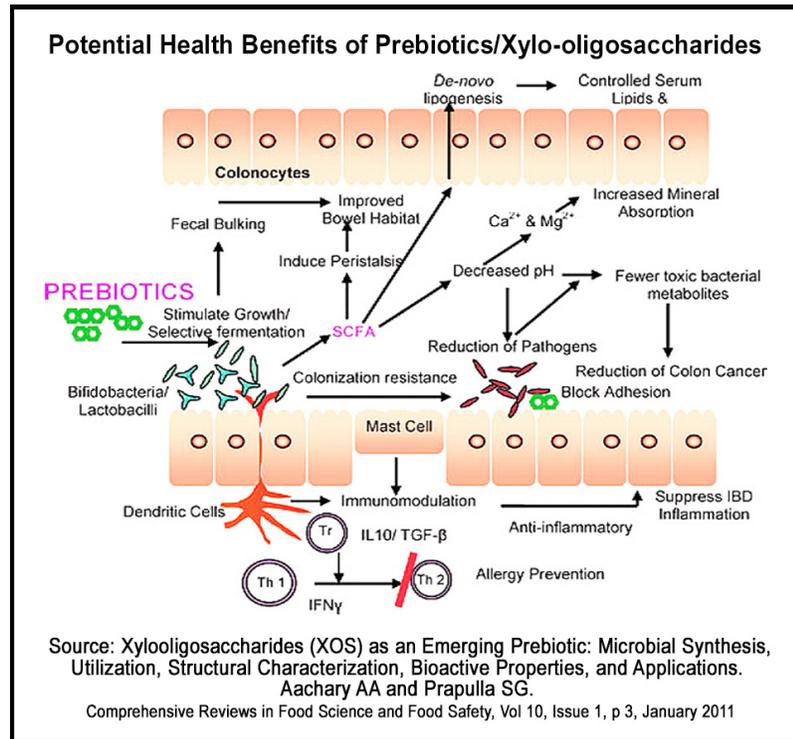
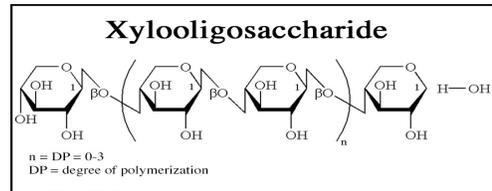


► **Xylo-oligosaccharides (XOS)** are prebiotics, ([non-digestible] dietary ingredients that pass unaltered into the lower GI tract and beneficially affect the host by selectively stimulating the growth and/or activity of one or more beneficial bacteria in the colon.<sup>1</sup> XOS are abundant in nature and derived from xylan, a yellow, water-soluble, gummy polysaccharide found in plant cell walls that yield xylose upon hydrolysis. Agroresidues [agricultural wastes] such as straw, stalk, cob, hull, husk, bagasse and pulp of hardwood represent a major source of xylan.<sup>2</sup> XOS provide a wide array of demonstrated and potential benefits, with no adverse effects were observed with dosages of (4 grams)<sup>3</sup> or even (8 grams)<sup>4</sup> daily. The fermentation of XOS produces short chain fatty acids (SCFAs), improves gut epithelial health and supports regulation of the metabolic process. XOS



possess bound phenolics including ferulic and coumaric acids that impart additional antioxidant effect and immuno-modulatory activity.<sup>5</sup> The graphic shown here provides representation of both numerous and wide-ranging established and potential benefits.<sup>6</sup> A referenced listing of research studies demonstrating such benefits follows.

### IMPROVED BOWEL HEALTH

is supported by: 1) **Promotion of healthy intestinal flora/Stimulation of beneficial bacteria:** primarily Bifidobacteria and lactobacilli;<sup>7,8</sup>

2) **Decrease in potentially harmful bacteria:** *Enterococcus*, *Enterobacter*, and *Clostridia*.<sup>9</sup> XOS stimulated the growth of beneficial bacteria and leading to a suppression of the pathogenic bacteria *Escherichia coli*, *Campylobacter jejuni* and *Salmonella enteritidis*.<sup>10</sup> XOS significantly decreased or reversed the increase in abundance of *Howardella*, *Enterorhabdus*, and *Slackia*.<sup>11</sup> 3) May reverse changes seen in gut microbiota during development of diabetes;<sup>12</sup> 4) Supports gut epithelial and

mucosal health;<sup>13</sup> 5) lowers intestinal pH.<sup>14</sup> and 6) Normalization of bowel movements by: a) Enhanced peristalsis (stimulation of intestinal transit),<sup>15</sup> b) Fecal bulking;<sup>16</sup> and 3) normalization of stool consistency.<sup>17</sup>

