Nutrition and Fresh Dairy Products

SYNDIFRAIS' Scientific and Pratical Newsletter

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Intestinal Microbiota

Yoghurts • Fermented milks • Living bacterial cultures • Microbiota • Nutrition • Health

INTESTINAL MICROBIOTA and the key role of Fresh Dairy Products

Our gastrointestinal (GI) tract is home to many bacteria that make up a veritable microbial ecosystem known as the **intestinal microbiota**. However, microbiota activities are still largely unknown due to the complexity of this ecosystem, which involves numerous interactions between the various bacterial species present, the body's cells and the food we eat. Nevertheless, it is certain that **a very close relationship exists between our microbiota and our state of health**.

Our diet is a key factor in the composition of our microbiota and how it functions. In particular, **yoghurts and fermented milks** contain bacteria traditionally used in their manufacture. These lactic bacteria interact with our organism and the bacteria present in our gut. They also induce demonstrable positive effet on our health in addition to their traditional nutritional effects. In particular, yoghurt is recommended for persons who have difficulty digesting lactose. Lactic bacteria may also aid in the treatment of certain types of diarrhoea.

CONTENTS

Key points

- **Our GI tract contains over 100,000 billion bacteria:**
  - An extremely complex ecosystem,
  - Unique to each individual,
  - Remarkably stable over time,
  - Closely related to health.
- **Yoghurts and fermented milks have demonstrated beneficial effects on health:**
  - Yoghurt ferments naturally produce an enzyme that digests the lactose present in yoghurt,
  - Yoghurt ferments are effective in the prevention and treatment of certain types of diarrhoea.

SYNDIFrais
FRESH DAIRY PRODUCTS

The intestinal microbiota: a complex ecosystem which provides many benefits

Composition of the microbiota

Around 80% of the bacteria that make up our microbiota cannot be cultured in a laboratory, which has long made their study difficult. It has been necessary to develop new analytical methods to enable researchers to really begin investigating the microbiota over the last 10 years.

Heterogeneous distribution throughout the GI tract

It has recently been shown that the intestinal microbiota is not distributed homogeneously. In fact, its composition changes, both qualitatively and quantitatively, along the length of the digestive tract. Towards the end of the intestine the microbiota becomes increasingly abundant and diverse, **with most bacteria being found in the colon** (70 % of bacteria)[1] (figure 1).

Three major bacterial groups predominate in all individuals

Current opinion is that three major bacterial groups — known as phyla — account for the majority of the diversity of the microbiota, making up **80 to 90 %** of the bacterial species found in all subjects[2] (figure 2).

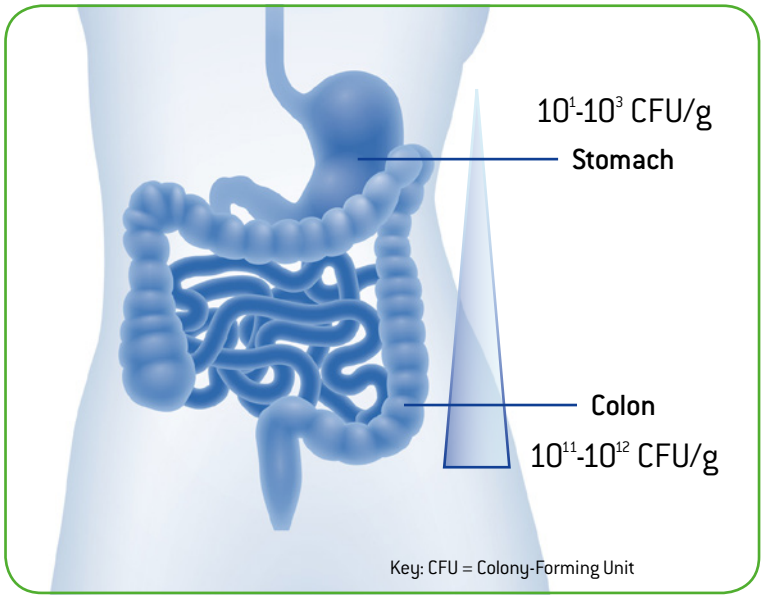


Figure 1 - Distribution of the main species throughout the GI tract

There is however a huge diversity of bacterial species within each individual

While the same major bacterial groups are found in all individuals, **each microbiota is unique in terms of the species of which it is composed**. In fact, the great majority (around 2/3) of dominant species within an individual's microbiota are specific to that individual and are rarely found to be dominant in any other person's microbiota[2]. Worldwide, **the diversity of species present is thus immense**, particularly since many species have not yet been identified.

