

*Efficacy of ready-to-eat probiotic artichokes in modulating gut microbial parameters in healthy subjects and patients with functional constipation.*



ISTITUTO DI SCIENZE  
DELLE PRODUZIONI  
ALIMENTARI

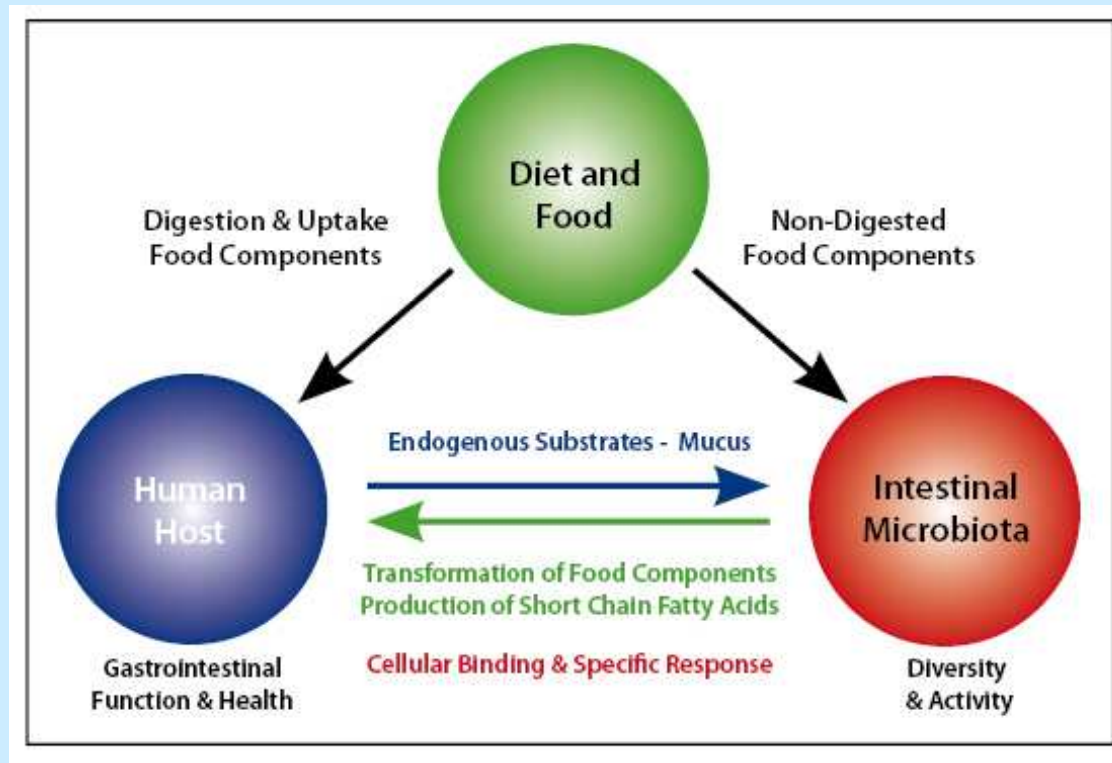
*Paola Lavermicocca*

*Institute of Sciences of Food Production, CNR,*

*Bari*

## *Mutually beneficial relationship between the host and its resident microbiota*

*'We feed our microbes, they talk to us and we benefit. We just have to understand and then exploit this.'*  
(Willem de Vos).

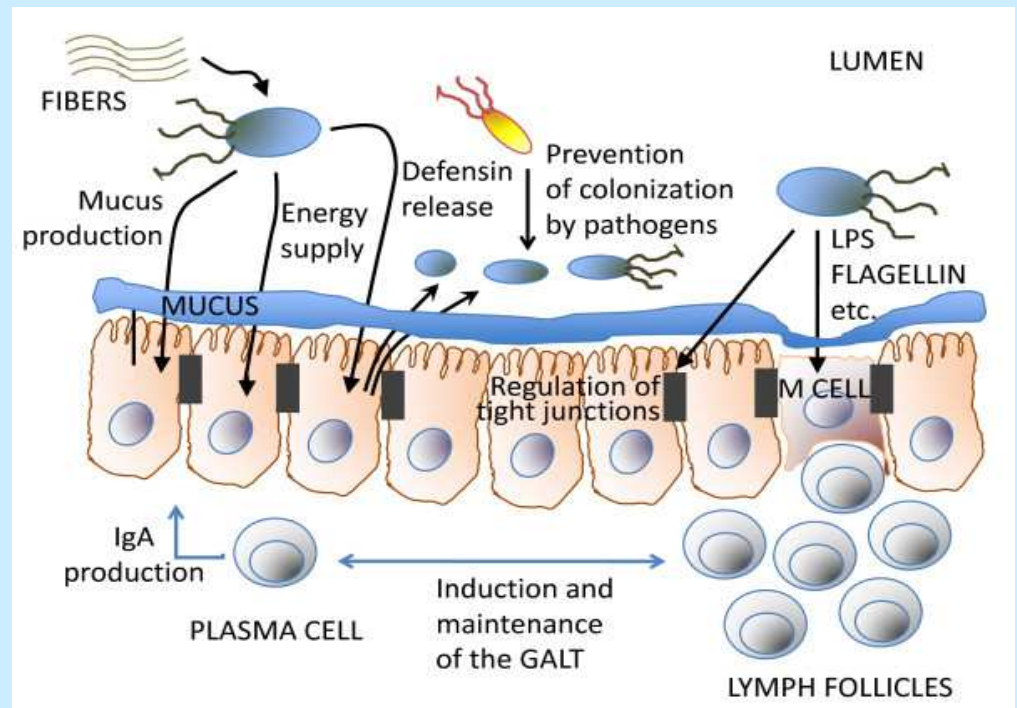


De Vos et al. 2012. Impact of Microbiota in Health and Disease. *SelfCare* 3(S1):1-68

## *Mechanisms of action of the intestinal microbiome on the gastrointestinal barrier*

### Commensal bacteria

- support the digestion of fibres and other nutrients
- contribute to energy and substrate supply
- Contribute to the acidification of the gut
- regulate epithelial functions;
- prevent colonization of pathogens in the gut
- regulate the mucosal immune system

