BUGS IN THE GUT:HEALTH OR HAZARD

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Introduction

Dietary intervention forms a major current focus for nutritionists, the food/ pharmaceutical industries, clinicians and researchers. Currently, there is much interest in the use of foods that may exert a functional effect on the human gut microbiota.

The intestinal microbiota forms a diverse and complex ecosystem. However, there is much variability in bacterial numbers and populations between the stomach small intestine and colon. In comparison to other regions of the gastrointestinal tract, the human colon is an extremely densely populated microbial ecosystem - with the resident microflora representing around 95% of all cells in the body. The large gut flora is now accepted as playing a major role in both human pathogenesis and health - with the colon being the body's most metabolically active organ. Through diet, the composition of this microbiota can be influenced such that microorganisms which are benign or even health promoting can he stimulated.

Composition and activity

The large gut microflora is acquired at birth. Initially, facultatively anaecrobic strains such as Escherichia coli dominate. Thereafter, differences exist in the species composition that develops and this is largely governed by the type of diet.

The faecal flora of breast fed infants is dominated by populations of bifidobacteria, with only about 1% enterobacteria. It is thought that certain bifidogenic factors are present in human breast milk. In contrast, bacteriological determinations in terms of species profiles (including non culturable forms).

Microflora modulation through diet

It is clear that diet plays an important role In the maintenance and improvement of human health through the provision of growth substrates for the microbiota, To generalise, it is possible to categorise the gut microbiota components on the basis of whether they exert potentially pathogenic or health promoting aspects.

Lactic acid producing genera such as the bifidobacteria or lactobacilli have along standing health image. As such, attempts to stimulate microorganisms that carry out the latter could give obvious benefits.

The use of probiotics has been widely supported. In this case, foodstuffs such as fermented milk products containing viable cultures perceived as beneficial (e.g. 1 aictobacilli, bifidobacteria) are used to proliferate populations in the colon.

Probiotics are defined as live microbial feed supplements which beneficially affect the host animal by improving its intestinal microbial balance.

To be effective, probiotics must be capable of being prepared in a viable manner and on large scale (e.g. for- industrial purposes), whilst during use and under storage the probiotic should remain viable and stable, be able to survive in the intestinal ecosystem and the host animal should gain beneficially from harbouring the probiotic. Clearly, the organisms used should be generally regarded as safe.

An alternative, or additional, approach is the prebiotic concept. A prebiotic is 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, that can improve the host health. Thus, the prebiotic approach advocates the administration of non viable entitles. Whilst any food ingredient that enters the large intestine is possibly a prebiotic, it is selectivity of the fermentation, in the mixed bacterial environment, that is critical and required. At present, most prebiotics are selected on the basis of their ability to promote the growth of lactic acid producing microorganisms. Dietary carbohydrates, such as fibres are candidate prebiotics but most promise has been realised with formula fed infants have a more complex microbiota with bifidobacteria, bacteroides, clostridia and streptococci all being prevalent. After weaning, a pattern that resembles the adult flora becomes established.

The composition is able to respond to anatomical and physiochemical variations that are present. The right or proximal colon is characterised by a high substrate availability (due to dietary input), low pH (from acids produced in fermentation) and a rapid transit. The left or distal area of the colon has a lower concentration of available substrate, the pH is approximately neutral and bacteria grow more slowly.

The proximal region tends to be a more saccharolytic environment than the distal gut, the latter having higher bacterial proteolysis. Several hundred different species of bacteria are thought to be present in the large intestine under normal circumstances, the vast majority of which are strict anaecrobes. Gram negative rods belonging to the Bacteroides fragilis group are the numerically predominant bacteria in the colon. The other main groups consist of different Gram positive rods and cocci, such as bifidobacteria, clostridia, pep-tococci, streptococci, cubacteria, lactobacilli, peptostreptococci and ruminococci A number of other groups which exist in lower proportions include enterococcio, coliforms, methanogens, dis-similatory sulphate-reducing bacteria and acetogens. Each of these bacterial groups has specialised ecological niche to fulfil and a variety of different nutritional patterns arise.

These include carbohydrate metabolisers, proteolytic species and bacteria which metabolize gases like H2.

