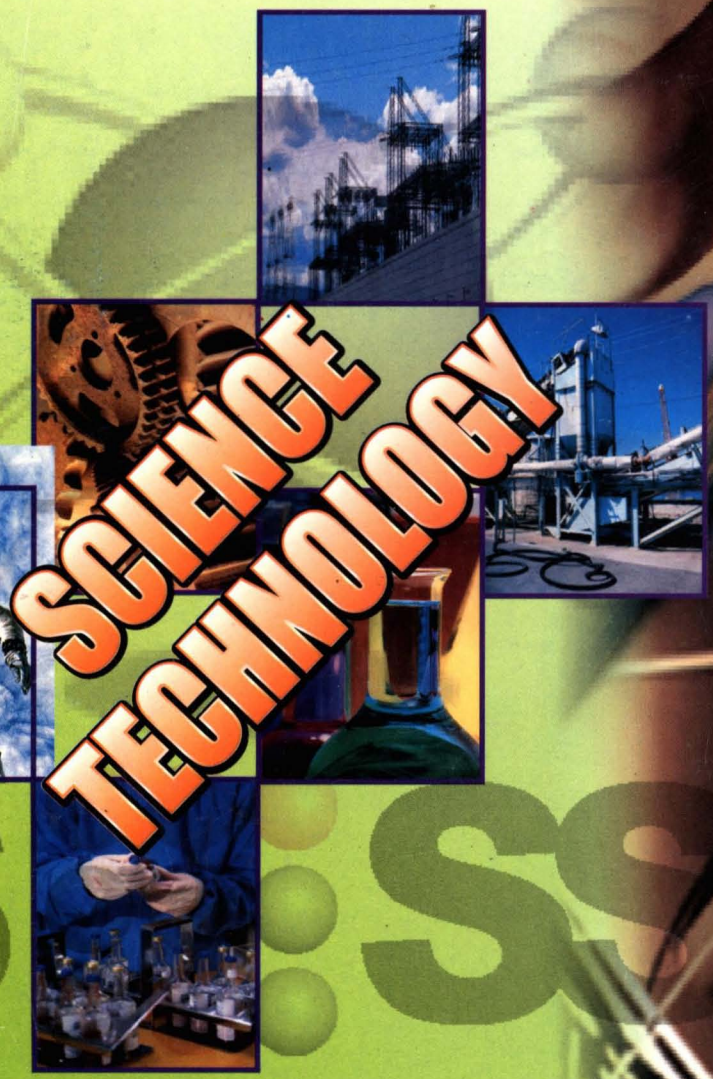
UNIVERSITI TEKNOLOGI MARA

ISO 9001:2000 No Sijil :0500132

Globalising Knowledge and Information



NATIONAL SEMINAR ON SCIENCE TECHNOLOGY & SOCIAL SCIENCES 2006

30-31 May 2006

Swiss Garden Resort & Spa

Kuantan, Pahang

Lactic Acid and Its Applications

Noorlis binti Ahmad
Hafizah binti Kassim
Mohd Noor bin Ramlan

ABSTRACT

For centuries, L (+) lactic acid has been a natural ingredients in a wide range of products. Long before it became commercially available; L (+) lactic acid was formed by natural products such as cheese, yoghurt, sourdough, meat product and wine. The animal and human bodies also produce significant amounts of L (+) lactic acid during daily activities, such as waling and running. It is present in blood, kidneys, muscles, hair and skin. Nowadays, L (+) lactic acid is produced on a large scale by the fermentation of sugar. Besides the well known applications of L (+) lactic acid and lactates in cosmetics products, it is also applied in pharmaceutical products and in many food products. Natural lactic acid and lactates have been used for many years in a wide variety of cosmetic products. The major applications are as moisturizer and AHA (alpha hydroxyl acid) in skin care product and as a pH regulator in hair care products and toiletries.

Keywords: *Lactic acid, L (+) lactic acid, Lactate, Lactic acid bacteria and alpha hydroxy acid (AHA).*

Introduction

Lactic acid bacteria (LAB) were created for bacteria that cause fermentation and coagulation in milk. Weigmann (1899) defined lactic acid bacteria as those which produced milk acid from milk sugar. However true LAB are bacteria which in fermenting sugar formed chiefly lactic acid.

Typical LAB should produce large quantities of lactic acid and resulting in a final pH below 4. The main importance of LAB is its ability to form lactic acid and other acids from carbohydrates. Since at least 50% lactic acid is formed by conversion of carbon source, the general name 'LAB' has been given to this important group of bacteria (Pot *et al.* 1994).

LAB is commonly found in foods, including fermented meat, vegetables, fruits, beverages and dairy products, but also in the respiratory intestinal and genital tracts of human and animals, in sewage and in plant materials (Pot et al. 1994). The most common and important LAB recently include *Streptococcus*, *Pediococcus*, *Leuconostoc* and *Lactobacillus*.

