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Lactic Acid Bacteria: A Biotechnological Friend for Industrial Prospective

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Abstract: Lactic acid bacteria(LAB) is group of gram positive organism which have the property of converting lactose and other sugars to lactic acid through the fermentation of carbohydrates. Lactic acid bacteria (LAB) are generally fastidious on artificial media, but they grow readily in most food substrates and lower the pH rapidly to a point where competing organisms are no longer able to grow. With the help of lactic acid bacteria we have produce many fermented foods. Lactic acid produce organic acid which have ability to inhibit the growth of many bacteria especially gram negative bacteria. It also have anti- inflammatory and anti- cancer activity.

Keywords: Lactic acid bacteria (LAB), Classification, Importance, Production of lactic acid, Uses of LAB.

I. INTRODUCTION

Lactic acid bacteria are among the most important groups of microorganism used in food fermentation. They contribute to the taste and texture of fermented products and inhibit food spoilage bacteria by producing growth inhibiting substances and large amounts of lactic acid. As agent of fermentation lactic acid bacteria are involved in making yogurt, cheese, cultured butter, sour cream, sausage, cucumber pickles, olive and sauerkraut, but some species may spoil beer, wine and processed meats. Lactic acid bacteria (LAB) are a group of gram positive, Non-spore forming cocci or rods, catalase negative and fastidious organism with high tolerance of low pH(5.5 to5.8) Lactic acid bacteria are group into *clostridium* branch of gram positive bacteria which is related to *bacilli* (14)(19)

A. Classification of lactic acid bacteria

Lactobacillus, lactococcus, leuconostoc, pediococcus, streptococcus, aerococcus, alioiococcus, carnobacterium, dolosigranulum, enterococcus, oenococcus, tetragenococcus, vagococcus. (it have largest genus more than 100 species) (19) Majority of them isolated from the gastrointestinal tract of humans and animals

Lactobacillus	Animal and human
Leuconostoc genus	Chilled meats or clinical source, plant material, fermented dairy product, wines
Pediococcus	Fermented beverages, beers
Lactococcus	Plant material sour milk

(TABLE 1 Organism and Its Source)(8)(19)

LAB obtain energy from the metabolism of sugars. LAB have the property of producing organic acid(acetic acid and lactic acid(15)which inhibits the growth of many bacteria especially pathogenic gram negative bacteria. LAB group of organism to kill the harmful microorganism around the environment.

B. Importance Characteristic of Lactic Acid Bacteria

- 1) They are ubiquitous flora of animal and plants
- 2) They are strictly fermentative in terms of energy metabolism and rely on free sugars as the subtract.(11)
- 3) They are microaerophilus. (11)
- 4) Lactic acid bacteria are widely used nowadays in different product formation like:
- 5) Sourdough fermentation and bread production.(9)
- 6) Tomato nutritional value increasing.(5)(3)
- 7) Meat product value and safety increasing.(2)(3)
- 8) Lactic acid bacteria used in agriculture field for feed production.(4)(3)

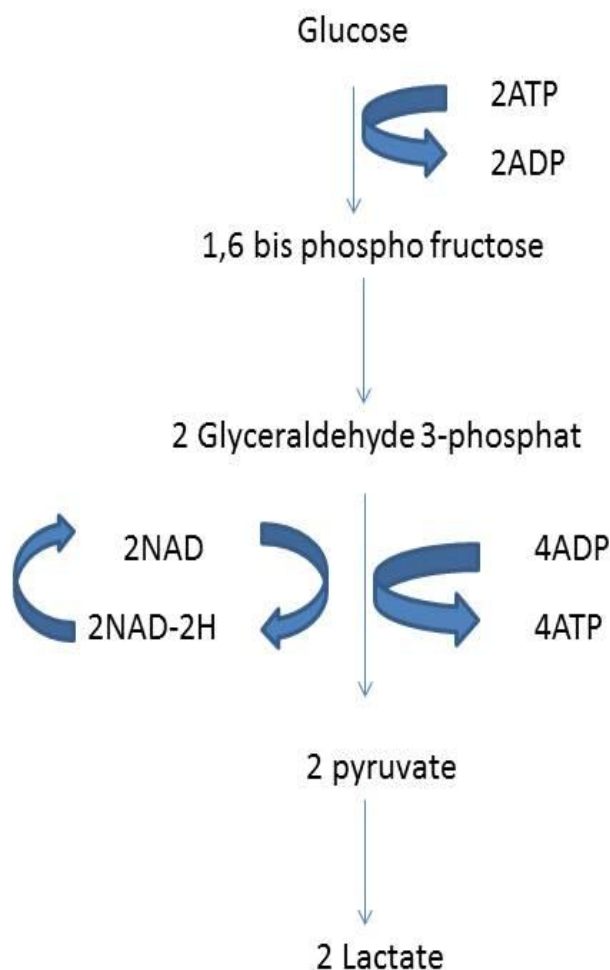
- 9) Lactic acid bacteria work as probiotics so in medical food production it's more important.(3)
- 10) Dairy waste is also used for the production of biopolymer.(24)

II. PRODUCTION OF LACTIC ACID BY USING LACTIC ACID BACTERIA

Lactic acid bacteria mainly produce lactic acid from sugars by a process called fermentation. They produce lactic acid as the major end product from the fermentation of carbohydrates. Based on fermentation pathway LAB can be divided into two physiological groups: Homo fermentatives-Homo fermentatives LAB metabolite one molecule of hexose sugar such as glucose to two molecules of ATP resulting in more than 85% lactic acid from one molecule of glucose.

