Fermenting Foods: Rediscovering Nutritional and Healthy Living Benefits





Pamela Starke-Reed, Ph.D.
Deputy Administrator, Agricultural Research Service
Nutrition, Food Safety and Product Quality
United States Department of Agriculture, USA

Linda Duffy, Ph.D., MPH
Scientific Chair, Trans-NIH Division of Nutrition Research Coordination, Probiotics/Prebiotics WG
Scientist Administrator, NCCIH
National Institutes of Health, USA

Definition of Fermentation



- **What is fermentation?**
  An anaerobic cellular process in bacteria, yeast or other microorganisms convert foods into simpler compounds and chemical energy (ATP) is produced.

- **Fermentation in food processing is the conversion of carbohydrates into alcohols and carbon dioxide or organic acids by yeast, bacteria or combinations of both.**

- **What are fermented foods?**
  Foods processed for example, through lacto-fermentation wherein natural bacteria feed on the sugar and starch, creating lactic acid. This process biopreserves the food, creates beneficial enzymes, b-vitamins, omega-3 fatty acids, and probiotic bacterial strains.

FERMENTATION

What is fermentation?

- General definition: An anaerobic cellular process in which bacteria, yeast or other microorganisms convert organic foods into simpler compounds, and chemical energy (ATP)is produced.
- Fermentation in food processing: the conversion of carbohydrates into alcohols and carbon dioxide or organic acids by yeast, bacteria or a combination of both.