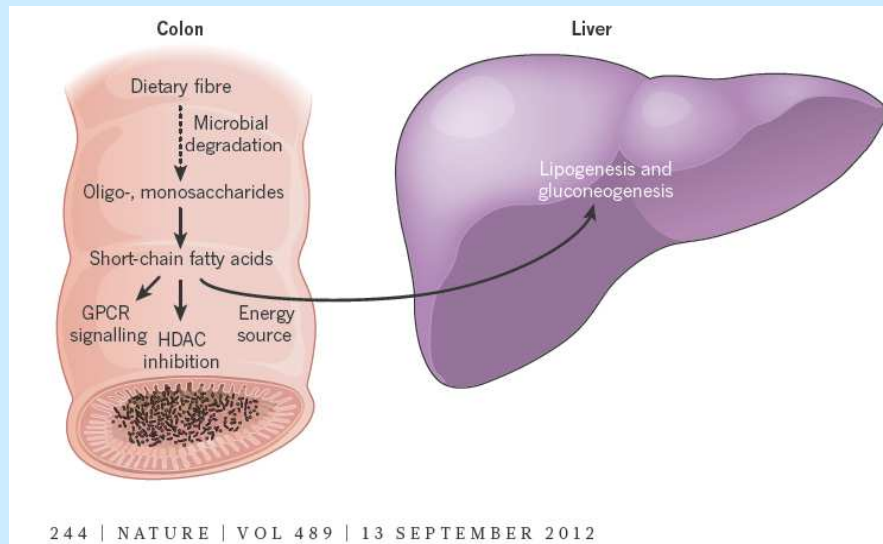


Bishoff BMC Medicine.

9:24

## *Colonic microflora: fermentation of polysaccharides*

Non-digestible carbohydrates  
fermented in the colon  
to yield energy for microbial growth  
and SCFAs.



### *Role of SCFA on intestinal functions*

Trophic effect of intestinal  
epithelium

Effect on the differentiation of  
epithelial cells

Modulation of ion absorption

Modulatory effect on glucose

metabolism

## *Gut microbiota manipulation: the use of probiotics*

Increase of the relative numbers of “beneficial bacteria” of  
gut microflora

Acidification of the gut and improvement of the nutritional  
status of gut epithelium

Strengthen intestinal barrier function and antagonize  
pathogens



## *Importance of food in probiotic efficacy*

- Probiotics transiently colonize the gut, large populations need to be ingested daily
- Survival is a strain-related ability but is influenced by the protective action of the carrier
- Foods help to buffer the probiotic through the gastrointestinal tract
- Regulate their colonization (presence of prebiotic substances)

# A DELICIOUS ALTERNATIVE? THE "HORTOBIOTICS"

Drawbacks associated with the consumption of probiotic products



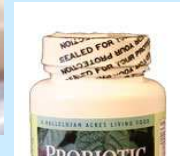
"Milk-based"

Lactose intolerances

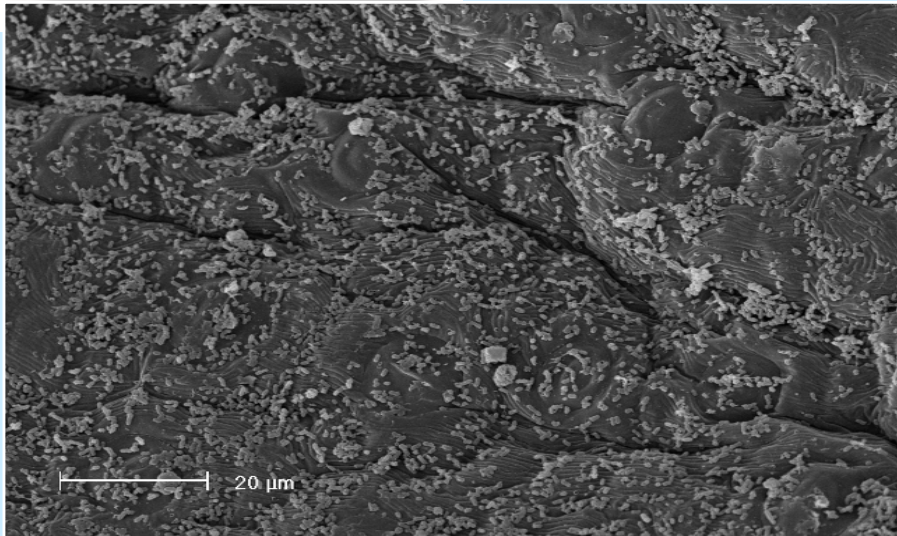
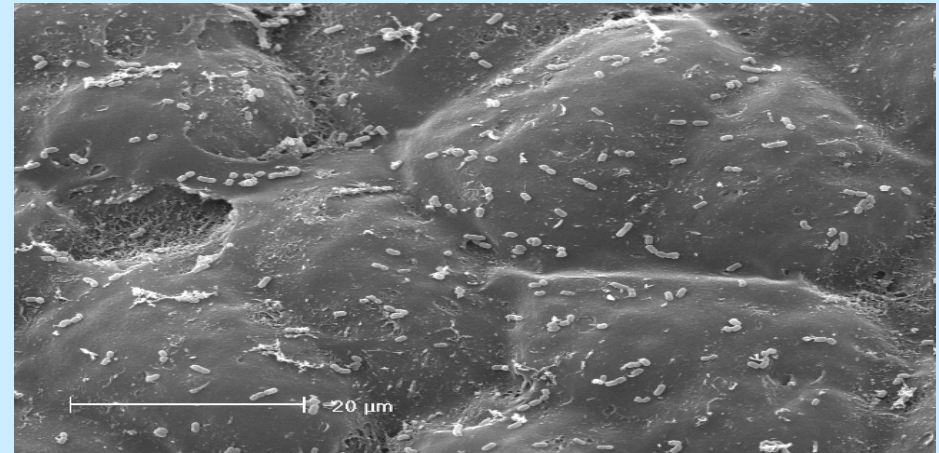
Cholesterol-restricted diets

Growing veganism

Consumers' taste (lack of sensory appeal)