The above data gives a glimpse of the complexity of the subject. Even though research is advancing rapidly, caution is required when drawing conclusions from new data in order to avoid erroneous oversimplifications.

A recent discovery, which still requires confirmation in a larger population of subjects, suggests it may be possible to type individuals based on their microbiota. It would appear that we can classify individuals in terms of **3 enterotypes** based on the dominant bacterial make-up of their microbiota[3] (figure 2).

Figures

- Our GI tract contains over **100,000 billion bacteria**, i.e. 10 to 100 times more than the total number of cells within our body.
- It is thought that the intestinal microbiota of an adult may be made up of as many as **1,000 different species**.
- Each individual carries some 540,000 bacterial genes.

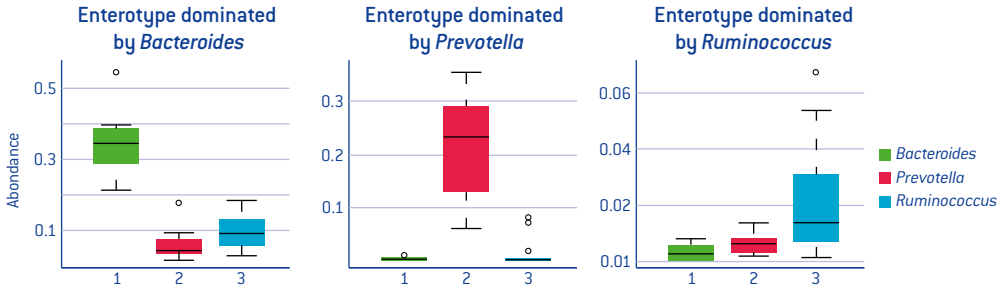
Key points

- The majority of bacteria are found in the **colon**.
- **3 enterotypes** appear to allow microbiota to be classified on the basis of the quantities of 3 bacteria.
- Each person's microbiota is made up of a **unique** mixture of species.

phylum → **3 main phylogenetic groups in all individuals**

Firmicutes	*Bacteroidetes*	*Actinobacteria*
+ 50 % of bacteria	**10 to 30 %**	**0.7 to 10 %**

genus → **Enterotypes: different dominant genus according to individuals**



From: Arumugam *et al.*, 2011

species → **Great diversity of species**

Around 1,000 species

strain

Figure 2 - Key characteristics of the gut microbiota composition

Remarkable stability over time

As with all complex microbial ecosystems, many factors may affect the stability of the microbial communities living within our GI tract: pH, quality and quantity of exogenous substrates and endogenous mucins, use of antibiotics, etc.

Nevertheless, the diversity of the dominant species in healthy adults is **remarkably stable over time**, for a period lasting several months or even several years [4,5].

Our intestinal microbiota thus exhibits a **marked ability to resist change**. For example, inclusion of a probiotic or prebiotic in the diet results in only a transient change in the microbial balance. Even after episodes of major stress such as antibiotic treatment, the prior equilibrium of the dominant species is restored within around one month [6].

This remarkable stability is almost certainly due to the extreme conditions found in the intestinal medium (e.g. pH, anaerobic conditions) resulting in selection of those bacteria most suited to the individual GI tract [7].

Key points

- The composition of the intestinal microbiota remains remarkably **stable over time**.
- The equilibrium of the microbiota is restored **even after episodes of major stress** such as antibiotic treatment.

What is the role of our intestinal bacteria? Microbial activities could play a fundamental role in our health

Even though little is understood about how our body communicates with the bacteria it contains, more and more studies show that our microbiota plays a part in many functions affecting our health.

