# NUTRIOSE® soluble fiber: prebiotic effects of a resistant dextrin

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## INTRODUCTION

The beneficial role of dietary fiber in general health is well recognized. Non-viscous soluble fibers have been widely used to fortify fiber contents of foods and several physiological and health effects have been proposed to be associated with their consumption, notably prebiotic effects.
Several definitions of prebiotic effects have been proposed in earlier decades, with more or less subtle variations. Recently, discussions within academic and industry experts (in the European International Life Sciences Institute Prebiotic Expert Group and Prebiotic task force) have agreed to define prebiotic effects as "the selective stimulation of growth and/or activity(ies) of one or a limited number of microbial genus/era/species in the gut microbiota that confer(s) health benefits to the host" (Roberfroid *et al.* 2010). According to others, prebiotic effects refer to the ability to (a) increase "beneficial bacteria" and or decrease "harmful bacteria", (b) decrease intestinal pH, (c) produce short chain fatty acids (SCFA) and (d) induce changes in bacterial enzyme concentrations (Woods & Gorbach 2001).
NUTRIOSE® is a resistant dextrin, a non-viscous soluble fiber obtained from wheat or maize starch which displays clinically proven health benefits in the management of weight, obesity, and metabolic syndrome parameters (Li *et al.* 2010, Guérin-Deremaux *et al.* 2011) and with an outstanding digestive tolerance (van den Heuvel *et al.* 2004, Pasman *et al.* 2006).
Recently, two human clinical trials have shown evidences that NUTRIOSE® displayed prebiotic effect through promotion of some beneficial bacteria and improvement of biochemical fecal parameters (Lefranc-Millot *et al.* 2012).

### Description of the studies

The first clinical trial was led on 48 healthy volunteers (male and female) and aimed at assessing the impact of three different dosages of NUTRIOSE® on *Bacteroides* and *Clostridium perfringens* fecal counts, two genera considered as beneficial and pathogen bacteria, respectively, and on other fecal parameters (pH, enzyme activity...). Subjects were randomly assigned into 4 groups of 12. The first group received 20g/day of glucose (placebo) in two equal doses for 14 days. The three others received 10, 15, or 20g/day NUTRIOSE®, respectively, in two equal doses for 14 days. Both products were powders dissolved in orange juice prior to consumption with the afternoon and evenings meals. Fecal samples were collected at the beginning and at the end of the study.

The second clinical trial was led on 40 healthy volunteers (female) and aimed at assessing the impact of a single dosage of NUTRIOSE® on *Bacteroides spp.* and *Clostridium perfringens* fecal counts using culture and molecular tool (real-time PCR), and on intestinal undesirable disorders (abdominal pain, bloating, flatulence…). Subjects were randomly assigned in two groups. One group received glucose (placebo) and the other one NUTRIOSE®, both 8g/day for 14 days. Both supplements were provided diluted into apple juice (1 bottle a day) and consumed before breakfast. Fecal samples were collected from day 0 to 3 (baseline) and from day 11 to 14.

### Results

*Consumption of NUTRIOSE® has an impact on fecal microbiota.*
In both studies the consumption of NUTRIOSE® soluble fiber led to significant improvement of fecal bacterial pattern at the end of the supplementation period. Indeed, *Bacteroides spp.* levels were increased and *Clostridium perfringens* levels were decreased. These improvements occurred since volunteers' diet has been supplemented with 8g/d of NUTRIOSE® (Figure 1; Table 1). These results were confirmed using both culture and molecular methods.

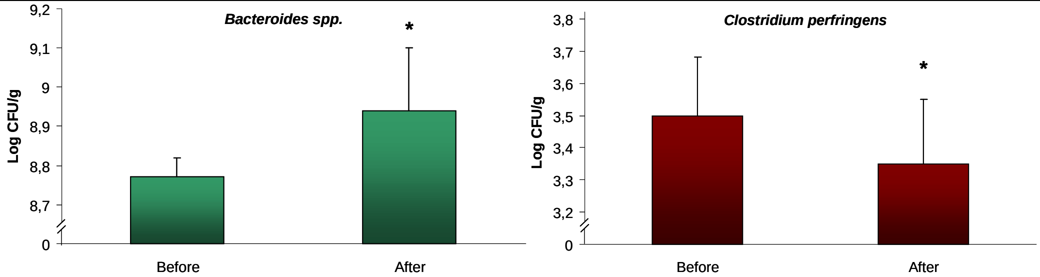


Figure 1: effect of 8g/day of NUTRIOSE® soluble fiber on "Beneficial" bacteria (*i.e. Bacteroides spp.* ■) and "Harmful" bacteria levels (*i.e. Clostridium perfringens* ■) in volunteers' feces: comparison before and after supplementation period. Data are presented as mean levels +/- standard deviation expressed in log of colony forming unit (CFU)/g of feces. Bacterial levels were assessed using molecular tools (Real-Time Polymerase Chain Reaction). * Results significantly different ($p<0.05$).