# Anchorage of *Lactobacillus paracasei* LMG-P22043 to artichokes



European Patent B1 (N1843664); PCT n° WO 2006/037517

A 13<sup>rd</sup> International Conference and Exhibition on

**Probiotics, Functional and Baby Foods**

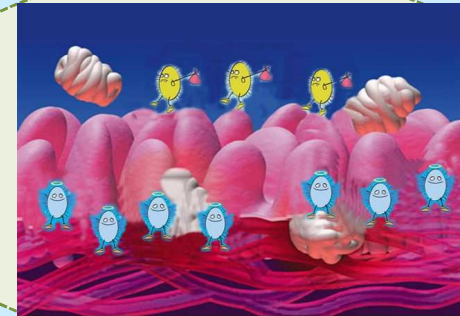
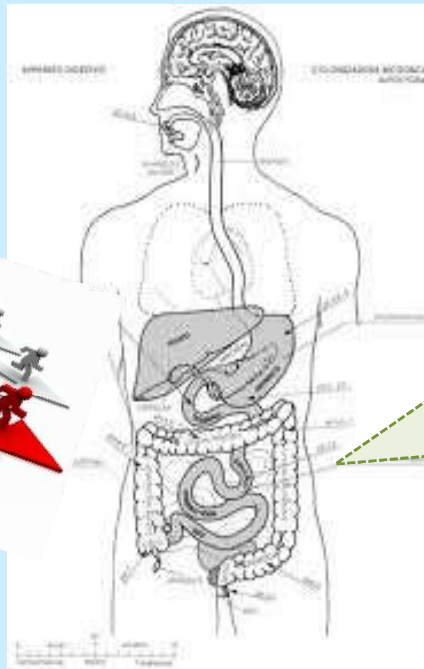
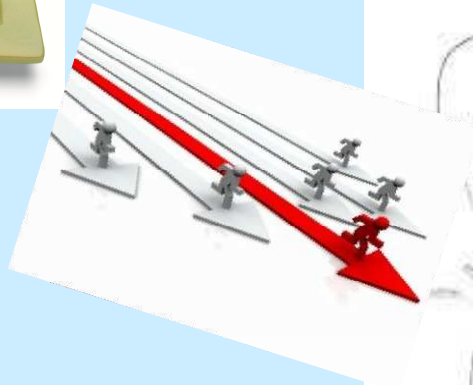
Approved by the Italian Ministry of Health

September 23-25, 2014 Hotel Royal Continental, Naples, Italy



# *Efficacy of the probiotic vegetable gastronomy*

A portion of artichokes can carry more than  
1 BILLION LIVE AND ACTIVE BACTERIA  
amount comparable or greater than those of milk- based  
products



## *Efficacy of probiotic artichokes in human trials*

Suitability to deliver the probiotic in adequate amounts

Modulation of intestinal microflora

Colonization of human gut

Probiotic artichokes enriched with *L. paracasei*

Effect on SCFA production

Effect on faecal enzymatic activities

Effect on constipation



# CLINICAL EVIDENCES

Journal of  
Applied Microbiology



Journal of Applied Microbiology ISSN 1364-5072

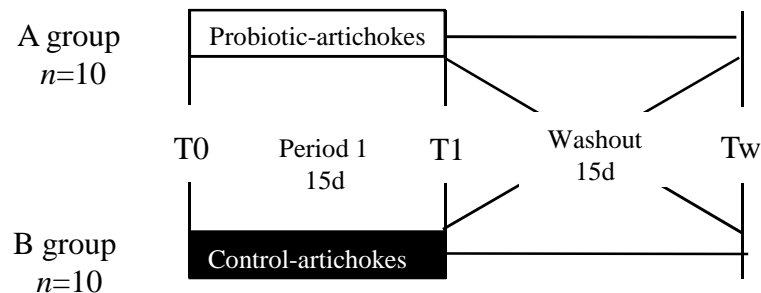
ORIGINAL ARTICLE

## Role of the probiotic strain *Lactobacillus paracasei* LMGP22043 carried by artichokes in influencing faecal bacteria and biochemical parameters in human subjects

F. Valerio<sup>1</sup>, S. de Candia<sup>1</sup>, S.L. Lonigro<sup>1</sup>, F. Russo<sup>2</sup>, G. Riezzo<sup>3</sup>, A. Orlando<sup>2</sup>, P. De Bellis<sup>1</sup>, A. Sisto<sup>1</sup> and P. Lavermicocca<sup>1</sup>

*Selection of subjects:* 20 healthy subjects (3 men and 17 women, age  $37.8 \pm 13.9$  years).

Randomized, double-blind human trial in comparison to probiotic-free artichokes (control)



## Artichoke preparation

Ordinary and probiotic artichokes were lightly seasoned with olive oil and packed in identical trays with modified atmosphere to obtain ready-to-eat artichoke products (about 180 g).

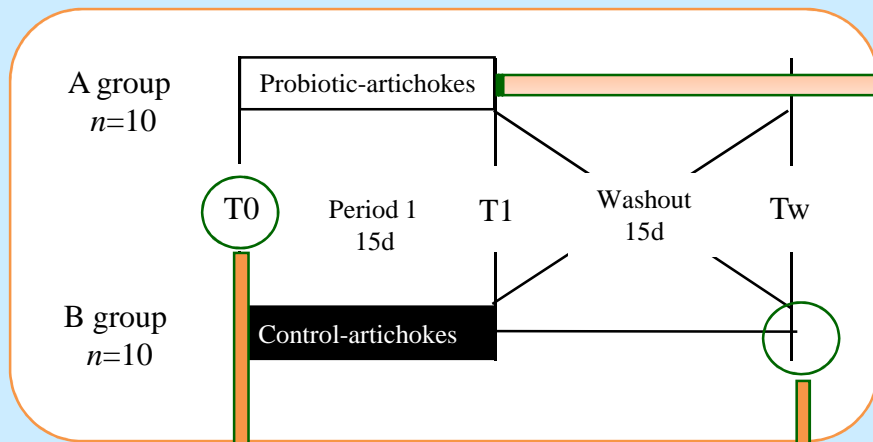
Final products had identical shape, texture, and appearance and there was no way to distinguish between the two products.