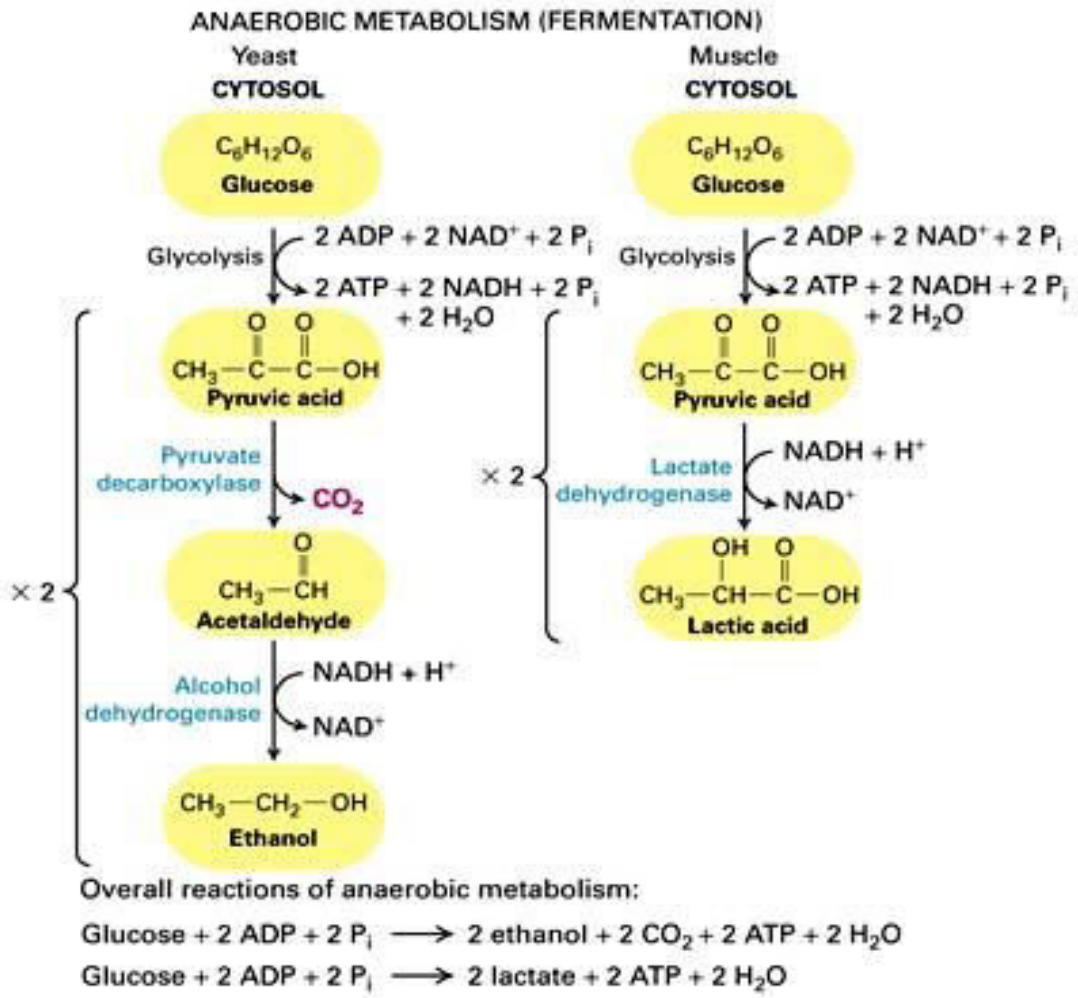


This age-old, inexpensive process of preserving vegetables is coming back into fashion. Cleaner and safer than canning, the process also produces the healthful bacteria known as probiotics. Root vegetables, cabbage and fruits are all well-suited for fermentation.





Fermentation



Two types of fermentation

Alcoholic

vs

Lactic Acid Fermentation

Fermented Food

Definition:

Fermented foods are those food produced by modification of raw material of either animal or vegetable origin by the activities of micro organisms. Bacteria , yeast and moulds can be used to produce a diverse range of products that differ in flavor, texture and stability from the original raw material.

Or

Fermented foods are those foods which are subjected to action of microorganisms or enzymes to get desirable biochemical changes and cause significant modification to food.







Fermentation Food Products and their Uses

- **Carbon dioxide – bread making using baker's yeast**
- **Alcohol – wine making and brewing using yeast**
- **Lactic Acid – lactic acid bacteria ferment milk into products as yogurt; Sauerkraut, fermented cucumbers, and kimchi are the most studied lactic acid fermented vegetables.**

Biopreservation in Different Food Products

- Dairy products - Curd ,yogurt , cheese
- Fermented meat products- Sausages,



- Vegetable products- Pickles, Sauerkraut, Kimchi,







Origins of Some Fermented Foods

Food	*Approximate year of introduction*	*Region*
Mushrooms	4000 BC	China
Soy sauce	3000 BC	China, Korea, Japan
Wine	3000 BC	North Africa, Europe
Fermented milk	3000 BC	Middle East
Cheese	2000 BC	Middle East
Beer	2000 BC	North Africa, China
Bread	1500 BC	Egypt, Europe
Fermented Meats	1500 BC	Middle East
Sourdough bread	1000 BC	Europe
Fish sauce	1000 BC	Southeast Asia, North Africa
Pickled vegetables	1000 BC	China, Europe
Tea	200 BC	China

Benefits of Fermentation

Benefit	*Raw material*	*Fermented food*
Preservation	Milk (Most materials)	Yoghurt, cheese
Enhancement of safety		
Acid production	Fruit	Vinegar
Acid and alcohol production	Barley	Beer
	Grapes	Wine
Production of bacteriocins	Meat	Salami
Removal of toxic components	Cassava	Gari, polviho azedo
	Soybean	Soy sauce
Enhancement of nutritional value		
Improved digestibility	Wheat	Bread
Retention of micronutrients	Leafy veges.	Kimchi, sauerkraut
Increased fibre content	Coconut	Nata de coco
Synthesis of probiotic compounds	Milk	Bifidus milk, Yakult, Acidophilus yoghurt