A. Example

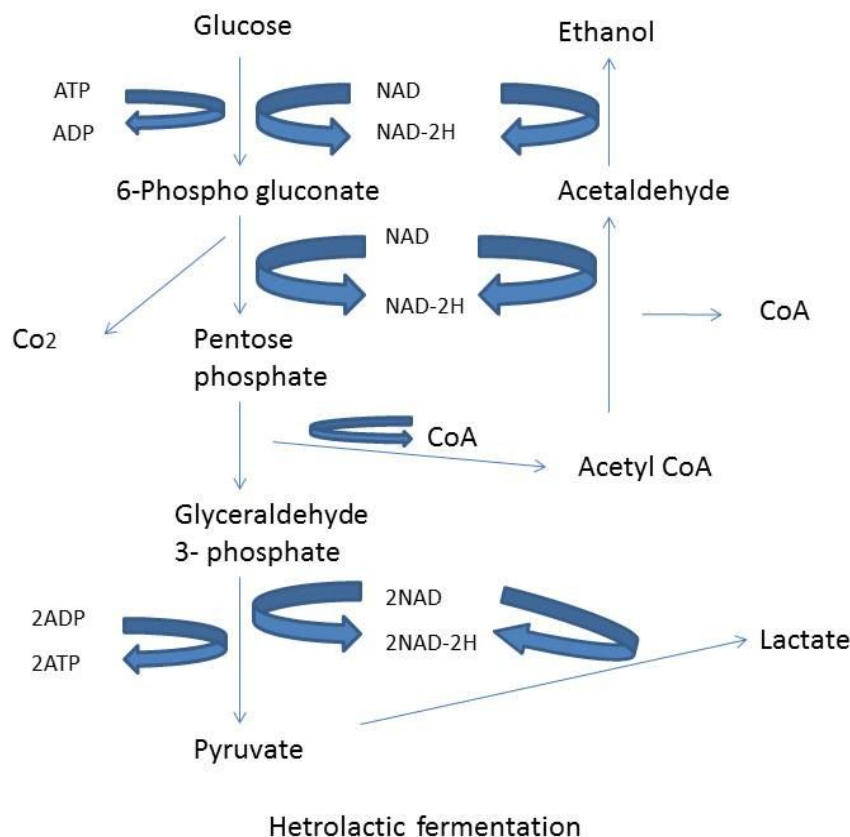
Lactococcus lactis, *Lactobacillus delbrueckii* and *Lactobacillus casei*.



Homolactic fermentation

(Fig.1 Homolactic fermentation)(11)

2.Hetro fermentative-Hetro fermentative LAB produce only 50% lactic acid fermenting one molecule of glucose to one molecule of lactic acid, one molecule of ethanol or acetate, one molecule of CO_2 and only one molecule of ATP.



(Fig.2 Heterolactic fermentation)(11)

B. Biochemical Environment of Lactic Acid Bacteria

Bacteria require particular environment to grow and express normal metabolic activities. Biophysical environmental factors are following:

- 1) Temperature
- 2) P
- 3) Water activity
- 4) Redox potential

LAB are also known as fastidious microorganism that can not grow on simple mineral and nutrient media .It require carbon source, free amino acid, peptides, nucleic acid derivatives, fatty acids esters, minerals, vitamin and buffering agent.

C. Required components for Lactic acid Bacteria

Component	Role of component	Reference
Carbon source	Carbohydrates are main source of carbon and energy. sugars require for optimum growth and metabolic activity and concentration of sugars used for LAB. Eg. Glucose, Sucrose and Dextrose	(10)
Amino acids and peptides	Lactic acid bacteria have multiple amino acid and peptides requirement to meet their demand of complex nitrogen. Yeast extract, meat extract, beef extract and peptone are nitrogen source that are not only nitrogen source but they also source of carbon, minerals and vitamins. It is crucial importance to include balance amount in LAB culture media to ensure suitable level of growth and better functionally	(10)