**OF NOTE: XOS may provide protective effect on development of aberrant crypt foci (ACFs) and metabolic abnormalities associated with colon cancer.** Beneficial effects of dietary XOS were observed on microbiota and the ACFs in the colon of DMH-treated animals. Dietary XOS significantly increased the population of bifidobacteria and alleviated the incidence and multiplicity of ACF formation in the colon. XOS supplementation also ameliorated the level of lipid peroxidation and improved the activities of glutathione-S-transferase and catalase in colonic mucosa and liver, which may have contributed to inhibiting the colon carcinogenesis. Thus, the results suggested the protective effect of dietary XOS on the development of ACFs and on metabolic abnormalities associated with colon cancer.<sup>18</sup>

**GENERAL HEALTH BENEFITS: XOS (alone or as active components of pharmaceutical preparations) exhibits a range of biological activities different from the prebiotic effects related to gut modulation.** The other effects for XOS include antioxidant activity (conferred by phenolic substituents), blood- and skin-related effects, anti-allergy, anti-infection and anti-inflammatory properties, immunomodulatory action, anti-hyperlipidemic effects, and cosmetic and a variety of other properties.<sup>19</sup>

**Additional Research findings:** 1) Supports immune function as an Immunomodulator and/or Immunostimulator<sup>20</sup> 2) Support enhanced metabolic process and mineral absorption;<sup>21</sup> 3) Contributes to antioxidant activity.<sup>22</sup> 4) Stimulation of Bifidobacterium and improved nutrient absorption and production of B complex vitamins.<sup>23</sup> and 5) Improved plasma lipid profile, including reduction in the level of triglyceride content of blood and liver.<sup>24</sup>

### Xylo-oligosaccharide-related References

<sup>1</sup> **Xylooligosaccharides: an economical prebiotic from agroresidues and their health benefits.** Jain I, Kumar V, Satyanarayana T. Indian J Exp Biol. 2015 Mar;53(3):131-42. <http://www.ncbi.nlm.nih.gov/pubmed/25872243> Full text <http://www.doc88.com/p-9923172851502.html>

<sup>2</sup> **Prebiotic potential of oligosaccharides: A focus on xylan derived oligosaccharides.** Ramkrishna D. Singh, Jhumur Banerjee, Amit Arora. Bioactive Carbohydrates and Dietary Fibre. 2015; 5(1): 19. Full text: [http://www.academia.edu/11781362/Prebiotic\\_Potential\\_of\\_oligosaccharides\\_A\\_focus\\_on\\_xylan\\_based\\_oligosaccharides](http://www.academia.edu/11781362/Prebiotic_Potential_of_oligosaccharides_A_focus_on_xylan_based_oligosaccharides)

