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Application Study of Xylo-oligosaccharide in Layer Production

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Abstract

Xylo-oligosaccharide (XO) is a kind of functional oligosaccharide, a kind of safe and health additive. Because of its unique properties, XO has been used in food, medicine and health care widely. As additives for functional foods, XO impels economy to create a great deal of nutrimental substance and presents prebiotic action. But its application in animal husbandry in China has just started. The research progress of xylo-oligosaccharide's physical-chemical properties, value and application in layer production is introduced in this article especially.

Keywords: Xylo-oligosaccharide, Layer, property, Value, Application perspective

1. Introduction

Xylo-oligosaccharides (XO) are sugar oligomers showing potential for practical applications in a variety of fields, including pharmaceuticals, feed formulation, agricultural purposes and food applications (Va′zquez , M.J. et al, 2001, 387-393). As additive for functional foods, XO present prebiotic action (Fooks, L.J. et al, 2002, 67-75), showing positive biological effects such as improvement of the intestinal function by increasing the number of healthy Bifidobacteria (Izumi, Y. et al, 2003, Patent 2003048901). Additionally, XO show an ability for suppressing the growth of Clostridium and bacteriostatic action against Vibrio anguillarum (Izumi, K. et al, 2001, Patent 2001226409). Commercial developments have been focused on the XO utilization as suitable components of synbiotic compositions. In 1993,Suntory company manufactured the functional food which contains xylo-oligosaccharide, bifidobacteria, mineral and tea extracts for the first time (Va′zquez , M.J. et al, 2000, 387-393).

Xylo-oligosaccharide's act as a new kind oligosaccharide additive, first throw up to market by suntory group in Japan in 1989. Xylo-oligosaccharide largely is mixture of disaccharide and trisaccharide which are hydrolyzed from xylan. Xylan is hydrolyzed by interior contact xylanase at β-1,4 glucosidic bond.

The safe and green livestock and poultry product has become a kind consume trend, the remaining problem of harmful materials in the product has become a key factor which hold-up the development of domestic livestock breeding. The animal feed additive is one of the main reasons which cause vestigital of harmful material in livestock and poultry product, so brought about researches upsurge in nuisanceless feed additive in recent years. Xylo-oligosaccharide in the same way as a kind of neotype, high performance and nuisanceless feed additive which not only can prevent disease and antidisease but also can elevate cultivational yield and quality.

2. Characteristic of Xylo-oligosaccharide

2.1 Physicochemical property

Xylo-oligosaccharide is one of the Oligosaccharide which is combined with 2-7 xylopyranoses through β-1,4 glycosidic bond.The main composition of its product is xylopyranose, xylobiose, trisaccharide and other oligosaccharides. Xylo-oligosaccharide's acid Stability and thermal stability are both better (Bhat M K., 1998, 787-802), when heated at pH4.0, 80-150℃ for 20min still keep 100% integrity, and at 120 ℃ for 1h still stable. Xylo-oligosaccharide's storage

stability is also very good, at pH 2.5-8.0, 37 ℃ deposit 3 months, it almost didn't break with loss. Digestion test in vitro showed that its digestion residual rateGastric in Juice, pancreatic juice and small intestinal mucosa enzyme juice is 99.9%, 99.8% and 99.6% respectively.

2.2 Physiology property

Xylo-oligosaccharide is physiology functionality oligosaccharide, which was confirmed by long term and widely research.It can be used by intestinal available bacteria bifidobacterium but not intestinal harmful bacteria clostridium perfringens.Its main physiology function be concluded as follows.

2.2.1 mediate the intestinal microflora

Health protection of xylo-oligosaccharide is mostly based on its differential effect on pathogens and probiotic. Xylo-oligosaccharide has strict selectivity proliferative effect on bifidobacterium and lactobacillus (Jeong K.J., 1998, 113-118), but has obvious restrain function on escherichia,enterococcus and clostridium.In vitro experiment showed that bifidobacterium could utilize xylobiose, trisaccharide and other oligosaccharides (Suwa Y. et al, 1999), lactobacillus and other probiotic also can ferment xylo-oligosaccharide ,but not escherichia, enterococcus and clostridium (Crittenden R. et al, 2002, 781-789). In vivo study on rats showed that xylo-oligosaccharide had strict selectivity proliferative effect on bifidobacterium, not only proliferate quantity, but also prolonged life time (Yuan X. et al, 2005, 225-229). The mechanism xylo-oligosaccharide multiplicating probiotic is that it affords carbon for probiotic(Crittenden R. et al, 2002, 781-789). Xylo-oligosaccharide is a kind of nondigestible oligosaccharide, it can't be capitulated by gastric acid and digestive enzyme and not absorbed by intestinal mucosa. After taking xylo-oligosacchride 24h, it can't be checked in the dejection and urine, indicating that it has been metabolismed by intestinal microflora (Okazaki M. et al, 1991, 41-44). Otherwise, it also indicated xylo-oligosacchride could knock-down intestinal deoxycholic acid, taking health products that contain xylo-oligosacchride can significantly reduce the risk of colon cancer (Rull P. S. et al, 2006, 1 614 357).