Probiotic artichokes contained approximately  $2 \times 10^{10}$  of probiotic cells per portion (daily-dose)





## Probiotic colonization



Presence of *L. paracasei* LMG P-22043 at  
T<sub>1</sub> only in Group A (6.87 log<sub>10</sub> CFU/g)  
(80% colonized subjects)

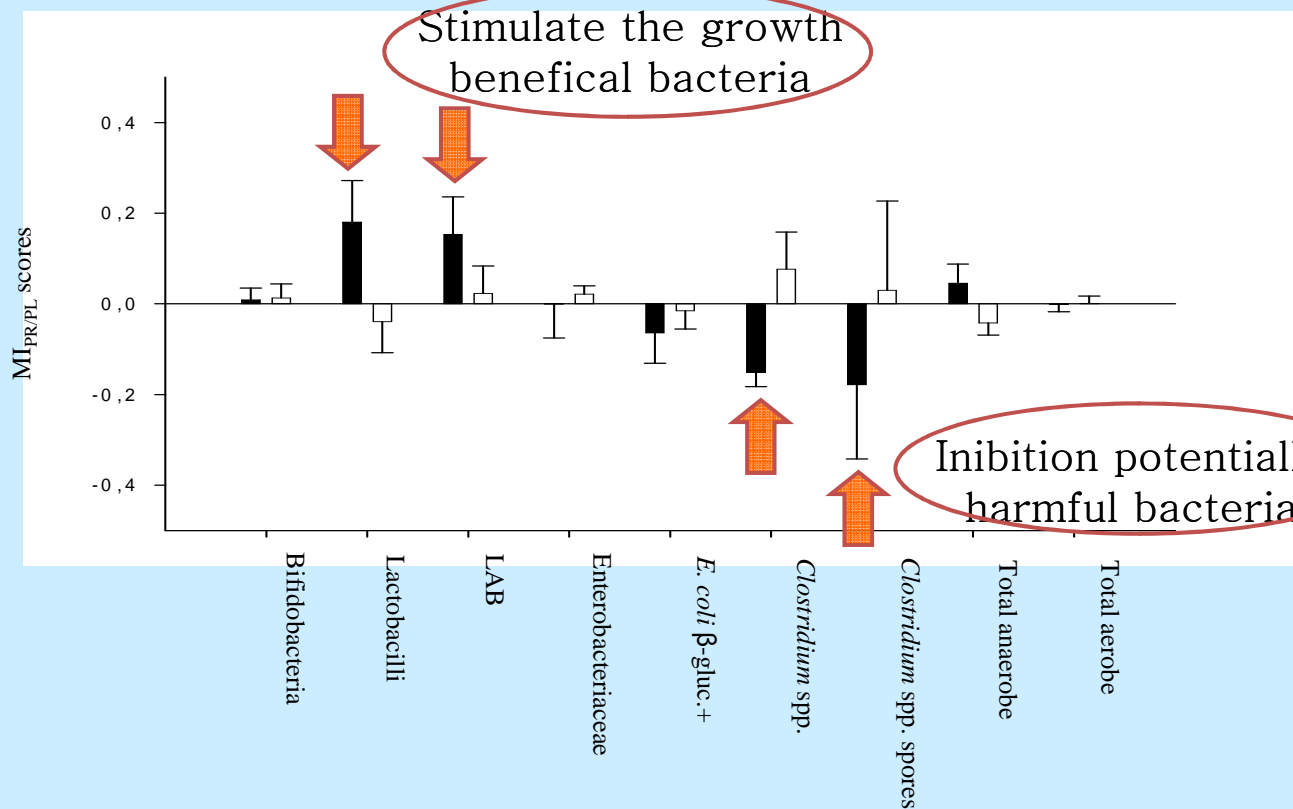
Absence of *L. paracasei* LMG P-

22043 at

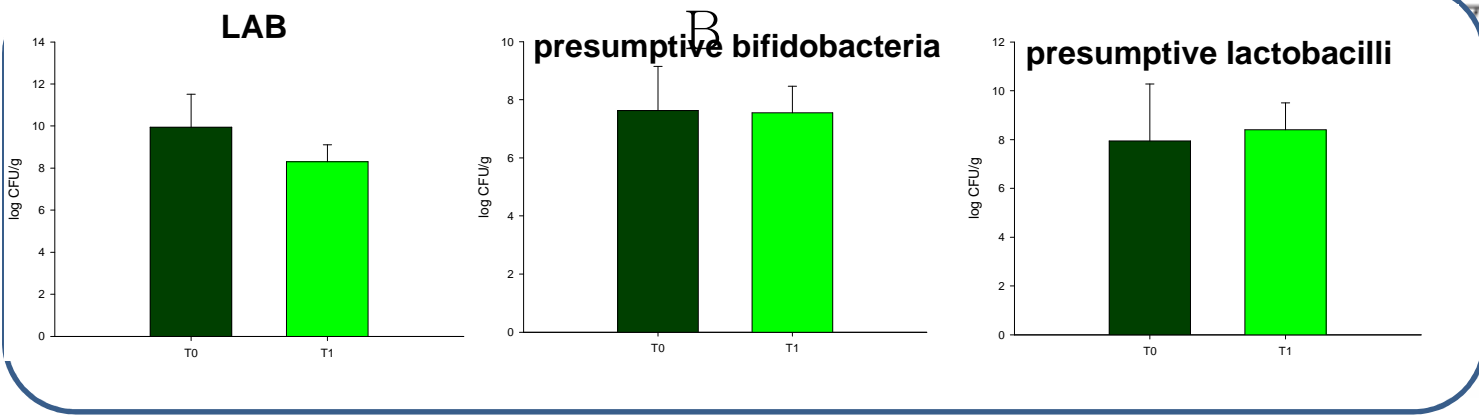
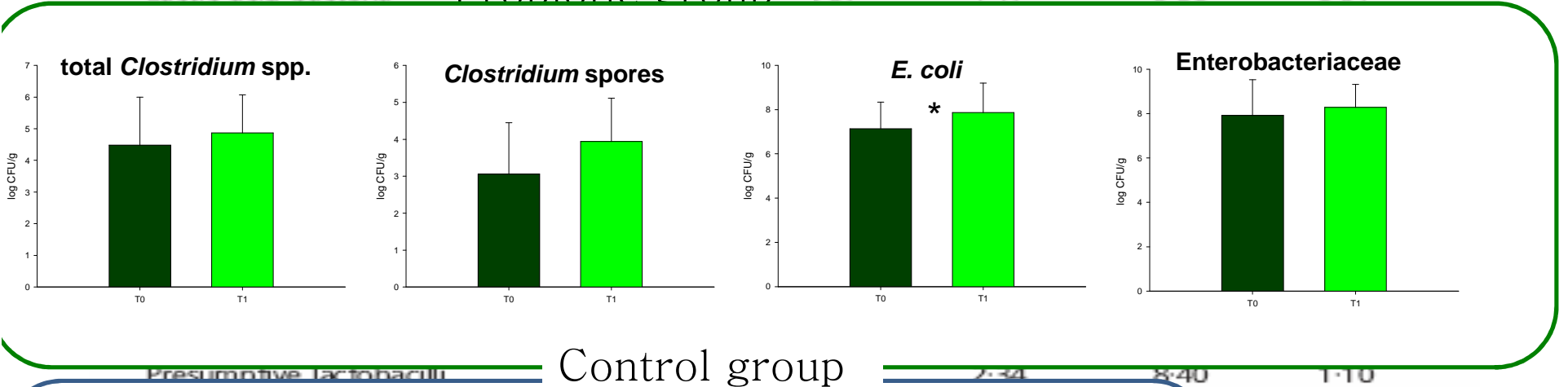
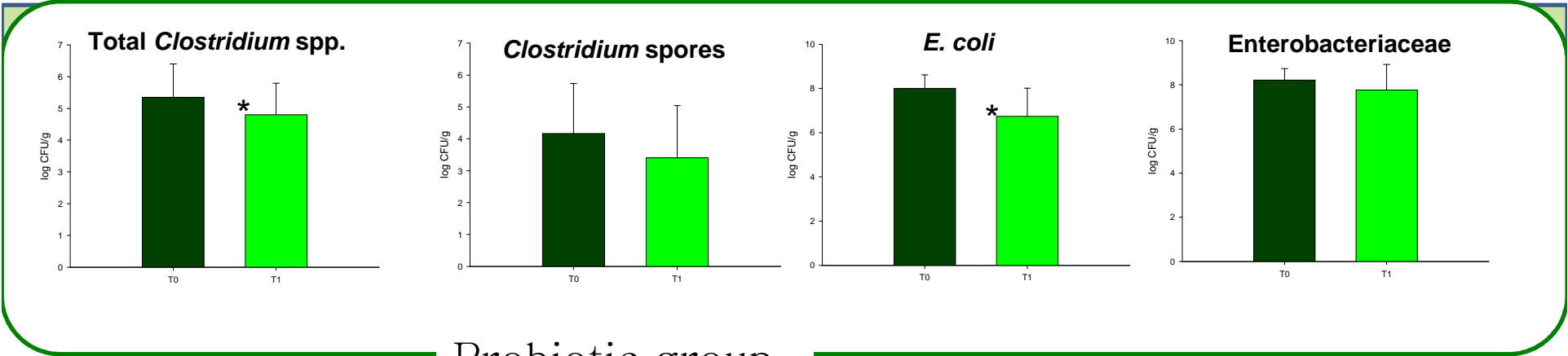
- To and Tw (Groups A and B)
- After control artichoke intake (T<sub>1</sub>, Group