- <sup>3</sup> **Effect of xylooligosaccharide intake on severe constipation in pregnant women.** Tateyama I, Hashii K, Johno I, et al. *J Nutr Sci Vitaminol (Tokyo)*. 2005 Dec;51(6):445-8. <http://www.ncbi.nlm.nih.gov/pubmed/16521705>
- <sup>4</sup> **Xylo-oligosaccharides alone or in synbiotic combination with *Bifidobacterium animalis* subsp. *lactis* induce bifidogenesis and modulate markers of immune function in healthy adults: a double-blind, placebo-controlled, randomised, factorial cross-over study.** Childs CE, Röytiö H, Alhoniemi E, et al. *Br J Nutr*. 2014 Mar 24;1-12. <http://www.ncbi.nlm.nih.gov/pubmed/24661576>; Full text available on request to: [ellieevans@aol.com](mailto:ellieevans@aol.com).
- <sup>5</sup> **Prebiotic potential of oligosaccharides: A focus on xylan derived oligosaccharides.** Ramkrishna D. Singh, Jhumur Banerjee, Amit Arora. *Bioactive Carbohydrates and Dietary Fibre*. 2015; 5(1): 19. Full text : [http://www.academia.edu/11781362/Prebiotic\\_Potential\\_of\\_oligosaccharides\\_A\\_focus\\_on\\_xylan\\_based\\_oligosaccharides](http://www.academia.edu/11781362/Prebiotic_Potential_of_oligosaccharides_A_focus_on_xylan_based_oligosaccharides)
- <sup>6</sup> **Xylooligosaccharides (XOS) as an Emerging Prebiotic: Microbial Synthesis, Utilization, Structural Characterization, Bioactive Properties, and Applications.** Achary AA and Prapulla SG. *Comprehensive Reviews in Food Science and Food Safety*, Vol 10, Issue 1, pp 2-16, January 2011 <http://onlinelibrary.wiley.com/doi/10.1111/j.1541-4337.2010.00135.x/full>
- <sup>7</sup> **Xylo-oligosaccharides alone or in synbiotic combination with *Bifidobacterium animalis* subsp. *lactis* induce bifidogenesis and modulate markers of immune function in healthy adults: a double-blind, placebo-controlled, randomised, factorial cross-over study.** Childs CE, Röytiö H, Alhoniemi E, et al. *Br J Nutr*. 2014 Mar 24;1-12. <http://www.ncbi.nlm.nih.gov/pubmed/24661576>; Full text available on request to: [ellieevans@aol.com](mailto:ellieevans@aol.com).
- <sup>8</sup> **Xylooligosaccharides (XOS) as an Emerging Prebiotic: Microbial Synthesis, Utilization, Structural Characterization, Bioactive Properties, and Applications.** Achary AA and Prapulla SG. *Comprehensive Reviews in Food Science and Food Safety*, Vol 10, Issue 1, pp 2-16, January 2011 <http://onlinelibrary.wiley.com/doi/10.1111/j.1541-4337.2010.00135.x/full>
- <sup>9</sup> **Prebiotic Potential of Xylooligosaccharides Derived from Corn Cobs and Their In Vitro Antioxidant Activity When Combined with *Lactobacillus*.** Yu X, Yin J, Li L, et al. *J Microbiol Biotechnol*. 2015 Jul;25(7):1084-92. <http://www.ncbi.nlm.nih.gov/pubmed/25791856> Free full text: <http://www.jmb.or.kr/journal/viewJournal.html?doi=10.4014/jmb.1501.01022>
- <sup>10</sup> **In vitro investigations of the effect of probiotics and prebiotics on selected human intestinal pathogens.** Fooks LJ, Gibson GR. *FEMS Microbiol Ecol*. 2002 Jan 1;39(1):67-75. doi: 10.1111/j.1574-6941.2002.tb00907.x. <http://www.ncbi.nlm.nih.gov/pubmed/19709185>, Full Text: <http://femsec.oxfordjournals.org/content/39/1/67.long><http://femsec.oxfordjournals.org/content/39/1/67.long>
- <sup>11</sup> **Xylooligosaccharide supplementation alters gut bacteria in both healthy and prediabetic adults: a pilot study.** Yang J, Summanen PH, Henning SM, et al. *Front Physiol*. 2015 Aug 7. <http://www.ncbi.nlm.nih.gov/pubmed/26300782>
- <sup>12</sup> **Xylooligosaccharide supplementation alters gut bacteria in both healthy and prediabetic adults: a pilot study.** Yang J, Summanen PH, Henning SM, et al. *Front Physiol*. 2015 Aug 7. <http://www.ncbi.nlm.nih.gov/pubmed/26300782>
- <sup>13</sup> **Xylooligosaccharides: an economical prebiotic from agroresidues and their health benefits.** Jain I, Kumar V, Satyanarayana T. *Indian J Exp Biol*. 2015 Mar;53(3):131-42. <http://www.ncbi.nlm.nih.gov/pubmed/25872243> Full text: <http://www.doc88.com/p-9923172851502.html>
