ANNALS OF GASTROENTEROLOGY 2006, 19(3):225-227

*Editorial*

# Dietary fibres and prebiotics: of proven benefit or a new fad

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*Intestinal bacteria and permeability during experimental acute pancreatitis in rats*
*Axelsson J, Eckerwall G, Norrman G, et al*

Acute pancreatitis has a spectrum of clinical presentations ranging from mild self-limiting disease to severe pancreatitis, which results in the development of local and systemic complications with a significant risk of death. Mortality follows a bimodal distribution: early death is related to the development of severe and irreversible multiple-organ dysfunction, and late mortality occurs in the second phase of illness, dominated by sepsis and the consequences of organ failure. Pancreatic necrosis and infection are strong determinants of organ failure and poor outcome, the mortality rate being 5 to 10 times higher if necrosis becomes infected.[1] Many of the infected necroses are gut derived, and bacterial translocation has been shown to be an important pathogenic factor for their development. Gut-derived sepsis is a term used to describe a state of systemic inflammation with organ dysfunction after severe catabolic stress hypothesized to be initiated and perpetuated by the intestinal tract microflora.[2]

It is well known from experimental studies with induced disease such as pancreatitis that a significant reduction in the commensal flora occurs as early as 6–8 h after the disease process, and is replaced within approximately 1 week by a significant overgrowth of potentially pathogenic microorganisms, such as E.coli, as well as non-coli Gram-negative bacteria [Pseudomonas, Klebsiella, Citrobacter, Enterobacter, Acinetobacter, Morganella, Serratia, or Proteus].[3] Numerous studies have demonstrated that pathogenic bacteria may disrupt the intestinal barrier and enhance the mucosal barrier permeability [lumen to blood] and endothelial permeability [blood to tissue],[4,5] associated with increased microbial translocation and microbial growth in mesenteric lymph nodes and pancreatic tissue.[1,2,6,7]

In the present issue, Axelsson J et al[8] have tried to modify intestinal pathogen overgrowth and intestinal permeability in a taurodeoxycholic acid-induced pancreatitis rat model, pretreated with cellulose derivatives, and/or N-acetyl cysteine. The luminal and mucosal contents of E. coli were found increased - both in the ileum and colon - after pancreatitis induction, but were restored to almost normal levels in all pre-treated groups, except that of N-acetyl cysteine. With respect to intestinal permeability, no group treated with cellulose derivatives alone or in combination with N-acetyl cysteine exhibited a significant restoration of permeability in relation to the pancreatitis group; moreover, the N-acetyl cysteine treated group demonstrated significantly increased permeability.

In the early 90's cellulose benefits were evaluated in different experimental conditions regarding gastrointestinal tract function and metabolism. Cellulose itself, as well as cellulose derivatives and dietary fibres in general, were considered to play a beneficial role in the prevention or treatment of gastrointestinal tract disturbance or disease. Additionally, it had already been proved that dietary fibre exerts a trophic effect on the intestinal epithelium by maintaining or increasing the intestinal cell mass as well as the specific activity of brush border hydrolase, and by stimulating enterocytes DNA synthesis and absorptive function[9].

Dietary fibre is a generic term covering a wide variety of substances with different physiologic properties and effects which have been associated with health benefits

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for centuries;[10] however only recently was the concept properly defined. At the moment, the most appropriate definition of dietary fibre is one that, besides specifications of the constituents in the fibre complex, also specifies their physiological and metabolic significances. According to this, dietary fibre are considered to be the edible parts of plants or analogous carbohydrates that are resistant to digestion and absorption in the human small intestine with partial or complete fermentation in the large intestine.[11]

Thus, dietary fibre includes non-starch polysaccharides [such as cellulose, β-glucans, pectins, gums, etc], non-digestible oligosaccharides [fructo-oligosaccharides, galacto-oligosaccharides, iso-maltooligosaccharides, lactulose and many others], lignin, substances associated with the non-starch polysaccharide-lignin complex in plants [waxes, cutin, saponins and tannins], and other analogous carbohydrates [resistant starches, maltodextrins and chemically synthesized carbohydrates (cellulose derivates)].

