

# Effects of the consumption of NUTRIOSE® 06 on the gut ecosystem

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## INTRODUCTION

Soluble dietary fibres are by definition not digested in the small intestine. They reach the colon where they induce changes of the gut ecosystem. Changes beneficial for the host are called prebiotic effects\*. Among them the literature mentions: an increase in bacteria generally recognized as desirable and/or a decrease in bacteria generally recognized as harmful, a reduction in intestinal pH, production of short chain fatty acids (SCFAs) and changes in bacterial enzymes<sup>(1)</sup>.

NUTRIOSE® 06 is a soluble dietary fibre because it is resistant to digestion in the small intestine and it is largely fermented in the colon<sup>(2)</sup>.

The beneficial changes of the human gut ecosystem through NUTRIOSE® 06 consumption are described below.

\* A prebiotic is a non-digestible food ingredient that beneficially affects the host by selectively stimulating growth and/or modifying the metabolic activity of one or a number of bacterial species in the colon that have the potential to improve host health<sup>(3)</sup>.

<sup>1</sup> Woods and Gorbach, 2001 - <sup>2</sup> Roberfroid, 2005

## RESULTS

### NUTRIOSE® 06 induces an increase of the colonic saccharolytic flora and a decrease in potentially harmful *Clostridium perfringens* in humans faeces<sup>(4)</sup>

These effects were noticed in 2 different clinical studies. In study 1, 48 volunteers were randomly included and distributed into 4 parallel groups. During the 14-day study, the first group consumed 20g glucose (placebo) and the 3 others respectively 10, 15 or 20g/day NUTRIOSE® 06. At the end of the experiment an increase in the saccharolytic flora was observed with 10g NUTRIOSE® 06. A decrease of the genus *Clostridium perfringens* was seen following 15g NUTRIOSE® 06 consumption. In study 2, 43 volunteers randomly assigned to 3 parallel groups (placebo, 30 and 45g/day NUTRIOSE® 06) completed the clinical trial. A significant increase in the mean lactobacilli numbers was observed after a 35-days NUTRIOSE® 06 consumption. During the study, a decrease in genus *Clostridium perfringens* was still observed confirming the previously described effect on potentially harmful bacteria.

<sup>3</sup> Pasmán et al., 2006 - EJCN (in press)

### NUTRIOSE® 06 induces a decrease in the fecal pH of human volunteers

In the previously described trials, pH measurements were performed at the end of the administration period. We noticed a significant decrease in the faecal pH following either the short or the long period of NUTRIOSE® 06 consumption. In study 1, faecal pH was 6.67 before the intervention phase and 5.99 after a 14 day administration period with 20g. In the long term study 2, faecal pH was 6.5 in the control group and 6.1 after a 35 day administration period with 30g/d NUTRIOSE® 06.

### NUTRIOSE® 06 and production of short chain fatty acids (SCFAs) in rats

Administration of NUTRIOSE® 06 on laboratory animals leads to production of SCFAs in the caecum. Animal models are described as the only way to study production of colonic SCFAs because they are absorbed by the gut mucosa essentially to produce energy after metabolism<sup>(4)</sup>. In a study conducted on laboratory rats, with 2.5%, with 5% and with 10% NUTRIOSE® 06 in feed, the total amount of SCFAs (acetic, propionic and butyric acids) were of 36.04, 38.63, 51.10 and 62.39 mg/caecum for respectively the control group and the rats treated for 14 days.

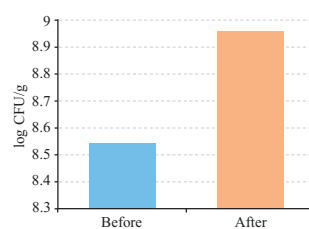
<sup>4</sup> Roberfroid et Slavin, 2001

### NUTRIOSE® 06 leads to changes in bacterial enzyme concentration in humans

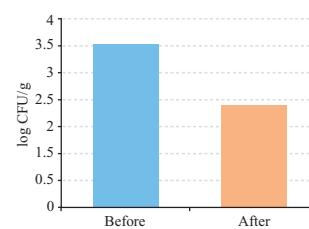
Administration of NUTRIOSE® 06 on human volunteers promotes changes in bacterial enzyme concentration in the faeces (study 1). This was particularly the case with production of the enzyme  $\beta$  glucosidase which is an inducible enzyme. Results in faeces were respectively 12.9 for the control group, 24.4, 22.6 and 31.4 U/min/g.