LACTOBACILLUS FERMENTATION

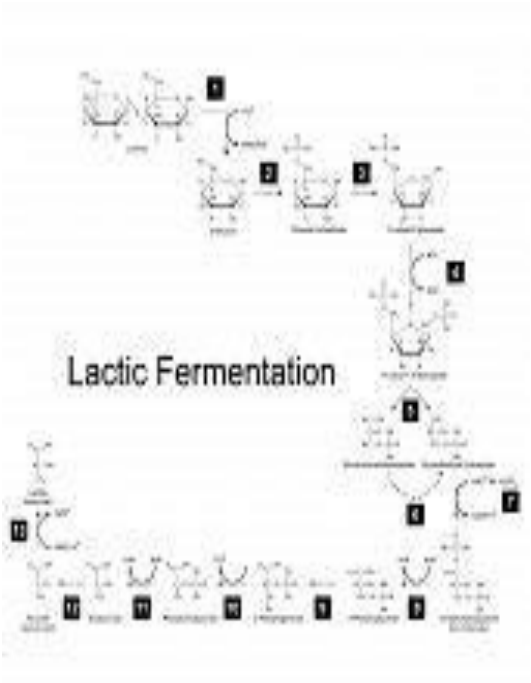
Fermentation of vegetables; definition

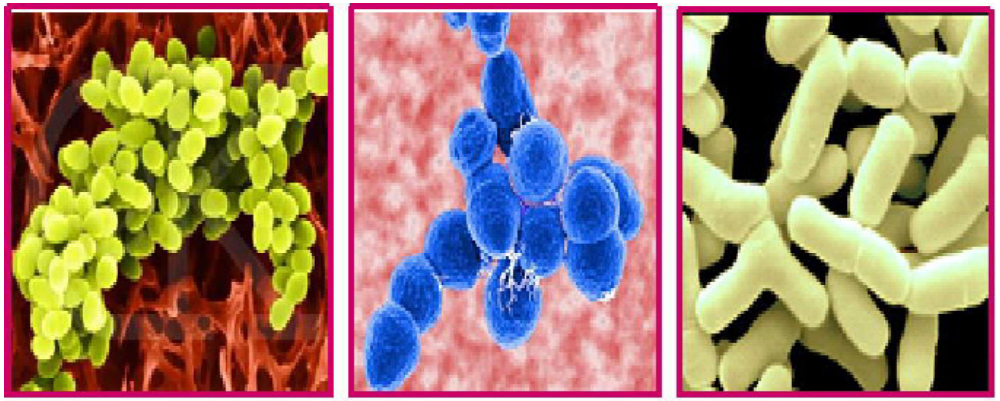
- Is a technique used, whereby Starches and sugars in vegetables are converted into lactic acid by the many species of lactic-acid-producing bacteria.
- This is done by bacteria present in the storage vessels and on the surfaces of vegetables.

- Members are responsible for lacto-fermentation of vegetables.
- They comprise of a genus known as lactobacillus. These bacteria get their name (lacto) because they are able to form lactic acid (from sugars).
- These are "friendly" bacteria that normally live in our digestive, urinary, and genital systems without causing disease. There are over 70 species recognised.
- *Lactobacillus* is very heterogeneous genus, encompassing species with a large variety of phenotypic, biochemical, and physiological properties. Most species of lactobacilli are homofermentative, but some are heterofermentative.