Whilst the diverse nature of the human gut microflora is recognised, it is likely that many bacterial species exist that have not been adequately characterised.

The application of modem molecular based technologies is likely to overcome this. In particular the use of 16SrRNA profiles as a major taxonomic tool is of significance and is of significance and is now being applied to human gut microbiology. Genotypic based probes may be developed for use in accurate monitoring studies of population changes, for example in response to dietary intervention. As such, this new technology

will allow much improved oligosaccharides. In particular the ingestion of fructooligosaccharides has been shown to stimulate bifidobacteria in the lower gut. As prebiotics exploit non-viable food ingredients, their applicability in diets is wide ranging.

A further approach is synbiotics, where probiotics and prebiotics are combined.

Here survivability of the live microbial addition in the gastrointestinal tract, could be enhanced by coupling it with a selective growth substrate.

Selected health related aspects.

A number of benefits can be ascribed to probiotic and prebiotic intake. However, 3 areas of interest are as follows:

Hypocholesterol action

The lipid hypothesis purports that dietary saturated fatty acids lead to an increase in blood cholesterol levels. This may have the effect of depositing cholesterol in the arterial wall leading to atherosclerosis and possibly coronary heart disease. Some studies have hypothesised a role for the lactic microflora in systemically reducing blood lipid values.

However, this has not been unequivocally proven and there are contrasting data from human volunteer trials.

Volunteer dietary trials should be carried out using a random double blind placebo procedure, with unequivocal testing of bacterial changes (e.g. using the genetic fingerprinting procedures mentioned earlier) and a range of human subjects.

Bowel cancer

In humans, colorectal cancer is thought to have a bacterial origin, with the following compounds all being microbiologically derived and carcinogenic or co-carcinogenic:

- nitrosamines

- fecapentacenes

- bile acids

- heterocyclic amines

- glucuronide compounds

- various aglycones

- phenolic/indolic compounds

- nitrated polycyclic aromatic

hydrocarobons

- diacylglycerol

- some azo compounds

- ammonia

Dietary strategies that lead to a reduced accumulation of such products may be possible.

Firstly, dietary fibres and resistant starches may be fermented in the large gut to increase faecal bulk and reduce the residence time of such materials in the gut.

Moreover, probiotics and prebiotics may modify the activities of enzymes that are involved in carcinogenesis, such as azoreductases, nitroreductases, B-glucuronidase, etc,

Effects on pathogens.

The most compelling evidence for the success of probiotics and prebiotics probably lies in their ability to improve colonisation resistance, i.e.resistance of the effects of pathogens.

Lactic acid excreting micro-organisms are known for their inhibitory properties.

In humans, viruses, protozoa, fingi and bacteria can cause acute gastroenteritis. Viral infections play a major role, but bacteria are also of high significance.

There are a number of potential mechanisms for probiotic microorganisms to reduce intestinal infections, both bacterial and viral.

Firstly, metabolic end products such as acids excreted by these microorganisms may lower the gut pH to levels below those at which pathogens are able effectively compete.

Also many lactobacilli and bifidobacterial species are both able to excrete natural antibiotics which can have a broad spectrum of activity.

For the bifidobacteria, our studies have indicated that some species are able to exert antimicrobial effects on various Gram positive and Gram negative intestinal pathogens. This includes the Verocytotoxin strain of Escherichia coli 0157:H7.

Conclusion

The microflora of the gastro-intestinal tract is key for nutrition and health of the host.

Micoflora modulation can occur through diets that contain probiotic and/or prebiotic.

The approach of using diet to induce microbial change offers a very straightforward approach towards improved health, that is consumer friendly and effective.

The following areas of research are worthwhile considering:

* The application of molecular procedures to more effectively identify the gut diversity and provide tools by for tracking microflora changes in response to diet more effectively

* Susceptible target groups (e.g. the development of specific health foodsí for the elderly, weaning population, institutionalised persons, hospital patients, formula-fed infants, etc.)

* Derivation of the most effective probiotics and prebiotics.

* A determination of the health consequences that can be associated with gut flora modulation (e.g. anti-pathogen activities, reduction in blood lipids, immunological effects, protective aspects for bowel cancer, neutralisation of certain toxins).