*NUTRIOSE® improves biological markers of prebiotic activity.*

Fecal pH and β-glucosidase activity are both markers of colonic fermentation which is recognized to be beneficial for the host. These parameters of fermentation were assessed in the first study. Consumption of 10 and 15g/d of NUTRIOSE® was associated with a significantly increased β-glucosidase activity, representative of the saccharolytic bacteria recognized to be beneficial for the host (Table 1). Moreover, fecal pH value was significantly lower after the consumption of 20g/d of NUTRIOSE® for 14 days. Another marker of prebiotic activity related to bacterial fermentation is the production of SCFA. SCFA such as acetate, butyrate, lactate or propionate are resulting products from the carbohydrates fermentation by some of the colonic bacteria. In the current study, the levels of SCFA measured in the feces of the volunteers displayed a trend to increase after consumption of NUTRIOSE® for 14 days. All together, these data show that NUTRIOSE® must have been fermented in the colon as a prebiotic fiber.

Table1: summary of the prebiotic effects of NUTRIOSE® soluble fiber from two clinical trials. Arrows represent a significant increase (↗), a significant decrease (↘) or no statistical differences (→) between the beginning and the end of the NUTRIOSE® supplementation period (nd: not determined).

| | Beneficial bacteria | Harmful bacteria | Fecal Enzymes | Fecal SCFAs | Fecal pH |
|---|---|---|---|---|---|
| Study 1 | ↗ | ↘ | ↗ | → | ↘ |
| Study 2 | ↗ | ↘ | nd | nd | nd |

*NUTRIOSE® is a very well digestive tolerated fiber.*

In both current studies, NUTRIOSE® displayed very good digestive tolerance whatever the dosage.

**Discussion**

The present studies demonstrated that NUTRIOSE® has a specific colonic fermentation pattern in humans and induces beneficial effects on the colonic environment, in accordance with the findings of other research (Pasman *et al.* 2006). This fermentation pattern is likely due to the structure of NUTRIOSE®. As a resistant dextrin, NUTRIOSE® reaches the colon where it stimulates saccharolytic bacteria (as shown by an increase in glucosidase activity) such as *Bacteroides* which are recognized to contribute to a healthy colonic ecology (Xu & Gordon 2003). In addition, supplementation with NUTRIOSE® induced a decrease in the potential harmful bacteria *Clostridium perfringens* in accordance with previous studies (Pasman *et al.* 2006). These effects are likely due to the decrease of the fecal pH value observed in the supplemented groups as a consequence of the dextrin fermentation and its associated SCFA production (Duncan *et al.* 2009). Surprisingly, there was only a trend towards an increase of the SCFA levels in the NUTRIOSE® groups from these trials which is not consistent with previous *in vitro* and animal experiments (Guérin-Deremaux *et al.* 2010).

Indeed, in the latest, SCFA levels were significantly higher in the NUTRIOSE® groups as compared with control ones. It is important to notice that measurement of SCFA levels in feces may not be exactly representative of the SCFA production all along the colon. As SCFA are absorbed by the gut mucosa, partly as fuel for colon cells, fecal SCFA represent the “reachable” part in non-invasive clinical trials. Thereby, the trend in increase of SCFA levels in the NUTRIOSE® groups is a reliable proof of the prebiotic effect of NUTRIOSE®. This point has to be compared with the well known prebiotics which include inulin, fructo-oligosaccharides or galacto-oligosaccharides. Indeed, excessive productions of digestive gas were reported when these prebiotics were consumed in large amounts (Marteau *et al.* 2001). Moreover, in high consumption amount, the low degree polymerization and the high fermentation rate of these prebiotics into SCFA, generate a high osmotic pressure in the colon which may lead to digestive discomfort (Stewart *et al.* 2007). In contrast, NUTRIOSE® displays a high degree of polymerization and as it is slowly fermented throughout the colon, it allows the produced SCFA to be progressively absorbed inducing low osmotic effect (Lefranc-Millot *et al.* 2009). Moreover, it has been shown that NUTRIOSE® displays an outstanding digestive tolerance up to 45g/day of consumption.

**Conclusion**

In the present trials, we showed that the consumption of NUTRIOSE® soluble fiber improved the beneficial/harmful gut bacterial ratio of healthy people, it increased the β-glucosidase activity and is associated with a trend in higher SCFA concentration in feces linked with their beneficial acidification. All together, these data enhance the accordance of NUTRIOSE® physiological properties with the commonly admitted definition of a prebiotic activity which can be a way of biological explanation of several digestive benefits such as improvement of metabolic syndrome and obesity parameters as previously shown. Therefore, NUTRIOSE® soluble fiber can be considered as an ingredient combining ease of use with proven health benefits. These are very promising results that open a new field of investigation in order to understand the relying biological mechanisms under prebiotic effects of NUTRIOSE®.

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