This effect was already observed in humans, in another clinical study during which volunteers had ingested 15g NUTRIOSE® 06 for 7 days (See the short term tolerance study). This clearly indicates that significant changes of the gut microflora occur quickly after starting to consume NUTRIOSE® 06. In the long term tolerance study (study 2), after consuming 30 and 45g per day for 35 days, production of  $\beta$  glucosidase was still maintained showing a modification and a stabilization of the colonic flora.

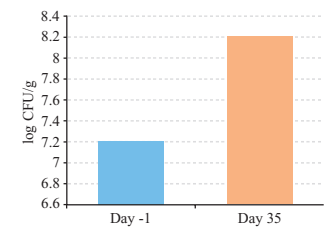
Effect of a 10 g/d NUTRIOSE® 06 administration on the saccharolytic flora in humans



Effect of a 15 g/d NUTRIOSE® 06 administration on *Clostridium perfringens* in humans



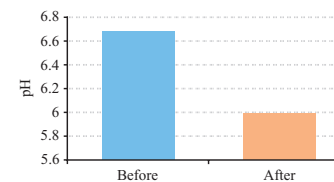
Effect of a 45 g/d NUTRIOSE® 06 administration on Lactobacilli in humans



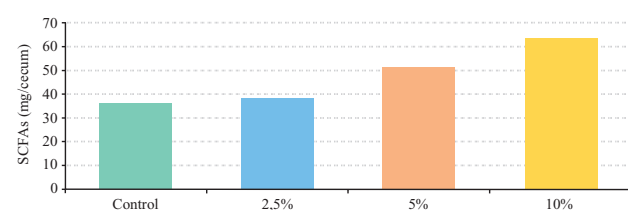
Study 1

Study 2

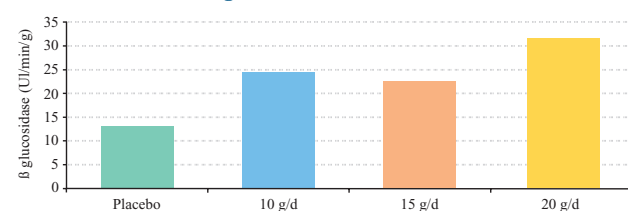
Effect of a 20 g/d NUTRIOSE® 06 administration on fecal pH in humans



Effect of NUTRIOSE® 06 administration on production of SCFAs in rats



Effect of NUTRIOSE® 06 administration on production of fecal  $\beta$  glucosidase in humans



## DISCUSSION

Results presented above show the specific pattern of fermentation of NUTRIOSE® 06 in humans. This pattern is related to the molecular structure of the dietary fibre and to its specific physical and chemical characteristics. As it is a glucose polymer, NUTRIOSE® 06 provokes the proliferation of colonic bacteria able to adapt to non digestible carbohydrates<sup>(5)</sup>. The genus *Bacteroides* belongs to these bacteria and is a well known producer of glucanases and saccharidases which is seen through the production of  $\beta$  glucosidase in the experiments described previously. This enzyme<sup>(6)</sup> clearly indicates that 15g/day NUTRIOSE® 06 induces deep changes in the colonic flora; secondly this enzyme can have an effect of residual polysaccharides possibly coming from foods that have not been totally digested and thus remain present in the gut content e.g. residues of non digested vegetables. This may result in end-products such as minerals and other micronutrients becoming available for the colon and for the body.

<sup>5</sup> Mateau et al., 1990

An increase in lactobacilli was also observed. These bacteria are considered as desirable colonic bacteria. They contribute to maintaining a healthy colon.

The study of production of SCFAs is difficult to manage in clinical studies for various reasons. Animal models are usually used to study the production of SCFAs following dietary fibre consumption. In all animal studies conducted, an increase in the production of SCFAs was observed. SCFAs and gases are markers of the fermentation processes that occurred following NUTRIOSE® 06 consumption. As a result of these colonic fermentations, a decrease in the pH of the colonic content is visible through the fall in the faecal pH in humans. This is very interesting in terms of colonic health as a weak decrease in gut pH is associated with a decrease in potentially harmful gram negative bacteria. This is the case with NUTRIOSE® 06 where a decrease of *Clostridium perfringens* was observed after consumption of 15g a day NUTRIOSE® 06.

## CONCLUSION

Results presented show that from 10g per day, positive effects of NUTRIOSE® 06 have been observed. Bacteria that may ferment NUTRIOSE® 06 are bacteria from the saccharolytic flora which grow to the detriment of proteolytic species such as *Clostridium perfringens* because of the promotion of acidic conditions of the gut content. The enzymes produced by the saccharolytic flora are enzymes that can play an ultimate role in the production of end products of interest in term of colonic health, like vitamins, minerals, antioxidants.

According to these observations, the changes in the colonic environment following NUTRIOSE® 06 ingestion suggest a prebiotic effect.

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