2.2.2 Improving immunity function of animal

Functional oligosaccharide can improve the development of enternal beneficial bacteria, form biological barrier, inhibit harmful bacteria. Normal flora has extensive immunogenicity, which can stimulate and promote a nimal generating immunity function, promote to produce interferon, activate macrophage and lymphocyte B and T,increase natural killing cells ability, induce antibody's producement, enhance immunity ability. Be also likely to low the assistance Th-2 (the T lymphoid cell) reactions combine to build up Th1, regulate Th1/Th2 of unbalance appearance. Study indicated that for infant who is devoided of breast milk, bifidobacterium proliferation can prominently improve the immunity ability, moreover, guard against and cure illness induced by immunity function lowlihead (Stahl B et al, Patent WO 2,005,039,597; 2005.).

2.2.3 Ferment the carbohydrate in the food,prevent constipation

Xylo-ologosaccharide makes bifidobacterium proliferate. Bifidobacterium use acetic acid and lactic acid,which produced by functional oligosaccharide, to stimulate gut motion, increase feces moist degree and keep certainly osmotic pressure, in order to prevent constipation. The results showed that xylo-ologosaccharide significantly improved the symptoms of constipation after three weeks taking it according to 0.7g/d, for the water in the feces increased from 35% to 75% before and after taking it (Jian-xian Zheng et al, 2004,181-182).

2.2.4 Synthesize vitamin

Functional oligosaccharide make bifidobacterium proliferate, bifidobacterium can synthesize vitamin B1, B2, B6, B12 ,nicotinic acid and folic acid and so on.

2.2.5 Participate in the digestion of food

Absorb of functional oligosaccharide can make bifidobacterium proliferative. Bifidobacterium can decompose all kinds of proteins to amino acid and peptide which can be easily absorbed, it also decompose cholesterol and lipid. Meanwhile in the acid environment, mineral solubility can increase, improve intestinal mucosa absorptivity.

2.2.6 Have parts of physiology functions of dietary fiber

Functional oligosaccharides belong to water-soluble dietary fiber, have parts of physiology functions of dietary fiber and cannot be easily absorbed. Functional oligosaccharides decrease cholesterol and triglycerides (GTO) in the blood and liver, urge blood lipid normalization, low the caloric value, won't induce blood glucoseirse.

2.2.7 Xylo-oligosaccharide special physiology function

Xylo-oligosaccharide can satisfy probiotic which is a functional component that can't be absorbed in vivo. Probiotic can selectively stimulate and promote one or more enternal microorganism to develop, so that it can improve the host's health.

3. Value and applications of xylooligosacc -harides in the layer production

Xylo-oligosaccharides have good physicochemical and physiological properties, so have following characteristics in the layer production.

3.1 Elevate brooding bred rate,laying period conserve rate and laying rate

In the production, xylo-oligosaccharides can boost organism immune function, so elevate brooding bred rate, laying period conserve rate. Shu-ying Han et al, found that brooding bred rat is 98.4% and 97.2% respectively in two batches roman chickens in 2003, and one of the batches laying period death and culling rate is 4.5%.Wang Hua added 0.05% xylo-oligosaccharides in animal feeds and elevated laying rate 4%-5% significantly (Hua Wang, 2005, 23-24). Besides, it shows that the yield and the weight of eggs rose respectively 2.0%~4.0% and 4.5%~6.3%, and the ratio between eggs and feed rose 3.6%~5.7% when the dosage of xylo-oligosaccharides was 0.007% (g/g feed) (Yong Xu et al, 2005,56-59). .

3.2 Elevate the egg's quality,stability and thickness,convenient for coloring

Xylo-oligosaccharides can make the egg yolk bright-coloured and well-distributed, the egg albumen thickening (Guo-hua Dang et al, 2005,29-36) divided 1260 newborn roman layer into 7 groups, added 0.01%,0.015%,0.02%,0.025%,0.03% xylooligosaccharides in the group 2,3,4,5,6 respectively, and the 7th group added 0.1% fructo-oligosaccharide as control. The results showed that adding 0.015% and 0.02% xylo-oligosaccharides could elevate layer daily mean laying rate and egg weight significantly(p<0.01),and also 0.02% group could increase eggshell intensity, eggshell thickness and egg rate(p<0.01), however had no effect on the egg shape index, egg yolk colorimetric, egg yolk rate and haugh unit.

Guo-hua Dang et alalso found that adding 0.015% xylo-oligosaccharides in the day food could decrease crude fat more significantly than 0.020% group (Guo-hua Dang et al, 2003, 33-34), and two groups both cut down cholest notablely, through 720 layers experiment. As the mechanism of oligosaccharide decrease fat, some investigate showed that it could promote intestinal bifidobacterium which can form bionic to hyperplasy. Bionic inhibits fat synthesis related hormone so as to depress lipopexia. There is report show that xylo-oligosaccharide can decrease more than 15% cholest. Study also considered that bacillus bifidus and lactobacillus could assimilate cholest, thus decrease cholest and fat. However the mechanism still needs more researches.