Lactic acid bacteria are Gram positive and non-sporulating microaerophilic bacteria. LAB are of paramount importance in foods and feed technology, where their major role is the inhibition of growth spoiling bacteria. This is attained not only by the production of growth inhibiting substances but also by the production of large amount of lactic acid (Pot et al. 1994).

Lactic Acid Bacteria and Their Uses in Food

Lactic acid bacteria have been used to ferment or culture foods for at least 4000 years. They are used in particular in fermented milk products from all over the world including yoghurt, cheese, butter and buttermilk. LAB especially the genera *Lactococcus*, *Lactobacillus*, *Leuconostoc*, *Pediococcus* and *Streptococcus* have been traditionally used as starter cultures for fermentation of foods and beverages because of their contribution to flavour and aroma development and spoilage retardation. It represents the oldest known techniques for food preservation (Vuyst & Vandamme 1994).

Taxonomy and Physiology

The classical term 'LAB' merely describe this group of microorganisms are those bacteria which produce lactic acid as one of their main fermentation products. This property alone is not sufficient for a clear taxonomic positioning. The pioneer of lactic acid bacteria taxonomy was Orla-Jensen who proposed a very clear cut differentiation on the basis of sugar fermentation, gas formation, morphology (cocci or rod), behavior against oxygen and optimum growth temperature (Cheong Weng Chung 2002).

Isolation of Lactic Acid Bacteria

All lactic acid bacteria are typical inhabitants of plants and animals. Accordingly, they are nutritionally fastidious.

derivatives, fatty acids and others. They can survive and grow at low pH values down to about pH 3 the dependence of LAB on many different growth factors has for a long time surely inhibited their genetic analysis.

Since defined minimal media are difficult to devise auxotrophic mutants are hard to get and maintain (Landman et al. 1996; Tenover 1998). Lactobacilli demand carbohydrates, proteins breakdown products, vitamins and usually a low oxygen tension. Their main product of fermentation is lactic acid. It had been found in healthy human mouth, intestinal tract and human vagina.

Application of Lactic Acid in Cosmetics

Natural L (+) lactic acid is used in much application in cosmetics. Lactic acid is an alpha hydroxyl acid (AHA) and is found in the skin. It is used as a skin rejuvenating agent, pH regulator (PURAC 2002). It is a common ingredient in moisturizers, skin whiteners, anti acne preparations, toners etc. Since L (+) lactic acid is naturally present in the skin, lactic acid and sodium lactate are extensively used as moisturizing agents in many skin care products. Lactic acid is also used as a pH-regulator. It is one of the most effective AHA and has the lowest irritation potential.

Lactates are regarded as skin whitening agents that have been shown to produce a synergistic effect when combined with other skin whitening agents. Sodium lactate is used in anti perspirant preparations. L (+) lactic acid is used as a pH regulator in many types of hair care formulations (Gijsen 1998).

Application of Lactic Acid in Pharmaceuticals

According to Shirai *et al.* (2001) a study carried out at Japan Toyama Medical and Pharmaceutical University that lactic acid was shown to be effective in repelling mosquitoes. They noted that varying concentrations of lactic acid are already present in human skin and sweat. They also explain that the mosquito's physiology plays apart. A pair of nerve cells on the insect's sensory probe reacts in opposite ways to lactic acid, one spike in frequency of impulses while the other decreases.

Application of Lactic Acid in Food Industry

i) Flavour enhancement in savoury applications and confectionary with lactic acid powder

Lactic acid helps to enhance the flavour of many food products. It is now available in a convenient, high-quality powder that expands its range of functional applications in many popular foods. Lactic acid powder demonstrates excellent flavouring opportunities when applied in instant noodle soup bases, dry mixes for dips, salsas and gravies, cheese sauces, cheese biscuits or crackers and seasoning for sour cream and onion crisps. It can also be used for sanding in confectionary applications. Food acids do contribute to the enhancement of flavour with its unique lingering sourness is known for its enhancement of cheese and dairy notes but also spices, onion, tomato and fermented flavours. In other words lactic acid powder can be a very creative tool in developing new food formulation (Doesburg 2003).

ii) Meat and poultry products

Several recent cases of food poisoning, linked to meat, have demonstrated that importance to incorporate safety hurdles in processed meat products. Controlling safety of meat products means reducing the risk of contamination with pathogenic microorganisms as well as inhibiting the growth of pathogens during handling and storage. Lactate ingredients inhibit the growth of pathogens, Eg. : *Salmonella*, *Listeria*, *E-coli* 0157:H7 and *Clostridium*. Sodium and potassium lactate are widely used to extend the shelf life and increase the safety of meat and poultry products. Research has demonstrated that lactate inhibits the growth of a wide range of bacteria. It inhibits Gram positive and Gram negative bacteria. Spoilage organisms and pathogenic bacteria (Bert de Vegt 2004, 2005).