Lactic Acid Bacteria

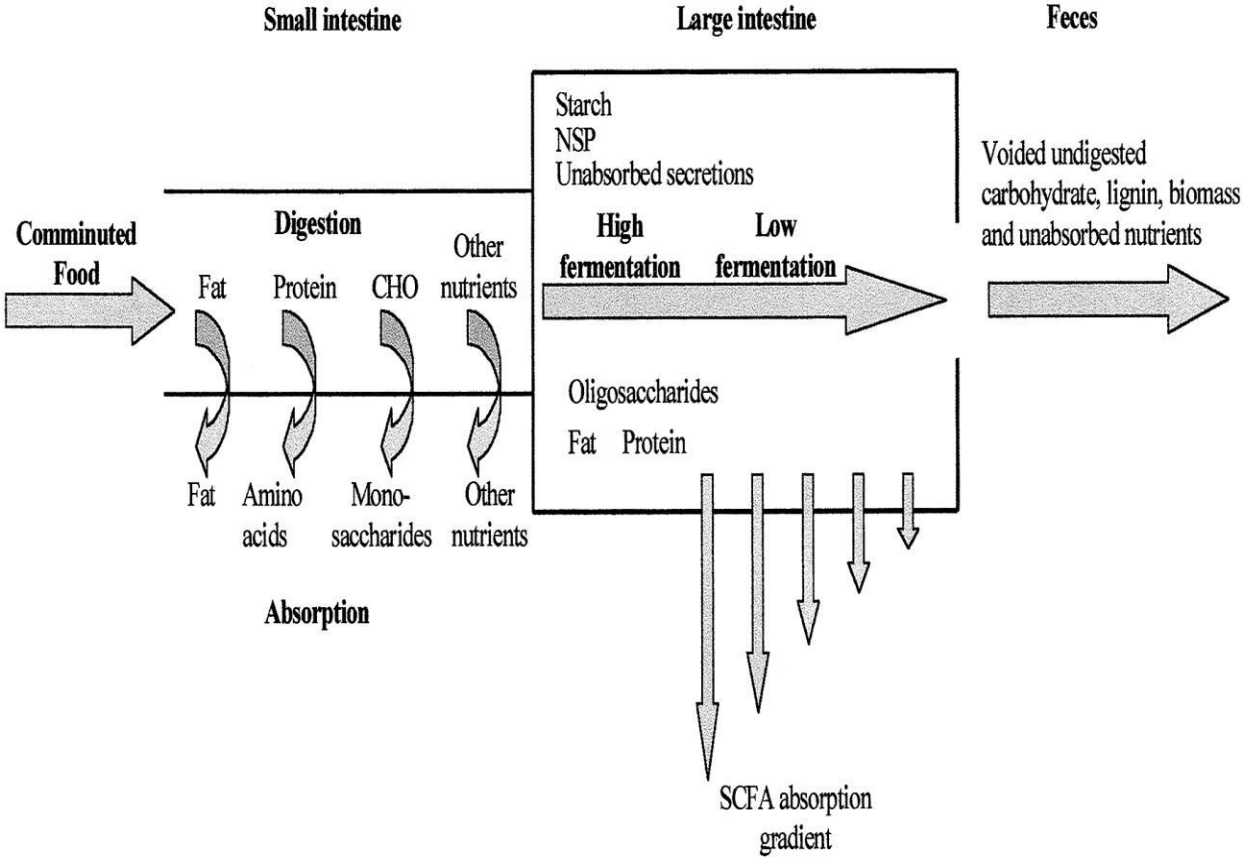
- **Lactic acid bacteria** have been used to ferment or culture foods for at least 4000 years.
- Examples: products like **yogurt and cheese**