Yong Xu et al detected the egg quality and found that there was no difference on the egg shape, eggshell, essential amino acid and microelement before and after adding xylo-oligosaccharide, meanwhile they found that adding 0.007% xylo-oligosaccharide could make the eggshell bloom, so develop a new way in high quality viridis egg production.

3.3 Raise immunity

Xylo-oligosaccharide excites layer's immune system, enhance immunity and disease resistance, reduce disease incidence, so diminish the antibiotic addition that low the medication cost. After adding the xylo-oligosaccharide, intestinal disease and respiratory tract disease significantly decrease, also washy disappeared,moreover there was no adverse effect after epidemic prevention, dejecture shape and colour at equal pace. .Feeding porcine with xylo-oligosaccharides, diarrhea rate reduce more than 60%, and Ig G, Ig M and Ig A in the serum boost notably, illuminating that xylooligosaccharide can improve the immunity markedly (Ji-cheng Wang et al, 2006, 3-7).

3.4 Improve the chicken house environment

In keep the chicken production, if there isn't enough airing, alkaline air will stir your nasal, especially in winter. After adding the xylo-oligosaccharide, nutrient substance absorb and use ratio can be elevated, there is less protein in dejecture so that alkaline air reduce and thus environment sanitation condition improved.

3.5 Improve feather sheen

Because of the fully absorption of nourishment material, strengthened the anti-disease ability of the layer, the layers feather color is shining, color and luster good, feather fluffy and sheen bad rarely seen.

3.6 Raise feed conversion rate

Xylo-oligosaccharide can improve animal intestinal microecology condition, inhibit pathogenic bacteria development, promote animal feed's digestion and absorption. Guohua Dang et al[17],added 0.015% and 0.02% xylo-oligosaccharide into the diet and found that layer feed conversion increasing significantly (p<0.01). Yong Xu et al reported that when xylo-oligosaccharide accounts for 0.007% of diet its growth promotion effect was best, so ratio of egg to feed can increase 3.6~5.7%.When xylo-oligosaccharide and calcium are absorbed in the meantime, it will promote calcium absorption, and stimulate organism to form many kinds nutrient substance, such as V_{Bl}, V_{B2}, V_{B6}, V_{Bl2},V_{PP} and V_M. Xylo-oligosaccharide influences layer productive performance. And xylo-oligosaccharides significantly reduced the cholesterol content of eggs, and moreover elevate the layersresistance and desend the death rate, so boost the comprehend economic returns of layer breeding, even make the population risk of the layer desend about 70%. In

conclusion, xylo-oligosaccharide is green color environmental protection additives

4. Mechanism of action

At present, action mechanism of xylo-oligosaccharide still needs further researches. Proliferation test in vitro confirmed that xylo-oligosaccharide extracted from vegetable fibre using biotechnology could make layer intestinal tract bacillus bifidus proliferate effectively, so it brings out much effect on health and growth. Now four action mechanisms of xylo-oligosaccharide on layer explained as follows. First, antagonism, xylo- oligosaccharide offers carbon source to probiotics, make banillus bifidus and other beneficial bacterium proliferate greatly so as to competively repel pathogenic bacteria field planting consolidation site and finally inhibit pathogenic bacteria. Second, improve animal intestinal microecology condition, inhibit pathogenic bacteria, elevates feeder digestion and absorption. Third, increase animal's non-specificity immunologic competence, enhance resistance of organism to pathogenic bacteria. Forth, decompose noxious substance, form organic acid and other beneficial substance, less dejecture odour, improve breeding circumstance.

5. Xylo-oligosaccharide's application prospect

Many study indicated that adding xylo-oligosaccharide into feeder could increase layer productive performance. Xylo-oligosaccharide can promote layer to absorb nutrient substance and utilize feeder, make layer grow and produce, improve product quality. Among more than ten kinds oligosaccharides product, xylo-oligosaccharide is the most famous. Currently in the animal feed additive, because of its special advantage, such as it is a kind of natural sugar material, is safe and animal digestive enzyme system cannot decompose it, xylo-oligosaccharide has a wide perspective in layer production. Xylo-oligosaccharide can all arrive large intestine, and its stability and compatibility are both good, moreover promote layer to grow. Therefore, as feed additive, xylo-oligosaccharides is provided with capacious development space.

In our country, xylo-oligosaccharide still be placed in a research and exploited phase, haven't entered large-scale industrialization production. Therefore, we shoud begin from three aspects in the production. Firstly, consummate xylo-oligosaccharide enzymic method production process. Secondly, Development of xylanase and xylo-oligosaccharide has great potentialities and profound significance, so must enlarge application range. Thirdly, take further research on xylo -oligosaccharide action mechanism in layer production.

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