Digestion of fibre and conversion of numerous other food constituents

Bacteria in the colon break down and ferment food constituents not already digested in the small intestine, as well as the products of intestinal renewal, so as to obtain the substrates they require for growth. The metabolites formed during these reactions may be absorbed by our body, with positive repercussions on our health. The intestinal bacteria are also responsible for biosynthesis of vitamins needed by the body such as vitamin K[8].

Maturation of the intestinal immune system

The presence of the microbiota in the gut is vital for maturation of the intestinal immune system and for the acquisition of tolerance to food antigens.

A natural defence against external pathogens

When external bacteria are ingested, they may compete with the bacteria resident in our GI tract for access to nutrients and for contact with the epithelium. Since the bacteria within our microbiota are better suited to our digestive environment, the chances of implantation of these foreign bacteria in our GI tract are reduced.

Key point

- A close relationship exists between our microbiota and our health.

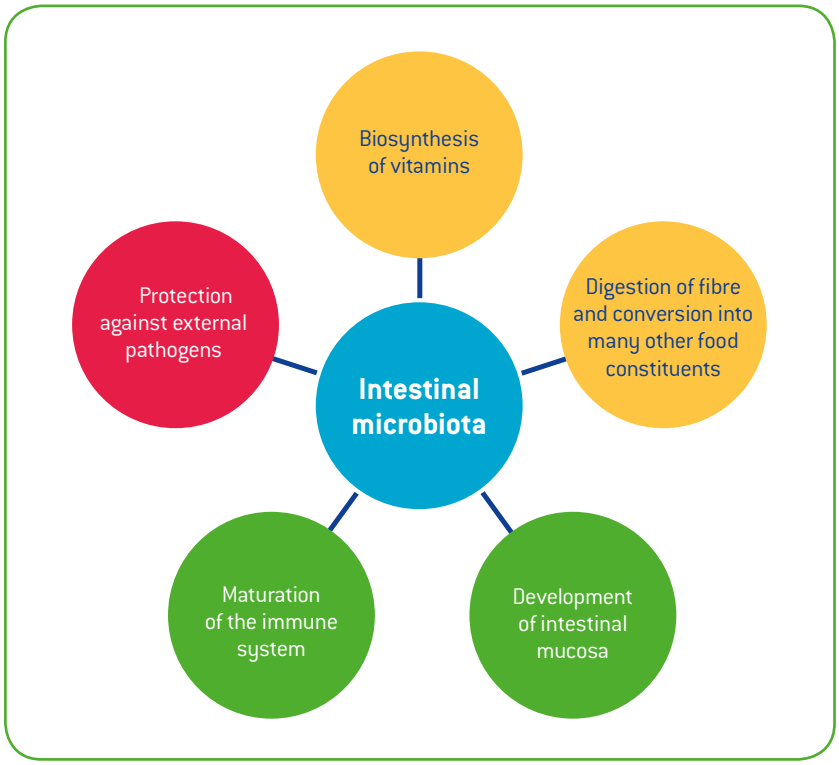


Figure 3 - Key functions of the intestinal microbiota

IN PRACTICE:

Each individual has his or her own microbial equilibrium, which is unique and stable and essential to their health.

The fundamental role of diet in microbiota composition

Ingested foods and microbial equilibrium

Microorganisms whose substrates of predilection are found in our food residues can develop preferentially. Our diet therefore plays a key role in the composition and functioning of our microbiota.

A base diet type is associated with stable microbial equilibrium

An astonishing discovery has shown an association between a diet consistent over the long term and a specific form of intestinal microbial equilibrium: a diet rich in protein and animal fat and the enterotype dominated by *Bacteroides* and a fibre-rich diet and the enterotype dominated by *Prevotella* [9].

However, dietary change may temporarily modify this equilibrium

During a change in eating habits, the composition of our intestinal microbiota may temporarily change to some extent. For instance, greater fibre intake enhances the development of bacteria capable of fermenting fibre. However, the microbiota very quickly returns to its initial equilibrium. **This modulation may have beneficial health effects even if it is transient**. In particular, this is the case with non-digestible prebiotic food ingredients which, once in the colon, may stimulate one or more bacterial groups able to improve the host's physiological condition [10].