# RESULTS

The probiotic strain modulates the intestinal flora by increasing the biodiversity of lactic acid bacteria and reducing potential pathogens

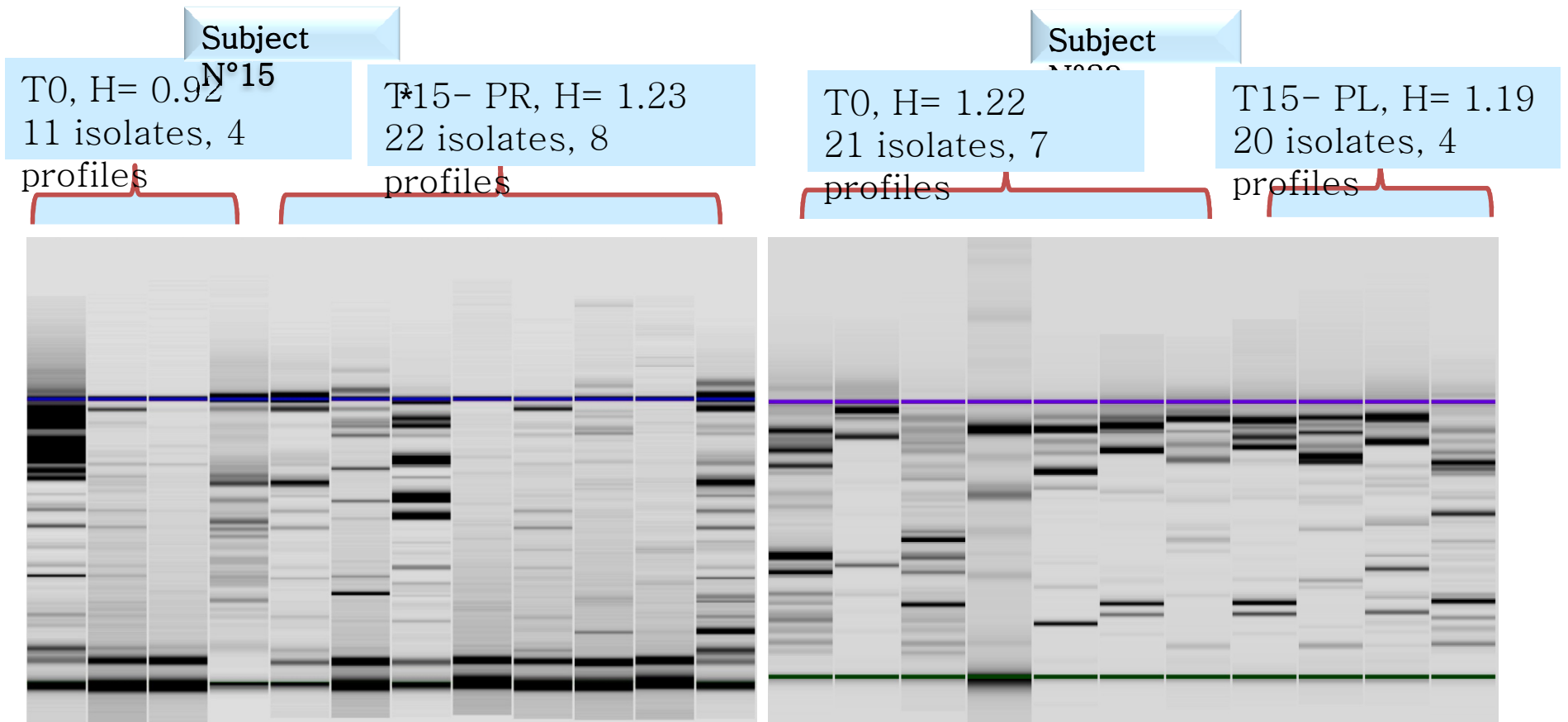


- Modulatory index MIPR/CTR indicates caused a shift of microbial counts towards lower numbers of Enterobacteriaceae, *E. coli*, total *Clostridium* and higher values of LAB, presumptive lactobacilli and bifidobacteria.