Transit of Food Through the Human GIT

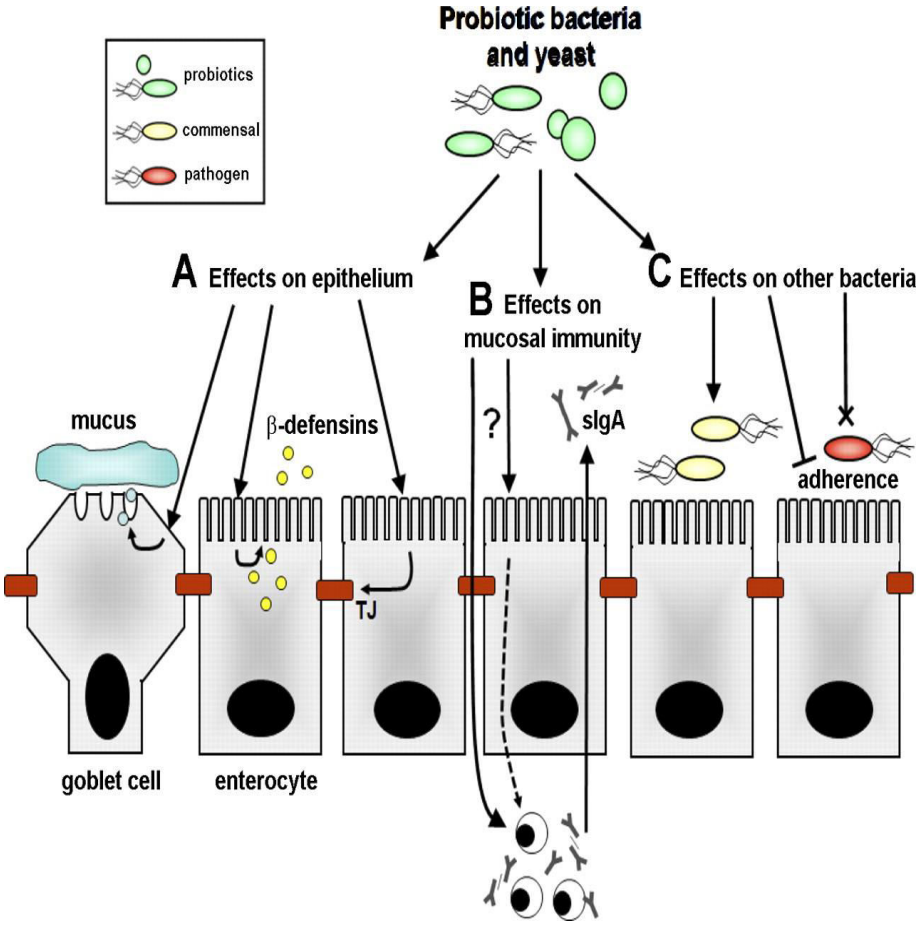




David L. Topping, and Peter M. Clifton Physiol Rev 2001;81:1031-1064

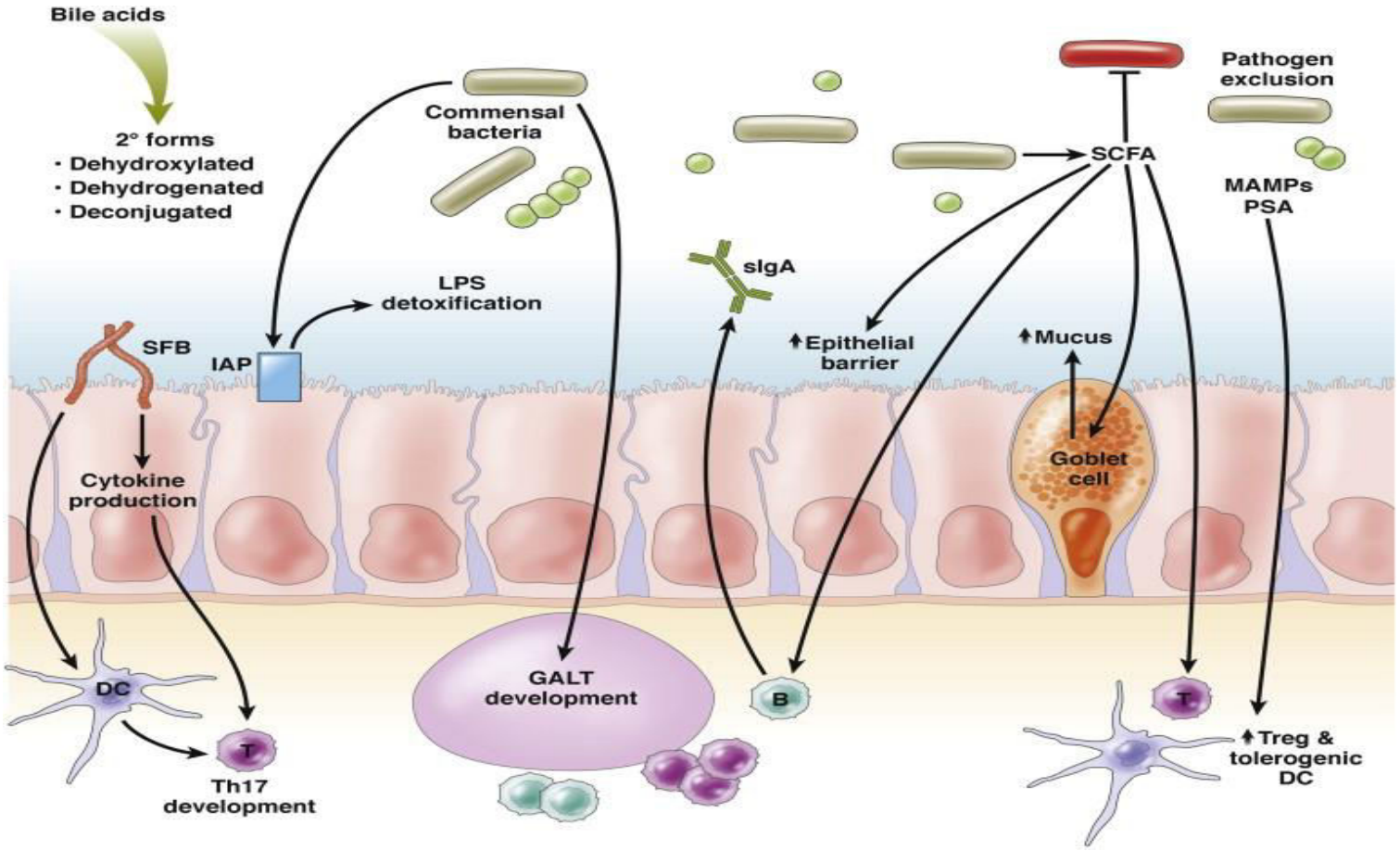
Effects of Probiotic Bacteria and Yeast





Christina L. Ohland, and Wallace K. MacNaughton Am J Physiol Gastrointest Liver Physiol 2010; 298:G807-G819