Key points

- Our microbiota composition depends on the type of foods we eat.
- Dietary change may cause a transient change in the composition of the microbiota and may have **beneficial effects on our health**.

Inclusion of bacteria in the diet may be beneficial for our health

The bacteria added to our foods are clearly in a minority compared with the microbiota. They are in transit, although some of them, known as "probiotics", may interact with our body and our microbiota.

When bacteria are ingested from food, the mobility of the small intestine means they are quickly carried to the colon and **generally disappear within a few hours**. Even if certain bacteria belong to species naturally present in the microbiota, none of these colonise the GI tract. In addition, the extreme conditions in the intestinal medium mean that not all bacteria survive until they reach the colon.

Certain bacteria added to our food in adequate quantities may interact with our microbiota and body despite being in transit. Some functions of bacteria found in food may also be activated (e.g. production of enzymes) during the passage through the GI tract and have a beneficial effect on the human body.

Furthermore, the effects of bacteria are closely related to the bacterial strain. In other words the properties described for a given strain cannot be automatically extrapolated to another strain or combination of strains, even if closely related [11]. The **matrix containing the probiotic** may also affect the physiology of the bacteria and thus its effects on health.

Yoghurts traditionally contain two live bacteria necessary for their production - *Lactobacillus bulgaricus* and *Streptococcus thermophilus* - certain beneficial effects of which have been demonstrated.

Key points

- The bacteria found in food are in a minority with regard to the microbiota and do not colonise the GI tract.
- If ingested in sufficient quantities, certain bacteria may be beneficial for our health.

IN PRACTICE:

Yoghurts contain bacteria which have a number of proven beneficial effects.

Yoghurt has recognized beneficial effects on health

There are two clinical situations in which yoghurt may be recommended: firstly in subjects with poor lactose digestion, and secondly, in children with certain types of diarrhoea.

Yoghurt contains at least 10 million lactic bacteria per gram of product. Following ingestion, a proportion of these bacteria remain alive all the way along the intestinal transit. **This survival is improved due to the protective role of the dairy matrix**.

Yoghurt is recommended for subjects with poor lactose digestion

Eating yoghurt helps lactose digestion and does not cause the fermentation characteristic of lactose intolerance, even though it contains as much lactose as the equivalent volume of milk. This effect of yoghurt has been validated by the European Food Safety Authority (EFSA) in 2010 [13].

Many people presenting, or who feel they are presenting, with lactose intolerance tend to reduce their input of dairy products, or even to completely cut them from their diet. However, as well as reducing calcium intake, this choice also reduces the intake levels of many micronutrients. As well as representing the main source of calcium (51 % of calcium intake in children and 46 % in adults [14]), dairy products also provide high concentrations of proteins, vitamins and minerals.

How does yoghurt improve lactose digestion?

No fewer than 14 clinical trials have demonstrated that specific bacteria in yoghurt improve lactose digestion in subjects who normally have difficulties digesting lactose [15]. The majority of these studies show at least one major episode of hydrogen excretion following yoghurt consumption, indicating better lactose absorption (figure 4).

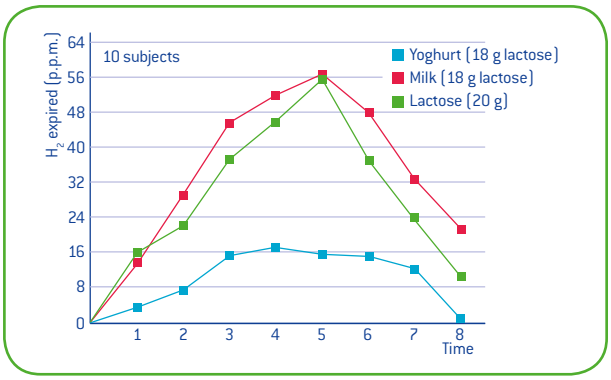


Figure 4 - Hydrogen expiration test showing improved digestibility of lactose in yoghurt *vs.* lactose in milk or water

Source : Kolars *et al.*, 1984 [17]

The lactic bacteria found in yoghurt naturally contain a lactase allowing them to hydrolyse lactose and utilise this disaccharide [16]. Bacterial lactase is inactive in yoghurt at pH 4 stored at +4 °C but it becomes active in the small intestine when lactic bacteria come into contact with it, in particular in the duodenum, where physicochemical conditions approach the optimal conditions for functioning of this enzyme (+37 °C, pH = 7) [17].