2.34  
 8.40  
 1.10  
 1.20  
 1.17  
 1.33  
 1.03  
 0.61  
 0.59  
 obtained from  
 T0.  $P < 0.05$

## Genetic diversity of faecal LAB population



$$H = \sum -\left(\frac{N_i}{N} \ln \frac{N_i}{N}\right)$$

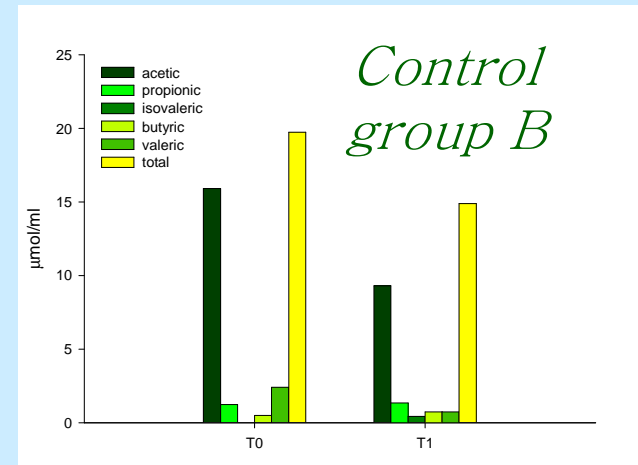
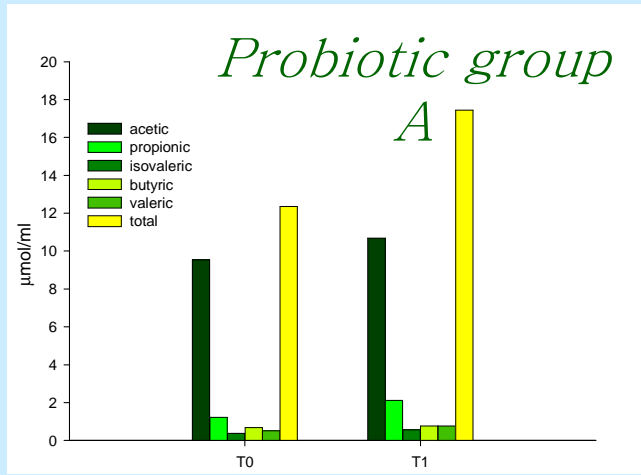
$N$  = total number of isolates

$N_i$  = number of isolates for each REP-PCR profile

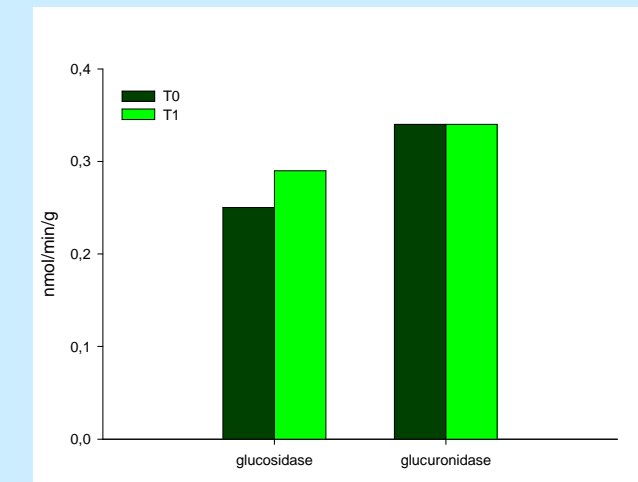
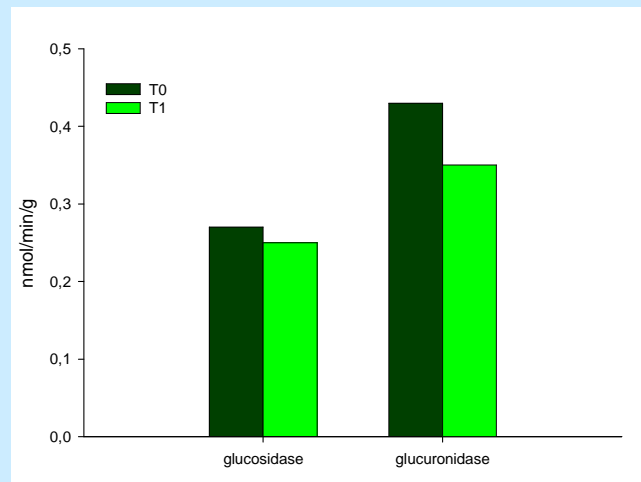


# Effect of probiotic artichoke intake on biochemical parameters

Short chain fatty acids



Faecal enzymatic activity



JOURNAL OF  
**CLINICAL GASTROENTEROLOGY**  
September 2010 | VOLUME 44 | SUPPLEMENT 1

**Effects of Probiotic *Lactobacillus paracasei*-enriched  
Artichokes on Constipated Patients  
A Pilot Study**

*Francesca Valerio, MS,\* Francesco Russo, MD,† Silvia de Candia, PhD,\* Giuseppe Riezzo, MD,‡  
Antonella Orlando, MS,† Stella Lisa Lonigro, Mrs,\* and Paola Lavermicocca, MS\**

*CNR-ISPA and I.R.C.C.S. 'Saverio de Bellis', National Institute of Digestive Diseases*

Disturbances in the gut microbiota may contribute to symptomatology and etiology of functional diseases

Functional constipation is associated to:

- Reduced levels of Lactobacilli and Bifidobacteria
- Increased levels of Clostridium
- Presence of “minimal inflammation”

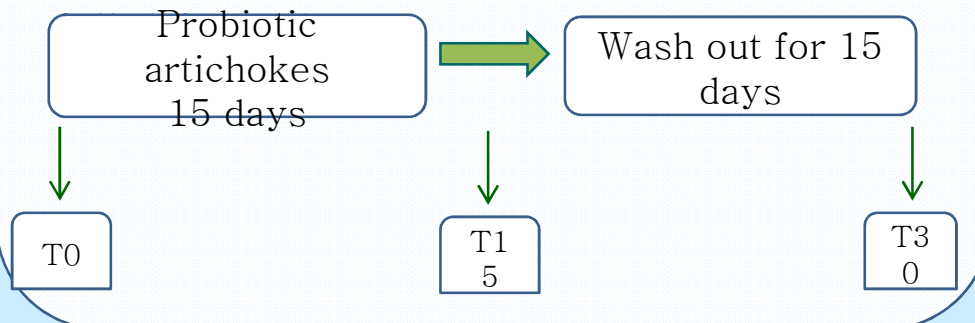
New therapeutic approach for constipation could be based on the modulation of intestinal microflora by administering prebiotics and/or probiotics.



