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Effects of corn husks derived xylooligosaccharides on performance of broiler chicken

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ABSTRACT

Pentose based prebiotic xylooligosaccharides attracts greater attention around the world because it exhibits several beneficial effects to the host. Therefore, an *in vivo* experiment was carried out to reveal the effects of corn husks derived xylooligosaccharides in broiler chicken. The day-old broiler chickens (96; divided into 2 groups) were raised for 3 weeks on control diet or same diet supplemented with 0.5% xylooligosaccharides (XOS); derived from corn husks. In order to produce the XOS, xylan was extracted from the corn husks by alkaline extraction. The xylan was subjected to enzymatic hydrolysis at pH 5.8, temperature 44°C, enzyme dose of 5.7U/ml for 17h to yield XOS. The concentrated XOS was supplemented in the diet of broiler chicken during the entire experimental periods. Albeit, no positive influence was noticed on either the live weight or feed conversion efficiency, but 0.5% XOS supplementation resulted in to selective stimulation of *Bifidobacteria*, coupled with reduction in the population of *Streptococci* and *E. coli* in the caecum of broiler chicken. In line with the caecal microflora changes, blood biochemical profiling reflected reduced cholesterol, triglycerides and glucose concentration as a result of XOS supplementation. Thus, corn husks derived XOS showed positive influence on caecal microflora and blood biochemical profile in broiler chicken and could be incorporated in the diets for ensuring beneficial effects.

Key words: Xylooligosaccharides, Feed additive, Broiler chicken, Gut microflora

The primary goal of the broiler chicken industry is to deliver the safe meat for human consumption after due contemplation on the public health, consumer mindset, environment and finally the welfare of the birds. In keeping with the pace for demands of the poultry meat by ever increasing human population, the broiler industry has made a long journey from its informal farmyard (backyard) activity to modern factory style enterprise involving dietary, management, housing, stress amelioration, quality control etc (Prasad *et al.* 2015). Along with the regular supply of meat to the consumer, the broiler chicken sector also ensures sustainable livelihood to the millions of people. The visible growth witnessed during the past century is the fruit of untiring efforts contributed by all sectors of people associated with one or other activities of broiler chicken industry. From nutritional point of view, application of antibiotics as feed additive was thought to be one of the major contributors for enhancement of productivity as well as control of diseases in the poultry industry (Samanta *et al*. 2013). As a result of continuous application of antibiotics as growth promoters in food animals, a serious public health issue has emerged out, particularly on development and transfer of antibiotic resistance gene from animal to human (Mathur and Singh 2005). Global apprehensions on "development of microbial resistance to antibiotic and transference of antibiotic resistance genes" from livestock to human led to the ban on antibiotics usages as growth promoters in the European nations since January, 2006 and several countries are on the way to restrict feed application of antibiotics in the poultry industry (Castanon 2007). This has resulted into substantial increase in the usages of therapeutic antibiotics (Gaggia *et al*. 2010). Therefore, finding out the viable alternative of antibiotic to protect the gastrointestinal tract of animals is an essential task with regards to animal welfare and public health concerns. One of the alternatives suggested is prebiotic supplementation (Biggs *et al*. 2007). Albeit, intensive research dedicated to the evaluation of fructose based oligosaccharides such as inulin and fructooligosaccharides in the diet of birds, however, meager information is available currently on the effectiveness of xylooligosaccharides (XOS), a xylose based prebiotic (Zhenping *et al*. 2013).

Recently, there has been a growing interest on the emerging prebiotic XOS; because its production largely

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depends upon the agricultural waste or byproducts; unsuitable for human consumption (Samanta *et al*. 2012). The XOS are the short chain carbohydrate molecules made up with xylose monomers linked by β-1,4- linkages. In the list of prebiotics, the XOS is the only one that could be produced from the abundantly available, renewable and low cost agricultural biomaterials such as corn cobs, corn husks, sugarcane bagasse, ragi straw, wheat straw etc. (Samanta *et al*. 2015). Albeit, fructo-oligosaccharides and galacto-oligosaccharides are extensively explored for application as prebiotic, XOS have been studied in fewer details (Immerzeel *et al*. 2014). Nevertheless, the available reports suggest its strong potential over fructo-oligosaccharides as prebiotic (Kumar and Satyanarayan 2015). Several health promoting effects of XOS including improvement of bowel function, calcium absorption, and lipid metabolism, prevention of dental caries, protection against cardiovascular disease and reduction of colon cancer are evident (Samanta *et al*. 2015). In view of the above perspectives, the present research was aimed to assess the effects of XOS on body weight, feed conversion ratio, caecum microflora and blood biochemical profile in broiler chicken.