The most important characteristic of them all is that they are resistant to hydrolysis by the human alimentary tract enzymes; they are neither degraded nor absorbed during their passage through the upper part of the gastrointestinal tract, and can exert nutritionally important effects by slowing down gastric emptying and affecting nutrient assimilation in the small intestine. When they pass into the large intestine, they can be degraded by bacterial enzymes and their degradation products can be fermented to produce various short chain fatty acids (SCFAs, such as acetate, propionate and butyrate) and fermentation by-products such as hydrogen, methane and carbon dioxide. However, these processes occur to extents absolutely dependent on the chemical structure and physical properties of fibre. Dietary fibres are usually classified according to their solubility into three groups: soluble fibres such as pectins and gums; insoluble fibres such as cellulose; and mixed-type fibres such as brans. Soluble fibres constitute the most important source of bacterial fermentation and microbial production of nutrients, antioxidants, vitamins, various bioactive amino acids, polyamines, antioxidants and various growth factors.[12,13]

Prebiotics are non-digestible food ingredients that beneficially affect the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon.[14] Indeed, they must modify the colonic microbiota in such a way that potentially health-promoting bacteria (especially lactobacilli and bifidobacteria) become numerically and/or metabolically predominant,[15] thus inhibiting colonisation of intestinal pathogens by means of organic acids production and by competing for nutrients and mucosal adhesion sites.[16]

As already mentioned, almost any carbohydrate that reaches the large bowel will provide a substrate for the commensal microbiota and will affect its growth and metabolic activities, but in a non-specific manner. The selective properties of prebiotics are supposed to relate to the growth of bifidobacteria and lactobacilli at the expense of other groups of bacteria in the gut, such as bacteroides, clostridia, eubacteria, enterobacteria, enterococci, etc.[17] However, whilst many bacterial species grow well on prebiotic carbohydrates such as low degree polymerization fructans, there may be a selective benefit to some types of bifidobacteria and lactobacilli, depending on the sugar composition and molecular size of the prebiotic.[18]

The new concept to decrease intestinal permeability and subsequent bacterial translocation is the administration of dietary bacterial [probiotics] and carbohydrate [prebiotics] supplements that aid the host's indigenous bacterial communities to form a barrier against invading pathogens. However, there is some evidence that fibres alone have also been found to reduce translocation by stimulating the growth of the commensal microflora. In a recent study, Rayes N et al[19] used the combination of four fibres, i.e. betaglucan, inulin, pectin and resistant starch - in a dose of 2.5g each one - as placebo treatment against a synbiotic formula containing the same fibres as for patients subjected to liver transplantation. The only fibre-treated patients experienced mild and only a few gut-derived infections in comparison to the fibre-free group of the previous similar study. However, not all fibres provide the same resistance to health challenges. Specifically, poorly fermented fibres, such as crystalline cellulose, do not selectively encourage the proliferation of lactobacilli and are not as effective as the β-fructans, oligofructose or inulin, although control mice fed a 10% cellulose diet surprisingly exhibited minimal translocation, despite the higher luminal contents of Candida. Similar low incidence of translocation was found for mice receiving a commercial non-purified diet containing crude fibre as low as 6%.[20]

To date, only one study has tried only prebiotics in critically ill patients. Forty-one burn patients were randomized to receive either 6g of oligofructose per day or sucrose as placebo during the first 15 days, but no difference in effect on lactulose/mannitol ratio or clinical outcome was observed between the groups.[21] A prospective, double-blind, randomized study comparing the influence of live or heat-killed L. plantarum 299 combined with oat fibre has been conducted in severe pancreatitis patients [Olαh et al., Unpublished data, 2001 referred by 3]. The study was designed to be concluded when statistical analysis

demonstrated statistically significant differences between the two groups. This occurred when 45 patients had entered the study. At that time, 22 patients had received treatment with live lactobacilli and 23 with heat-killed, for 7 days. Infected necrosis and abscesses occurred in one (4.5%) out of 22 and in seven (30%) out of 23 patients. Although the conclusion of the study is that treatment [probiotics plus prebiotics] should be provided for a minimum of 14 days, from our point of view the conclusion is that prebiotics as a sole treatment, i.e. with no probiotic bacteria is not enough to compensate for the needs of the critically ill. This is probably due both to the significant elimination or loss of the entire Lactobacillus flora early after the disease process as well as to stress-released norepinephrine which dramatically increases the virulence of gut luminal bacteria.[2,7] Additionally, since the colonic mucosa normally receives its energy requirements, mainly SCFAs, from the gut lumen and most of the absorbed nutritive substances are either produced or released by microbial fermentation of plant fibres, both prebiotics and probiotics, namely synbiotics, are necessary.[7] Furthermore, ongoing research in prebiotics reveals the need for a refinement of the prebiotic definition, termed butyrogenic prebiotics, because of the additional functionality of some carbohydrates: a recent study demonstrated that the prebiotic oligofructose, which is known to be fermented mainly by acetate and lactate-producing bacteria rather than butyrate-producing bacteria can increase butyrate production in vitro by means of selective stimulation of the bacterial conversion of acetate and lactate to butyrate, which is the main energy source for the colonic epithelial cell.[21]

This finding, combined with the almost daily improvement in our knowledge of „immunomodulation“ by the combination of fibres and bacteria, leads us to conclude that a new era of treatment is *ante portas*. The eating of random fibre will surely be replaced by the specific medical prescription of specialized fibre formulas.

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