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Application of Prebiotics in Poultry Production

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KEYWORDS :

Introduction:
Prebiotics are defined as 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 (Gibson and Roberfroid, 1995). In other words, prebiotics are meant to provide a substrate for beneficial gastrointestinal microbes.

Prebiotics are non-digestible food ingredients that stimulate the growth and activity of bacteria in the digestive system in ways claimed to be beneficial to health. Large amounts of bacteria present in the monogastric small intestine, which are potentially capable of utilizing indigestible carbohydrate sources for energy. They can be used as potential alternatives to growth promoting antibiotics. For several decades, antibiotics and chemotherapeutics in prophylactic doses have been used in animal feed to improve animal welfare and to obtain economic benefits in terms of improved animal performance and reduced medication costs.

The use of prebiotics or fermentable sugars instead of antibiotics is going to be popular in birds in order to improve the useful microbial population of the Gastrointestinal (GI) tract. Enteric diseases are an important concern to the poultry industry because of lost productivity, increased mortality and the associated contamination of poultry products for human consumption. Prebiotics have been shown to alter GI microflora, alter the immune system, reduce pathogen invasion including pathogens such as *Salmonella enteritidis* and *E. coli*.

What's Really Growing in Your Food!
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Prebiotics are food ingredients that are not digested by birds but can be utilized by probiotic bacteria to spur their growth and aid their survival in the digestive tract. They also can provide the building blocks used by bacteria to synthesize compounds beneficial to the host. Prebiotics generally take the form of carbohydrates and are often also classified as soluble fibers. Popular prebiotics found in many food products include various types of oligosaccharides as well as inulin. An interesting facet of prebiotic function is that the area of the digestive tract in which the prebiotic nourishes its target bacteria is dependent upon the chemical chain length of the prebiotic. Short chain prebiotics are fermented more quickly, allowing them to feed bacteria inhabiting the primary areas of the digestive tract. Longer chain prebiotics ferment more slowly and are consumed by bacteria living further along in the colon. So-called "full-spectrum" prebiotics are comprised of compounds of many different chain lengths and are able to nourish the entire colon.

Characteristics of prebiotic:
- It should be neither hydrolyzed nor absorbed in the upper part of the gastrointestinal tract.
- It should be a selective substrate for one or limited number of commensal bacteria in caecum/colon, which are stimulated to grow or metabolically activated.
- Able to alter the colonic flora in favour of a healthier composition.
- Alter luminal or systemic aspects of the host defense system.
- It should be palatable as food ingredient and large-scale processing must be easy.
- It should have known structure, which can be documented.

Sources
Traditional dietary sources of prebiotics include soybeans, inulin sources (such as Jerusalem artichoke, jicama, and chicory root), raw oats, unrefined wheat, unrefined barley and yacon. It is becoming more common to properly distinguish between prebiotic substances and the food that contains them. References to almonds, honey and other foods (most commonly in promotional materials from growers of those foods) as "a prebiotic" are not accurate. No plant or food *is* a prebiotic.

Substances used as prebiotic:
Non-digestible carbohydrates (oligo and polysaccharides), some peptides, proteins and certain lipids (both ester and disaccharide consist of glucose and galactose, which has prebiotic effect in chickens. Since chickens does not have lactase enzyme, lactose enters to the lower segment of the intestine and caeca, where hydrolyzed by microbial activity.

Prebiotics & their types:
Classification of some naturally occurring and synthetic prebiotics and their sources are given below in the table.

Classification	Origin / Manufacturing Procedure
Disaccharides, Oligosaccharides	Sugar
Lactulose	Lactose synthesis
Lactitol	Lactose synthesis
Fructo- oligosaccharides	Legumes, *vegetables, extracts hydrolysis of cereals.*
Soybean oligosaccharides	Extraction / hydrolysis of soy bean
Xylo-oligosaccharides	Plant sources
Trans Galacto-oligosaccharides	Lactose synthetic
Inulin	Extracts obtained from legumes, vegetables and cereals.
Resistant starches	Extracts obtained from legumes, vegetables and cereals.

Comparative usage of probiotics and prebiotics:

Probiotics	Prebiotics
Modify intestinal microbiota	Increase production of VFA
Increase immune system	Stimulate biomass and stool bulking
Reduce inflammatory reactions pathogen colonization	Increase B vitamin synthesis Prevent Improve mineral absorption
Enhance animal performance	Prevent cancer
Decrease carcass contamination	Lower serum cholesterol
Decrease ammonia and urea excretion	Lower skatol, indole, phenol, etc