Microbial Fermentation and Effects on Host Functional Properties

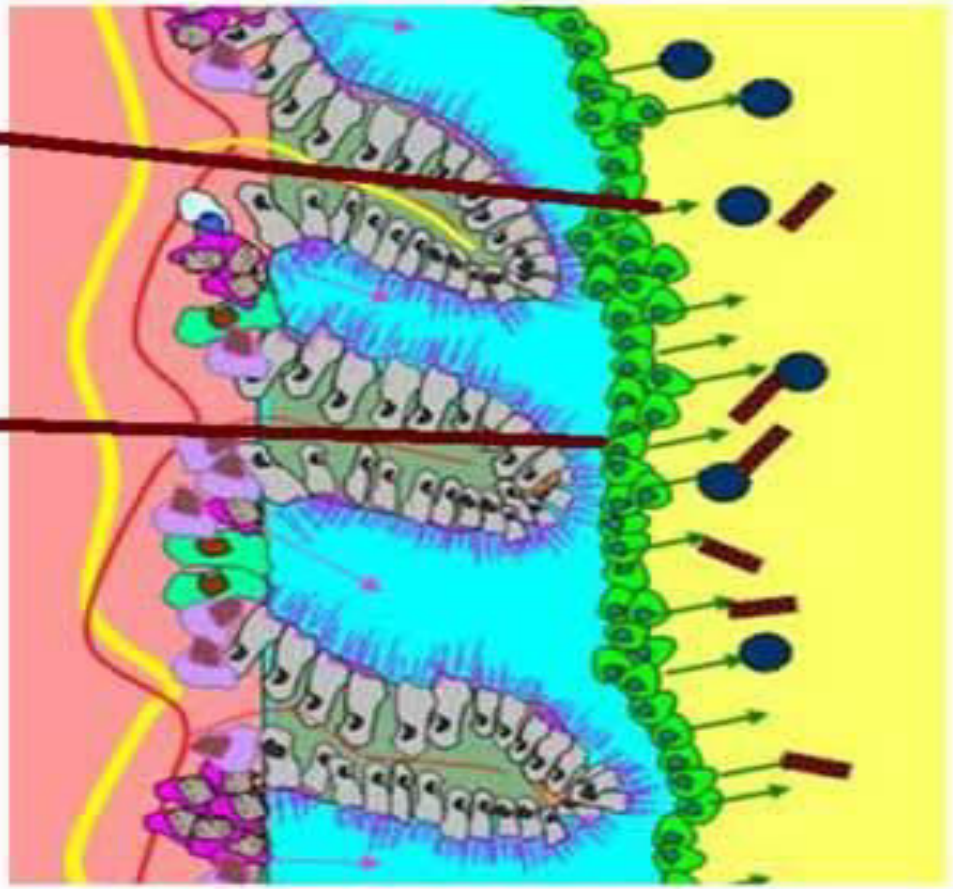


Probiotic Benefits in Food Consumption Being Studied

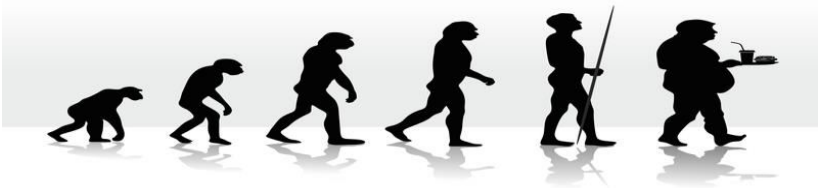
ACIDOPHILUS AND OTHER PROBIOTIC BACTERIA SECRETE: ANTIVIRAL ANTIBACTERIAL AND ANTIFUNGAL CHEMICALS.

