to pass unaltered to the large intestine where they are fermented by the microflora. Fermentation of FOS leads to the production of short chain fatty acid, which is substrate for energy metabolism in the colonic mucosa stimulating epithelial cell growth.
- Galacto-oligosaccharides – produced industrially by the transgalactosidase activity of beta-galactosidases.
- Mannan – oligosaccharides (MOS) or mannose-based carbohydrates occur naturally in many products such as yeast cell walls and gums. A commercial product is available for poultry, which contains yeast cell wall fragments derived from *Saccharomyces cerevisiae* after centrifugation of a lysed yeast culture (Spring *et al*., 2000).

IV. Polysaccharide prebiotic

The most commonly used polysaccharide prebiotic for chickens is guar gum, produced from the seeds of the guar bean, Cyamopsis tetragonolobus. By selectively cleaving the mannan backbone-chain of guar gum, galactomannans is obtained which is known as Partially Hydrolysed Guar Gum (PHGG).

Mechanism of action of prebiotics

(a) By lowering pH through lactic acid production

Dietary oligosaccharides may directly inhibit the growth of certain intestinal pathogenic species by increasing the concentration of lactic acid, thereby decreasing pH in the lower gut. Like other carbohydrates such as glucose, fructose, sucrose, starch and pectin fructo oligosaccharides induce decrease in pH of the culture medium during anaerobic fermentation.

(b) By inhibiting/preventing colonisation of pathogens

Microbes are able to attach themselves to the mucosa through recognition of oligosaccharide binding sites in the wall. Dietary oligosaccharides attract microbes away from the intestinal sites and thereby reduce colonisation by pathogens. Chickens treated with fructo oligosaccharide had a four fold reduction in the level of Salmonella present in caeca.

(c) Systemic effects

Fructo oligosaccharides are fermented by bifido bacteria, and they partly utilize the energy released by such a metabolism to grow and to incorporate carbon atoms from the fermented carbohydrates into their structural and functional molecules. After quantitatively utilized, this organism produce a mixture of SCFA, L-lactate and carbon dioxide which comprises of 40 % as SCFA, 15 % L-lactate, 5 % as CO_2 and 40 % as bacterial biomass. By production of SCFA and lactate, the metabolic absorption of various ions including Ca, Mg and Fe increases.

After being absorbed SCFA are metabolically utilized by various tissue i.e. butyrate by colonic epithelium, propionate, lactate and acetate by the liver and acetate (partly) by the muscle and other peripheral tissue. SCFA are likely to play a regulatory role in modulating endogenous metabolism.

Prebiotics on health and productivity

Dietary supplementation of mannan oligosaccharides significantly improved the performance and reduced the mortality of chicken reared in a house with a history of performance and mortality problems.

Ishihara *et al*. (2000) reported prevention of *Salmonella enteritidis* colonisation in young and layer chicken. They further observed that supplementation with 0.025 % Partially Hydrolysed Guar Gum (PHGG) to the laying hens decreased the incidence of *S. enteritidis* on the surface of egg shell and in egg white and yolk.

Spring *et al*. (2000) reported that supplementation of mannon oligosaccharides in diet of 3 day-old chicks @ 4000 ppm reduced *S. typhimurium* in caecum at day 10. The mannose residue was effective in preventing Salmonella spp. colonisation.

It is possible that oligosaccharides acting as soluble fibre reduce translocation and help to produce systemic immunity. Mannan oligosaccharide also reduces the antinutritional properties of dietary lectin.

SYNBIOTICS AS FEED ADDITIVE

A synbiotic is, in its simplest definition a combination of probiotics and prebiotics (Collins and Gibson, 1999). Thus the live microbial addition would be used in conjunction with a specific substrate for growth. As such, improved survival and growth of the probiotic ought to occur.

Bailey *et al*. (1991) used a combination of FOS and competitive exclusion flora to reduce Salmonella colonization in chickens. The combination was more effective in reducing Salmonella colonization than FOS or competitive flora alone.

Bengmark (2001) defined synbiotics as products produced by fermentation. Since in mixtures of pre-and probiotics, the prebiotics will be fermented when the appropriate choice of products is made.

Examples of synbiotics:

1. Combination of a fructose-containing oligosaccharide with a Bifido bacterium strain is a potentially effective synbiotic.
2. Use of lacitol in conjunction with lactobacilli as an effective synbiotic.

Use of "designer synbiotics" indicates when the probiotic is genetically modified for improved metabolism of the prebiotic.

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