- <sup>14</sup> **Xylooligosaccharides: an economical prebiotic from agroresidues and their health benefits.** Jain I, Kumar V, Satyanarayana T. *Indian J Exp Biol*. 2015 Mar;53(3):131-42. <http://www.ncbi.nlm.nih.gov/pubmed/25872243> Full text: <http://www.doc88.com/p-9923172851502.html>
- <sup>15</sup> **Xylooligosaccharides (XOS) as an Emerging Prebiotic: Microbial Synthesis, Utilization, Structural Characterization, Bioactive Properties, and Applications.** Achary AA and Prapulla SG. *Comprehensive Reviews in Food Science and Food Safety*, Vol 10, Issue 1, pp 2-16, January 2011 <http://onlinelibrary.wiley.com/doi/10.1111/j.1541-4337.2010.00135.x/full>
- <sup>16</sup> **In vitro study of the prebiotic xylooligosaccharide (XOS) on the growth of *Bifidobacterium* spp and *Lactobacillus* spp.** Li A, Summanen PH, Komoriya T, Finegold SM. *Int J Food Sci Nutr*. 2015 Dec;66(8):919-22. <http://www.ncbi.nlm.nih.gov/pubmed/26171632>
- <sup>17</sup> **Effect of xylooligosaccharide intake on severe constipation in pregnant women.** Tateyama I, Hashii K, Johno I, et al. *J Nutr Sci Vitaminol (Tokyo)*. 2005 Dec;51(6):445-8. <http://www.ncbi.nlm.nih.gov/pubmed/16521705>
- <sup>18</sup> **Protective effect of xylooligosaccharides from corncob on 1,2-dimethylhydrazine induced colon cancer in rats.** Ayyappan A. Achary, Duraiswamy Gobinath, et al. *Bioactive Carbohydrates and Dietary Fibres* 5(2015) 146-152. Full text available on request to [ellieevans@aol.com](mailto:ellieevans@aol.com).
- <sup>19</sup> **Prebiotic potential of oligosaccharides: A focus on xylan derived oligosaccharides.** Ramkrishna D. Singh, Jhumur Banerjee, Amit Arora. *Bioactive Carbohydrates and Dietary Fibre*. 2015; 5(1): 19. Full text : [http://www.academia.edu/11781362/Prebiotic\\_Potential\\_of\\_oligosaccharides\\_A\\_focus\\_on\\_xylan\\_based\\_oligosaccharides](http://www.academia.edu/11781362/Prebiotic_Potential_of_oligosaccharides_A_focus_on_xylan_based_oligosaccharides), p 11.
- <sup>20</sup> **Xylo-oligosaccharides alone or in synbiotic combination with *Bifidobacterium animalis* subsp. *lactis* induce bifidogenesis and modulate markers of immune function in healthy adults: a double-blind, placebo-controlled, randomised, factorial cross-over study.** Childs CE, Röytiö H, Alhoniemi E, et al. *Br J Nutr*. 2014 Mar 24;1-12. <http://www.ncbi.nlm.nih.gov/pubmed/24661576>
- <sup>21</sup> **Prebiotic potential of oligosaccharides: A focus on xylan derived oligosaccharides.** Ramkrishna D. Singh, Jhumur Banerjee, Amit Arora. *Bioactive Carbohydrates and Dietary Fibre*. 2015; 5(1): 19. Full text : [http://www.academia.edu/11781362/Prebiotic\\_Potential\\_of\\_oligosaccharides\\_A\\_focus\\_on\\_xylan\\_based\\_oligosaccharides](http://www.academia.edu/11781362/Prebiotic_Potential_of_oligosaccharides_A_focus_on_xylan_based_oligosaccharides).
- <sup>22</sup> **Prebiotic Potential of Xylooligosaccharides Derived from Corn Cobs and Their In Vitro Antioxidant Activity When Combined with *Lactobacillus*.** Yu X, Yin J, Li L, et al. *J Microbiol Biotechnol*. 2015 Jul;25(7):1084-92. <http://www.ncbi.nlm.nih.gov/pubmed/25791856>. Free full text: <http://www.jmb.or.kr/journal/viewJournal.html?doi=10.4014/jmb.1501.01022>
- <sup>23</sup> **Xylooligosaccharides: an economical prebiotic from agroresidues and their health benefits.** Jain I, Kumar V, Satyanarayana T. *Indian J Exp Biol*. 2015 Mar;53(3):131-42. <http://www.ncbi.nlm.nih.gov/pubmed/25872243> Full text: <http://www.doc88.com/p-9923172851502.html>
- <sup>24</sup> **Xylo-oligosaccharides alone or in synbiotic combination with *Bifidobacterium animalis* subsp. *lactis* induce bifidogenesis and modulate markers of immune function in healthy adults: a double-blind, placebo-controlled, randomised, factorial cross-over study.** Childs CE, Röytiö H, Alhoniemi E, et al. *Br J Nutr*. 2014 Mar 24;1-12. <http://www.ncbi.nlm.nih.gov/pubmed/24661576> Full text available on request to: [ellieevans@aol.com](mailto:ellieevans@aol.com).