IN PRACTICE:

DIFFICULTY IN DIGESTING LACTOSE SHOULD NOT BE CONFUSED WITH LACTOSE INTOLERANCE

Normally, the activity of lactase, an enzyme that digests lactose, decreases during early childhood before stabilising at different levels which vary according to the individual. **This decrease is a normal physiological phenomenon**. If residual lactose activity is insufficient for the digestion of large quantities of lactose, **difficulty in digesting lactose occurs**, which may present as clinical symptoms indicative of **lactose intolerance**, namely abdominal distension, diarrhoea and abdominal pains.

DIAGNOSING LACTOSE INTOLERANCE

Self-diagnosis by patients is not sufficient to identify lactose intolerance. Clinical diagnosis is necessary to prove that the clinical symptoms are associated with a true difficulty in digesting lactose. It may be measured by a hydrogen expiration test, available in most gastroenterology departments.

Key point

- The **specific live bacteria found in yoghurt** naturally produce an enzyme that digests lactose.

IN PRACTICE:

Yoghurt consumption is recommended for persons who have difficulty digesting lactose.

Yoghurt and its bacteria in the prevention and treatment of acute and persistent diarrhoea in children

All available scientific data show that probiotics (taken alone or in combination with other foods) - including yoghurt bacteria - may be effective in the prevention and treatment of certain types of diarrhoea.

Diarrhoea is a particularly common digestive symptom in infants and children. It is generally of viral origin and subsides spontaneously within 2 to 3 days. The main risk associated with acute diarrhoea is the onset of dehydration, which can result in marked weight loss. The management of sick children thus involves **oral rehydration** and **renutrition**.

Yoghurt ferments in the prevention of acute diarrhoea in children

Probiotics (taken alone or in combination), particularly yoghurt ferments, are effective in reducing the risk of onset of acute diarrhoea in children, **cutting such risk by 57 % on average** [18].

Use of yoghurt ferments in reducing the duration of diarrhoea episodes in children

Probiotics (taken alone or in combination), including yoghurt bacteria, may also reduce the duration of episodes of diarrhoea in children:

- **Acute diarrhoea:** probiotics **reduce the duration of episodes of diarrhoea by an average of around 1 day** [19].
- **Persistent diarrhoea:** taking probiotics reduces the duration of persistent diarrhoea in children by an average **0.7 days** [20].

A new study has shown that **consumption of yoghurt could also be effective in combination with a rehydration solution** in reducing the duration of persistent diarrhoea in children [21]. In developing countries, the World Health Organisation (WHO) also recommends associated consumption of yoghurt during persistent diarrhoea in children [22].

Hydration and improvement of nutritional status

Yoghurt is a **food that provides hydration because of its high water content** (approximately 90 % water). Furthermore, the nutritional qualities of yoghurt, which is rich in protein, calcium and numerous other nutrients, ensure **rapid improvement in the nutritional status of sick children**.

Key points

- Yoghurt ferments may **reduce the risk of onset of diarrhoea and reduce the duration of episodes of diarrhoea**.
- Yoghurt is **a food that provides hydration** and also actively **improves the nutritional status** of sick children.

IN PRACTICE:

Yoghurt can be helpful in the treatment of diarrhoea in children.

AND IN THE CASE OF DIARRHOEA ASSOCIATED WITH ANTIBIOTIC TREATMENT?

Probiotics, including those found in yoghurt, **significantly reduce the risk of the onset of diarrhoea during antibiotic treatment:** overall reduction of **12 % to 29 %** in children and of **44 % to 53 %** in adults [23,24,25].