PROBIOTICS FORM A PHYSICAL BARRIER TO HINDER INVASION OF BACTERIA AND YEASTS

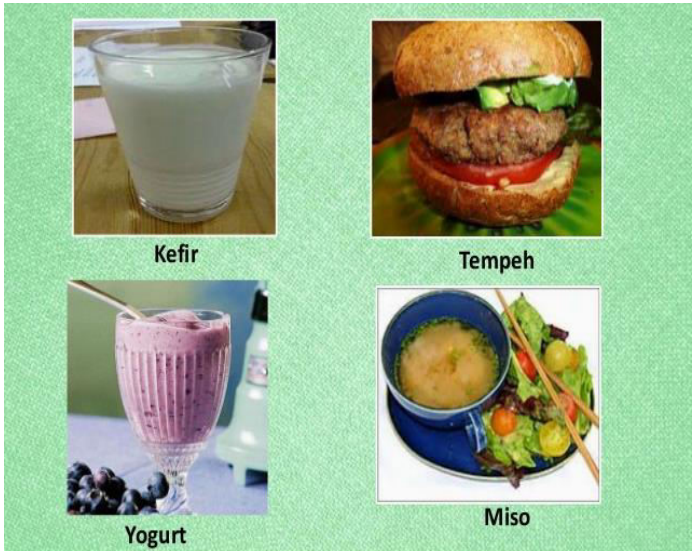
PROBIOTICS LIKE ACIDOPHILUS CREATE AN ACIDIC MICROENVIRONMENT WHICH PROMOTES IRON AND OTHER MINERAL ABSORBTION.



Functional Fermenting Foods Research



Sources of Probiotics



Sources of Prebiotics



Fermentable Cabbage
Probiotic Functional Foods

- In fresh cabbage, vitamin C is bound in the cellulose structure and various other molecules, and our digestive system is just not able to cleave it off and absorb it. Lots of it goes undigested and come out right out of you. So despite the fact that cabbage may be very rich in vitamin C, most of us will not be able to absorb. However, by fermenting the cabbage [sauerkraut; kimchi], all the vitamin C becomes bioavailable,"

- Cabbage is high in anti-inflammatory properties, vitamins A and C. Cabbage also reduces lipids in the bloodstream. When cabbage is fermented into sauerkraut the fermentation process opens up the cell walls accessing a higher ratio of vitamins. It has been said that sauerkraut has 200 times more vitamin C than the head of cabbage before fermentation.





WANTED:
GOOD BACTERIA

Want to look and feel your very best? Start enjoying more foods naturally high in probiotics — and in the fiber-rich prebiotics that help those good bugs thrive.



PROBIOTIC-RICH FOODS

DAIRY SOURCES

- Yogurt
- Kefir
- Buttermilk
- Crème fraiche
- Lassi, a drink made from yogurt and water
- Aged cheeses, such as bleu, Gouda and cheddar

FRUIT AND VEGETABLE SOURCES

- Brined pickles
- Tangy chutneys
- Brined olives
- Sauerkraut and its ethnic variations — kimchi (Korean), tsukemono (Japanese), choucroute (French)
- Sauerruben (fermented sour turnips)
- Pickled beets

SOYBEAN SOURCES



- Miso
- Tempeh
- Natto
- Soy sauce
- Tamari

GRAIN SOURCES

- Traditional sourdough breads

NONDAIRY BEVERAGES

- Kombucha



PREBIOTIC-RICH FOODS

VEGGIES

- Tomatoes
- Artichokes
- Onions
- Chicory
- Greens (especially dandelion greens)
- Asparagus
- Garlic
- Leeks

FRUIT

- Berries
- Bananas

WHOLE GRAINS

- Oatmeal
- Barley
- Flaxseeds
- Wheat

LEGUMES

- Lentils
- Kidney beans
- Chickpeas
- Navy beans
- White beans
- Black beans











Fermenting Foods Bio-Fortification as Alternative Strategies for Improving Nutritional Status