iii) Beverages

Lactic acid is a natural beer acid and hence it is used for pH adjustments during the mashing process and in wort cooking. Lactic acid improves the microbial stability and also enhances the flavour. Lactic acid due to its mild nature is the acidulant of choice in delicately flavoured soft drinks and fruits juices. It does not mask or over power the natural flavour. Its flavour enhancing property makes the beverage more palatable and leaves a lingering taste. Lactic acid is preferred over citric acid for these reasons.

iv) Dairy products

Lactic acid bacteria (LAB) are widely used in the production of fermented dairy product (FDP) due to their specific metabolic activities. The production of FDP and the development of their typical flavour. Acidification, production of organic acids, and other antimicrobial substances such as bacteriocins, contribute greatly to the preservation of FDP by inhabiting pathogens and other contaminants. The transformation of lactose by lactic cultures improves the digestibility of FDP. Various metabolic and enzymatic activities of LAB lead to the production of volatile substances, which contribute to flavour, aroma and texture developments in FDP. Certain LAB produce exopolysaccharides which play a major role in texture developments in many FDP (Bert de Vegt 2004, 2005).

v) Olives, Pickles, Cabbage, Gherkins

Green olives, gherkins and others are often packed in a solution of salt, lactic acid and water. The lactic acid acts as preservative and improves the clarity of the brine and flavour. A mixture of acetic acid and lactic acid in pickled products such as gherkins, silver skin onion etc. imparts a milder taste and flavour and improves microbial stability. Calcium lactate is reported to be used as firming salt, which have been used as firming salt, which have been used for canned fruits and vegetables.

Lactic Acid Does More than Cause Fatigue

While lactic acid may play a role in fatigue its supposed role in muscle soreness has been disproved and it is now being recognized as more of a positive player in metabolism. Lactic acid is also described as a key substance used to provide energy, dispose of dietary carbohydrate, produce blood glucose and liver glycogen and promote survival in stressful situations.

Muscle glycogen is one of the main energy sources for exercise. In order to be utilized, stored muscle glycogen must be broken down into glucose, a process known as glycolysis. During glycolysis, each glucose molecule is cleaved into two pyruvic acid molecules, and energy is released to form adenosine triphosphate -ATP (Cheong 2002).

Conclusion

In summary, lactic acid is not a useless metabolic by-product. It can serve as a very important and useful energy source. However, if the lactate threshold is reached during exercise, excessive lactic acid can accumulate, causing fatigue. Fortunately in human this negative effect can be partially offset by proper training, warm down and a high carbohydrate diet.

References

Bert de Vegt (2004, 2005). English EU Food Safety. p 1-4.

Cheong, W.C. (2002). Master thesis: Production of L-lactic acid using various carbon sources by *Enterococcus Gallinarum* EB1. Universiti Putra Malaysia.

Gijsen, R. M. R. (1998). L (+) lactic acid and lactates: Natural active ingredients. Euro Cosmetics.

Landman, D., quale, J. M. Oydna, E. Ditore, V. Zaman, M. Patel, K., Suarina, G., and Huang, W. (1996). Comparison of five selective media for identifying fecal carriage of vancomycin-resistant entericocci. *J. Clin. Microbiol.* 34): 751-752.

Pot, B., Ludwing, W., Kersters, K. and Schleifer, K. H. (1994). Taxonomy of LAB. Bacteriocins of LAB, L. De Yuyst and E. J. Vandamme (eds). Blackie Academic & Professional. An Imprint of Chapman Hall. Glasgow, NZ. P 13-90.

PURAC (2002). Cosmetic applications. Avalaible:http://www.purac.com/literature/focus_cosmetics1.html

Shirai, Y., Kammura, K., Seki, T. and Morohashi, M. (2001). L-lactic acid as mosquito (*Dipterai : cullicidae*) repellent on human and mouse skin. *J. Med. Entomol.* 38(1): 51-54.

Tenover, F. C. (1998). Laboratory methods for suivellance of vancomycin-resistent enterococci. *Clin. Microbiol. Newslatter*. 20: p 1-5.

Vuyst, L. D. and Vandamme, E. J. (1994). Antimicrobial potential of LAB. Bacteriocins of LAB. Edited by L. De Yuyst and E. J. Vandamme. Blackie Academic & Professional. An Imprint of Chapman Hall. Glasgow, NZ. p 91-142.

http : //www.fsaa.ulaval.ca/stelawww/en/bacteries.htm.

http://sportsmedicine.about.com/cs/exercise/physiology/htm.

NOORLIS AHMAD, HAFIZAH KASSIM & MOHD NOOR RAMLAN, Universiti Teknologi MARA Pahang. anorlis@pahang.uitm.edu.my, hafizah_kassim@pahang.uitm.edu.my, mnoor@pahang.uitm.edu.my