MATERIALS AND METHODS

Commercial day-old broiler chicks (Vencob) were procured from the M/S Venkateshwara Hatcheries Private limited, India and were randomly divided into 2 groups (N=96). The starter diet of both the groups comprised maize 58.65 parts, soybean meal 36 parts, vegetable oil 2 parts, limestone 1 part, dicalcium phosphate 1.7 parts, salt 0.35 parts, lysine 0.25 parts, methionine 0.13 parts. The calculated metabolizable energy, crude protein, lysine and methionine of the diet were 3008 kcal/kg, 22.21%, 1.37% and 0.5%, respectively. In the XOS supplemented group, concentrated XOS syrup was mixed daily with the diet in such a way so that prebiotic concentration reached to 0.5% level of diet. The experimental birds were housed in 8 cages (12 chicks in each cage) with 4 replicates each in control as well as XOS supplemented groups. The experimental protocols met the regulations of the Institute Animal Ethics Committee guidelines. The birds were offered *ad lib.* feed and water. Measured quantity of feed was offered daily to the birds in each cage and weekly feed intake and body weight gains were recorded. After 3 weeks of feeding with the experimental diets, 10 birds from each group were sacrificed by cervical dislocation to collect caecal samples for monitoring the microflora changes. The caecal contents were homogenized in sterile saline solution (0.9% W/V) and shaken vigorously. Further, serial dilutions were made to enumerate the population of gut microflora. The caecal population of *Lactobacillus*, *Bifidobacteria*, *E. coli* and *Streptococcus* was carried out in agar plates from the serially diluted samples and expressed as $\log_{10}$CFU. Prior to sacrifice, blood samples were collected through jugular vein to study the blood biochemical profiles.

The XOS was produced through enzymatic hydrolysis of xylan obtained from the corn husks. Corn husks are reported to be one of the richest sources of xylan among the agricultural wastes and it ranges between 33 to 44% on dry matter basis. In the present investigation, it was found to be as high as 39% on dry matter basis. Xylan was extracted from corn husks with 12% NaOH coupled with application of steam. The extracted xylan was subjected to enzymatic hydrolysis into XOS at pH 5.8, temperature 44°C, duration 17.5 h and xylanase enzyme 5.73 U as the above variables yielded highest XOS (9.55 g /100g of xylan) production (Samanta *et al.* 2016). The XOS was harvested following enzymatic hydrolysis after centrifugation at 6000 rpm for 30 min and concentrated by evaporation. It was further utilized in the diets of broiler birds during the investigation. The data were analyzed by one-way ANOVA.

RESULTS AD DISCUSSION

To assess the efficacy of the corn husks derived XOS (0.5%) in maintaining favorable gut microflora and blood biochemical profile, a feeding trial was conducted in broiler chicken for 3 weeks. As inclusion of prebiotic through feed is better than mixing with drinking water, hence concentrated XOS syrup was uniformly mixed with the diets and offered to the treatment group only. Weekly live weight changes and feed conversion efficiency are presented in Table 1. In the current study, no significant effect of XOS supplementation was noticed on the body weight gain or feed conversion efficiency in the broiler chickens. Earlier reports also indicated no significant influence of dietary supplementation of prebiotics (inulin, oligofructose, mannanoligosaccharide, short-chain fructooligosaccharides, transgalactooligosaccharides, XOS or arabino-XOS) on the body weight gain in birds (Biggs *et al*. 2007). In contrast, around 9.44% greater body weight gain and 4.18% lower feed conversion efficiency was recorded in chicken with 1% XOS supplementation for a period of 59 days (Zhenping *et al*. 2013).