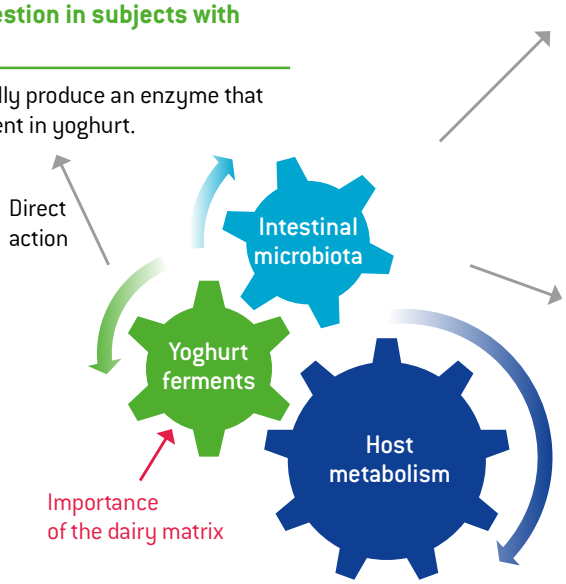
The beneficial effects of yoghurt and fermented milks bacteria : an active and promising area of research

Research work is underway on certain strains of bacteria, including those found in yoghurt and fermented milks, potentially of use in the treatment or prevention of certain disorders, in particular: • **irritable bowel syndrome** • **respiratory infections** • **allergic diseases** • **obesity** • **chronic inflammatory bowel diseases (CIBD)** • **metabolic syndrome, etc.**

Summary

Improved lactose digestion in subjects with lactose intolerance[13]

Yoghurt ferments naturally produce an enzyme that digests the lactose present in yoghurt.



Value of yoghurt in the management of certain types of diarrhoea

- acute and persistent diarrhoea in children ;
- diarrhoea associated with use of antibiotics.

Areas of research concerning yoghurt bacteria and associated fermented milks

Metabolic syndrome Irritable
Bowel syndrome
Allergy
Obesity
IBD
etc.

Figure 5 - Beneficial roles played by yoghurt and its ferments in health

In practice: key points to remember

- **All yoghurts, regardless of their texture and flavour (0 %, natural, blended, fruit flavoured, yoghurt drinks, etc.), contain living bacteria in large quantities.** In France, the term yoghurt may be only used for products that specifically and exclusively contain the 2 bacteria *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

- **You may recommend yoghurt to your patients who have difficulty in digesting lactose.** The live ferments found specifically in yoghurt help improve digestion of the lactose present in yoghurt. Yoghurt consomption not cause digestive problems for subjects with poor lactose digestion. It is in fact recommended for such subjects to provide them with all the nutritional benefits of yoghurt and to cover their calcium requirements.

- **Yoghurt consumption may be useful in managing certain forms of diarrhoea (acute and persistent diarrhoea in children, diarrhoea associated with antibiotic treatment).**

- **The dairy matrix in itself has an effect on the physiological activity of the lactic bacteria.**

- **In summary, 125g of yoghurt each day provides:**
  - 13 billion live lactic ferments biologically active throughout the entire GI tract;
  - 140 to 180 mg[a] of dairy calcium;
  - 5 g[a] of proteins;
  - vitamins B2, B12, B3, B5 and B6;
  - phosphorus, iodine, magnesium, zinc and selenium;
  - 1 of the 3 dairy products recommended daily.

IT IS NOT ALWAYS EASY TO CHANGE PATIENTS' EATING HABITS! HERE ARE 3 LITTLE STORIES THAT MAY BE OF USE TO YOU...

Did you know: in Central Asia fermented milks have long been renowned for their therapeutic and medicinal properties and are drunk by most people in the firm belief that they are beneficial to health. For example, they are used to treat GI diseases, and more generally to reinforce immunity.

Did you know: in the 15th century, a Turkish physician cured François I's digestive ailments by prescribing him yoghurt.

Did you know: at the start of the 20th century, Elie Metchnikoff, following in the footsteps of Louis Pasteur on lactic fermentation, discovered the two bacteria responsible for fermentation of milk: *Lactobacillus bulgaricus* and *Streptococcus thermophilus*.

Source : Observatoire CNIEL des Habitudes Alimentaires (OCHA – CNIEL Observatory on Dietary Habits)

[a] Values based on the principal products on the french market

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Next issue:
Obesity and IBD: the role of the gut microbiota

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Nutrition and Fresh Dairy Products

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