## *Efficacy of probiotic vegetables in a human*

*study*

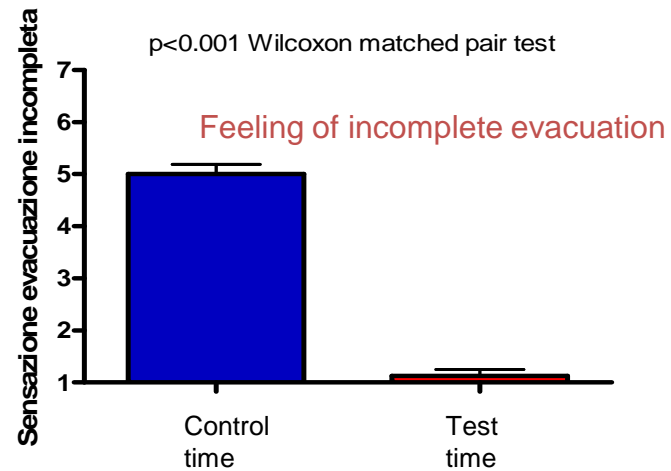
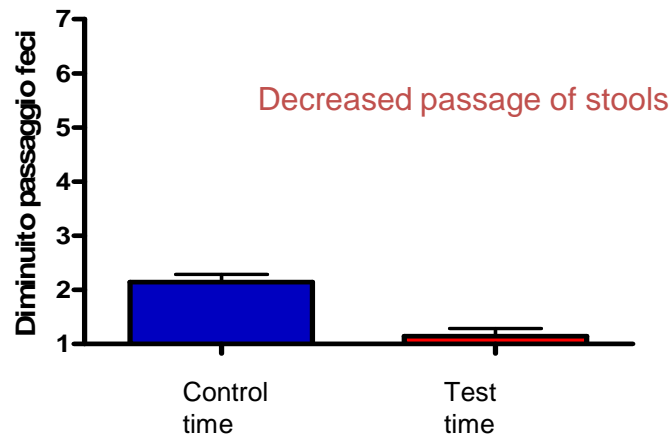
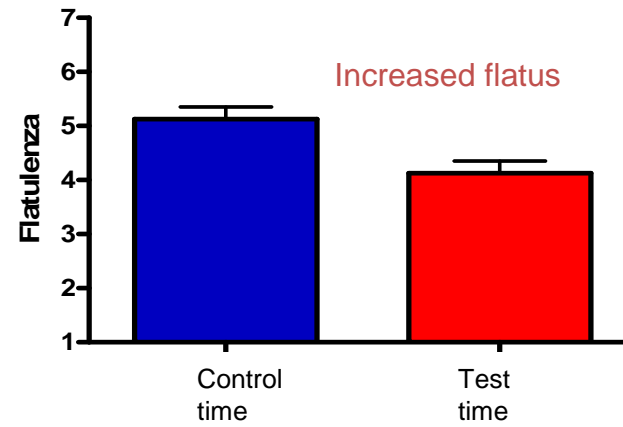
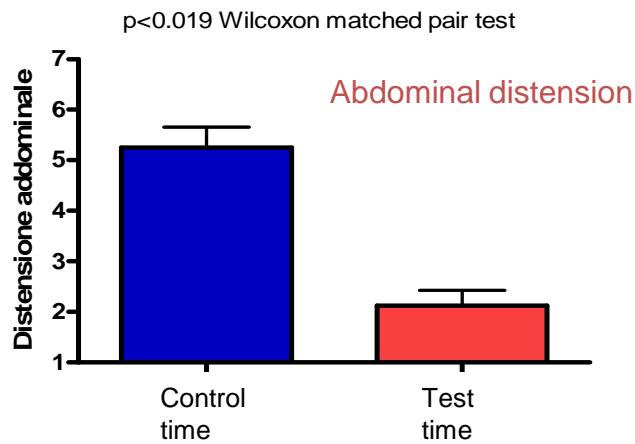
8 subjects, 3M/5F age  $40 \pm 14$  yr suffering for mild constipation (Rome II criteria) integrated their usual life style with probiotic artichokes on the base of the



Microbiological and biochemical analyses of faecal samples;  
Gastro-intestinal symptom questionnaire (*GSA*) and Bristol form chart compilation

- Colonization by the probiotic strain of the human gut of all volunteers
- Individual response of subjects to the probiotic artichokes regarding the modulation of microbial population
- Overall positive effect on symptoms profile of participants

## Gastro-Intestinal Symptom Rating Scale



Bristol form  
chart result:  
stool  
consistency  
softer in all  
subjects



**Randomised clinical trial: efficacy of *Lactobacillus paracasei*-enriched artichokes in the treatment of patients with functional constipation – a double-blind, controlled, crossover study**

**Patients**

G. Riezzo\*, A. Orlando<sup>†</sup>, B. D'Attoma<sup>†</sup>, V. Guerra<sup>‡</sup>, F. Valerio<sup>§</sup>, P. Lavermicocca<sup>§</sup>, S. De Candia<sup>§</sup> & F. Russo<sup>†,1</sup>  
*CNR-ISPA and I.R.C.C.S. 'Saverio de Bellis', National Institute of Digestive Diseases*