The efficacy of XOS in modulating the gut microflora and altering the blood biochemical indicators towards beneficial side was evident even before the emergence of the concept of prebiotic. In the present investigation, the XOS exerted a positive influence over beneficial microflora and a negative influence on harmful microflora inhabited

Table 1. Effect of xylooligosaccharides (XOS) supplementation on the body weight changes, feed conversion efficiency in broiler chickens

Parameters	Control birds	0.5% XOS administered birds
BW of day-old chicks	45.6±1.68	45.5±1.54
BW at 1st wk of age	145.73±5.28	145.29±2.57
BW at 2nd wk of age	355.15±9.81	353.82±4.52
BW at 3rd week of age	710.98±11.77	679.04±10.30
FCR at 1st wk of age	1.409±0.06	1.453±0.02
FCR at 2nd wk of age	1.646±0.06	1.716±0.03
FCR at 3rd wk of age	1.798±0.04	1.948±0.05

in the caecum of broiler chicken (Table 2). Further, the supplementation of XOS significantly (P<0.05) reduced blood cholesterol, glucose and very low density lipoprotein in the experimental group as compared to the control. Additionally, although not significant, XOS supplementation reduced the blood level of low density lipoprotein and triglycerides in the experimental birds.

Nevertheless, extensive *in vivo* evaluation of the XOS has not been performed because of the ready availability of commercial fructan group of prebiotic especially inulin, oligofructose and fructo-oligosaccharides. The importance of well-balanced gut microbial ecosystem in birds is well recognized because it ensures healthy status with higher production performances. Following the ban on the application of antibiotic as growth promoters, prebiotic is recommended as preferred choice of feed additives as these have the capability to selectively promote the growth and multiplication of beneficial gut microflora coupled with the inhibition of pathogenic microflora (Gaggia *et al*. 2010). In the present investigation, although not significant, XOS supplementation resulted in the increased population of beneficial (*Bifidobacteria*) and decreased population of pathogenic (*Streptococci* and *E. coli*) bacteria. Inconclusive reports are available on the effect of prebiotic supplementation on animal performance as its efficacy depends on many other factors such as nature of the prebiotic molecules, levels of inclusion, duration of supplementation, housing management etc. The current findings are in agreement with the previous reports on the efficacy of inulin or mannan-oligosaccharides in maintaining the favourable gut microflora composition in chickens (Kleessen *et al*. 2003). The present paper demonstrated the effects of XOS on blood biochemical profile in broiler chickens. The cholesterol and glucose lowering effects of XOS in the broiler chickens may be due to higher production of short chain fatty acids from the fermentation of XOS. Among the different short chain fatty acids produced during the course of prebiotic fermentation, the propionate is one of them. In laboratory animals, propionate is reported to inhibit the metabolic pathways of gluconeogenesis and cholesterol synthesis and thereby demonstrates positive effects (Santini *et al*. 2010). In the present investigation, the similar blood biochemical changes were noticed as a result of 0.5% corn husks derived XOS supplementation in broiler chickens.

Table 2. Effect of xylooligosaccharides (XOS) supplementation on ceacum microflora, visceral organs and blood biochemical profile of broiler chickens

Parameters	Control birds	0.5% XOS administered birds
Microbial population log_{10} CFU/g of caecal contents		
E. coli	6.84±0.32	6.35±0.09
Streptococci	5.53±0.18	5.36±0.23
Lactobacillus	3.27±0.33	3.26±0.28
Bifidobacteria	7.08±0.47	7.26±0.53
Visceral organs		
Bursa weight (g)	3.20±0.34	3.18±0.20
Caecum weight (g)	10.83±0.78	10.90±0.79
Gizzard weight (g)	23.17±0.81	25.54±0.89
Heart weight (g)	7.33±0.23	7.66±0.20
Small intestine weight (g)	76.07±3.19	73.63±3.95
Spleen weight (g)	0.948±0.09	1.079±0.07
Blood biochemical profile		
Cholesterol (mg/dl)*	151.6±5.43	138.3±4.48
Glucose (mg/dl)*	235±3.91	219±8.50
High density lipoprotein	41.4±1.30	44.7±0.83
Low density lipoprotein	82.7±5.25	72.6±5.71
Triglycerides	113.8±8.80	91.2±5.96
Very low density lipoprotein*	22.3±1.74	17.7±1.17

* P<0.05.

The current study revealed that the dietary inclusion of XOS in broiler chickens promoted the favorable caecal microflora composition and blood biochemical indicators. These findings underline the value of prebiotic XOS on modulating gut microflora in broiler chicken.

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