Prebiotics in Poultry Production
The intestinal microbiota, epithelium and immune system provide resistance to enteric pathogens. Recent data suggest that resistance is not solely due to the sum of the components, but that cross-talk

between these components is also involved in modulating this resistance. Inhibition of pathogens by the intestinal microbiota has been called bacterial antagonism, bacterial interference, barrier effect, colonization resistance and competitive exclusion. Mechanisms by which the indigenous intestinal bacteria inhibit pathogens include competition for colonization sites, competition for nutrients, production of toxic compounds, or stimulation of the immune system. These mechanisms are not mutually exclusive and inhibition may comprise one, several, or all of the mechanisms. Consumption of fermented foods increase the population of lactic acid bacteria (lactobacilli and bifido bacteria) which has been associated with improved health. Research over the last century has shown that lactic acid bacteria and certain other microorganisms can increase resistance to disease and that lactic acid bacteria can be enriched in the intestinal tract by feeding specific carbohydrates.

Function

The prebiotic definition does not emphasize a specific bacterial group. Generally, however, it is assumed that a prebiotic should increase the number or activity of bifidobacteria and lactic acid bacteria. The importance of the bifidobacteria and the lactic acid bacteria is that these groups of bacteria have several beneficial effects on the host, especially in terms of improving digestion including enhancing mineral absorption and the effectiveness and intrinsic strength of the immune system. A product that stimulates bifidobacteria is considered a bifidogenic factor. Some prebiotics may thus also act as a bifidogenic factor and vice versa, but the two concepts are not identical.

Effects

Studies have demonstrated positive effects on calcium and other mineral absorption, immune system effectiveness, gastric pH and intestinal regularity. It has been argued that many of these health effects emanate from increased production of short-chain fatty acids (SCFA) by the stimulated beneficial bacteria. Thus food supplements specifically enhancing the growth of SCFA producing intestinal bacteria (such as clostridia and bacteroides species) are widely recognized to be beneficial. Production of SCFA and fermentation quality are reduced during long-term diets of low fiber intake. Until bacterial flora are gradually established to habilitate or restore intestinal tone, nutrient absorption will be impaired and colonic transit time temporarily increased with an immediate addition of higher prebiotic intake.

The recommended intake of Prebiotics:

The dietary intake of oligosaccharides is difficult to estimate, Although no standards are available for the intake of *prebiotics* (inulin and oligofructose), a minimum of 5 g per day is recommended. All fibres act as prebiotic in varying degrees. Fibre consumption benefits our intestinal ecosystem, improve immunity and overall health. Prebiotics, especially, inulin helps in the improvement of mineral absorption like zinc and copper, improve calcium bioavailability, results in better lipid metabolism, improved immuno stimulation and helps in combating lactose intolerance.. Prebiotic agents have significant clinical beneficial effects in the prevention and management of abnormalities of gastro intestinal tract. Prebiotics also aid in treating various disorders like necrotic enteritis and gastrointestinal disorders by increasing the biomass of *probiotics* and stool bulking.

Prebiotics and thier resistance to gastrointestinal infections

Certain individual pathogens of the gut, often transmitted in food or water, have the ability to cause severe discomfort. There is a need to manage such conditions more effectively. The route of reducing the risk of intestinal infections through diet remains largely unexplored. Antibiotics are effective at inhibiting pathogens; however, these should not be prescribed in the absence of disease and therefore cannot be used prophylactically. Moreover, their indiscriminate use has reduced effectiveness. Evidence has accumulated to suggest that some of the health-promoting bacteria in the gut (probiotics) can elicit a multiplicity of inhibitory effects against pathogens. Hence, an increase in their numbers should prove effective at repressing pathogen colonization if/when infectious agents enter the gut. As such, fortification of indigenous bifidobacteria/lactobacilli by using prebiotics should improve protection. There are a number of potential mechanisms for lactic acid bacteria to reduce intestinal infections.

Firstly, metabolic end products such as acids excreted by these micro-organisms may lower the pH to levels below those at which pathogens are able to effectively compete. Also, many lactobacilli and bifidobacteria species are able to excrete natural antibiotics, which can have a broad spectrum of activity. Other mechanisms include an improved immune stimulation, competition for nutrients and blocking of pathogen adhesion sites in the intestine. Many intestinal pathogens like type 1 fimbriated Escherichia coli, salmonellae and campylobacters utilize oligosaccharide receptor sites in the gut. Once established, they can then cause gastroenteritis through invasive and/or toxin forming properties. One extrapolation of the prebiotic concept is to simulate such receptor sites in the gut lumen. Hence, the pathogen is 'decoyed' into not binding at the host mucosal interface. The combined effects of prebiotics upon the lactic acid flora and anti-adhesive strategies may lead towards new dietary interventions against food safety agents.

Bacteria form a principal concern because they are very ubiquitous and are therefore likely to contaminate food in the first place. Moreover, the food environment can provide a good matrix and substrate supply for growth. Bacteria proliferate at a quick rate, although the minimum level for detection does vary markedly.

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