Fatty acids	Fatty acids with short, medium or long chain of carbon atoms that are either saturated or unsaturated. Fatty acids in general can inhibit the growth of microorganism but small amount such as 0.1% of fat may tend to stimulate bacterial growth.	(10)
Vitamins	Vitamins require to LAB can be classified into three group essential vitamins, stimulatory vitamins, non -essential vitamins. Pantothenic ,riboflavin, nicotinic acid are essentially more require for the growth of LAB .Individual strains of LAB require from one to four vitamins for normal growth.	(10)
Minerals	Minerals play an important role in microbial growth in general and have a special effect on bacterial enzymatic activity heavy metals such as Hg^{+2} , Cu^{+2} , Ni^{+2} , Zn^{+2} , and Co^{+2} could inhibit the enzymatic activity whereas Mn^{+2} and Mg^{+2} are known to enhance the enzymatic activity.	(10)
Tweens	Tweens are polysorbants which are a class of emulsifiers used in pharmaceuticals and food preparation Tween20,Tween 40,Tweens 60,Tweens 80 and Tween 80 is used for LAB in MRS media because it contain oleic acid which enhance the growth of LAB and other organism.	(10)
Buffering agent	LAB produce acid during growth which lower the pH value of the media and thus slams down or inhibits the growth sodium acetate, tri sodium citrate, di-sodium glycerol phosphate are essential buffering agent commonly used in media MRS and M17. In MRS other components used such as disodium phosphate, ammonium citrate and dipotassium phosphate	(10)

(TABLE-2 Components and It's Role)

III. PRODUCTS ARE FORMED BY USING LACTIC ACID BACTERIA AS THE FOLLOWING:

No.	Main product	Fermented foods	Definition	Lactic acid bacteria present in food	Country	Reference
1.	Cereal based	Idli	Idli is fermented, thick suspension used in several traditional food in south Asian country	Lactobacillus delbruckii, lacto bacillus fermenti, lactobacillus lactis	South asian country	(1)(16)(20)
		Kishk	Fermented milk and wheat mixture	Lactobacillus plantarum, lactobacillus casei, lactobacillus brevis, bacillus subtilis	Egypt, Syria, Arab world	(1)(16)(20)
2.	Milk based	Yogurt	Yogurt is one kind of fermented milk produced by process known as proto cooperation .proto cooperation is the process that produce yogurt by mutual stimulation of LAB	Lactobacillus delbruckii and its sub spp. streptococcus thermophiles, lactobacillus bulgaricus	All country	(1)(7)(21)(23)
		Cheese	A food made from the pressed curds of milk, firm and elastic or	Lactobacilli and pedio cocci	All country	(1)(7)(21)(23)

			soft and semi-liquid in texture			
		Koumiss (Airag)	Quick fermentation of lactose to lactic acid and alcohol, it's traditional fermented camel milk product	Lactobacilli, lactobacillus plantrum, lactobacillus helveticus, lactobacillus casei, lactobacillus kefir+yeast	Central asia	(1)(7)(23)
3.	Vegetable based	Pickles	It's made from vegetables and fruits and very popular part of daily diet	Autochthonous LAB+yeast	Asian and African country	(1)
		Suan – tsai	It's made from cabbage or mustard fermentation	Lactobacillus, leuconostoc, pediococcus	China	(1)
		Sauerkraut	It is a brine-salted and lactic acid fermented vegetable product	Lactococcus lactis subsp. lactis, Leuconostoc mesenteroides subsp. mesenteroides, Lactobacillus plantarum, Lactobacillus casei Tetragenococcus halophilus	China	(1)
4.	Soy based	Soy milk	Water extract of soy beans which are valuable and inexpensive source of protein and calories	Lactobacillus casei, lactobacillus acidophilus, lactobacillus bulgaricus, streptococcus, thermophilus, bifidobacterium longum	Japan	(6)
		Miso	Soy cheese . soy bean fermented food	Lactobacillus plantarum, lactobacillus fructivorans	Japan	(6)
		Soy sauce	Dark brown liquid	Halo tolerance Lactic acid bacteria + yeast	Japan, China, Far east countries	(6)
5.	Meat based	Chinese style sausage	Meat based indigenous fermented food	Lactobacillus	China	(1)(13)
		Cincauk	Malaysian sauce produce by shrimp fermentation	Staphylococcus, piscifermentans	South Asian	(1)(13)
6.	Beverages	Kefir	By the fermentation of milk, a smooth, white coloured, lightly foamy drink is produced which is carbonated and viscous called kefir	Lactobacillus spp., lactococcus lactis	Asian country, Turkey	(1)(18)(22)

(TABLE 3 Product formed by Lactic Acid Bacteria)

IV. CONCLUSION

Lactic acid bacteria play important roles in many fermented food, especially in non-dairy fermented vegetable products. The recent advances in biotechnology have increased the production of high quality, nutrient and tasteful foods, But the probiotic function of lactic acid bacteria in fermented foods have not fully identified and investigated, so more research needed to identified the lactic acid bacteria. It also ensure the conversion of waste product of dairy industry into a by product with immerse in commercial application.

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