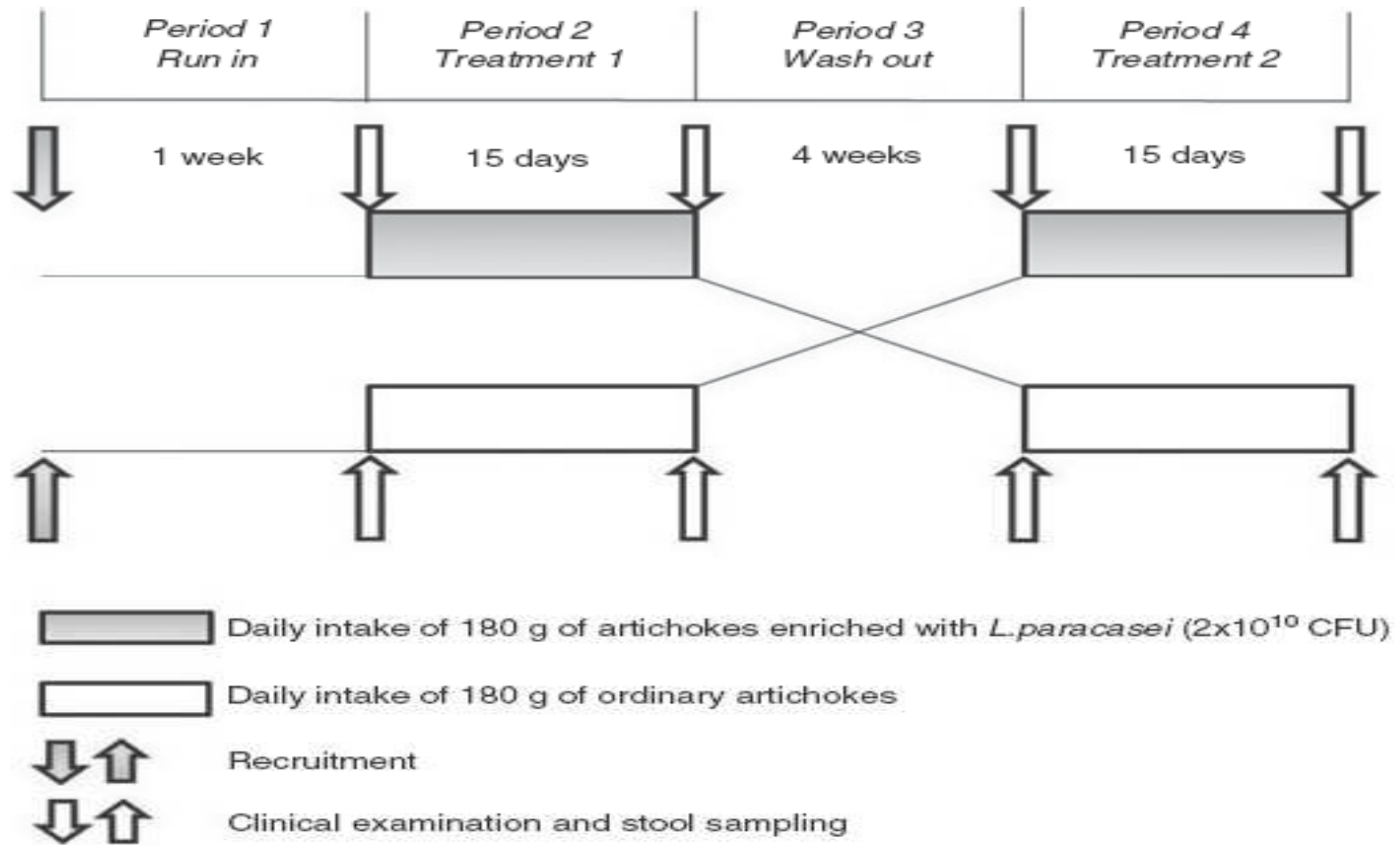
**Inclusion criteria**

- ✓ 30 patients - age 19–70 years
- ✓ functional constipation
  - Rome II criteria
  - Constipation Scoring System (CSS) (symptom questionnaire)
- ✓ GI imaging study < 5 yrs

**Exclusion criteria**

- ✓ major abdominal surgery;
- ✓ the presence of any concomitant diseases;
- ✓ alarming symptoms;
- ✓ abnormal laboratory data or thyroid function;
- ✓ family history of peptic ulcer, colorectal cancer, or IBD.





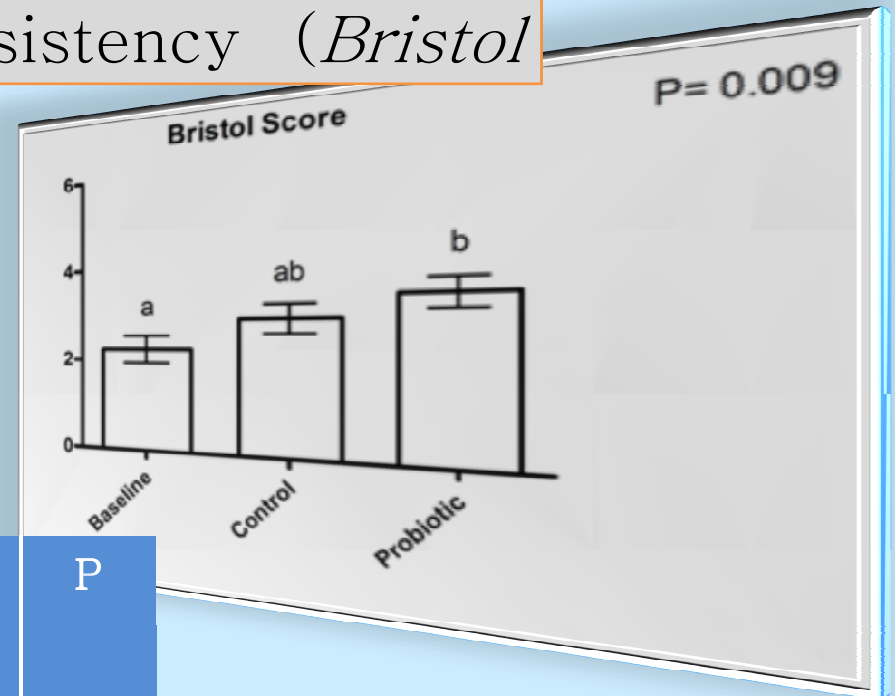
Design of the study.

# RESULTS

Stool consistency (*Bristol score*)

Colonization: 17/20 subjects

Symptom profile (*GSRS score*)



	Baseline run-in	Control Ordinary artickokes	Probiotic Enriched artickokes	P
Reduced Frequency of evacuation	2.9 ± 1.5 <sup>a</sup>	2.5 ± 1.6 <sup>ab</sup>	1.9 ± 1.6 <sup>b</sup>	0.005
Hard stool	3.0 ± 1.6	1.9 ± 2.0	1.5 ± 2.1	0.03
Feeling of Incomplete evacuation	4.4 ± 1.7 <sup>o</sup>	3.7 ± 2.3 <sup>ab</sup>	2.8 ± 2.2 <sup>b</sup>	0.004

## CONCLUSIONS

### Probiotic-enriched artichokes

- ❑ reduce GSRS item scores
- ❑ improve stool consistency
- ❑ Improve microbiological intestinal parameters

### Take home message

*The introduction of vegetables enriched with probiotics such as artichokes, but also salads and olives, (hortobiotics) could represent a way to achieve the target “functional diet”*



## Final thoughts

Probiotic vegetable gastronomy provides a concrete opportunity to convey probiotic benefits already appreciated by consumers in other market sectors.

The proficient association of the strain with a food carrier rich in fibre can represent a new strategy for favouring a daily supply of probiotics and attracting more consumers to foods fortified with probiotic strains.





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