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LACTOBACILLUS PLANTARUM AS A MAJOR SPOILAGE ORGANISMS ON FRESH GREEN VEGETABLES

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ABSTRACT

The exact definition of "vegetable" may vary simply because of the many parts of a plant consumed as food worldwide—roots, stems, leaves, flowers, fruits, and seeds. The broadest definition is the word's use adjectivally to mean "matter of plant origin". More specifically, a vegetable may be defined as "any plant, part of which is used for food", a secondary meaning then being "the edible part of such a plant". A more precise definition is "any plant part consumed for food that is not a fruit or seed, but including mature fruits that are eaten as part of a main meal". Falling outside these definitions are edible fungi such as edible mushrooms and edible seaweed which, although not parts of plants, are often treated as vegetables.

Lactobacilli are facultative anaerobic, non-spore forming, lactic acid producing, and Gram-positive bacilli. They are found in the normal microbiota of the oral cavity, gastrointestinal tract, and female genitourinary tract. Although lactobacilli are generally considered non-pathogenic microbes and some of their strains are utilized as probiotics to prevent and treat some infections, they have been implicated in some serious clinical infections including bacteraemia, infective endocarditis and intra-abdominal abscess including liver abscess,

pancreatic necrosis infection, pulmonary infections, pyelonephritis, meningitis, postpartum endometritis, and chorioamnionitis.

Keywords: Vegetables, gastrointestinal tract, Lactobacilli, diseases, symptoms

INTRODUCTION

Lactobacillus Plantarum has medical and industrial interests as it isa non-pathogenic species. It is also known for its health, nutritional and fermentative benefits **[1]**. The application and metabolization of the Lactic acid bacteria for food preservation against spoilage has created great interest towards their identification and isolation **[2]**. Being very versatile and flexible, *Lactobacillus Plantarum* is a species that is one of the largest known genomes among the lactic acid bacteria (LAB) **[1, 2]**. It can grow in an environment with a temperature ranging between 12ºC to 40ºC and a pH of between 3.4 and 8.8 **[3]**. Additionally, **[1, 4]** state that lactic acid bacteria are a very significant source of bioactive enzymes and metabolites. To determine the antimicrobial, adhesion, and enzymatic activities, lactic acid bacteria that were evaluated were isolated from fresh vegetable sources.

The *Lactobacillus Plantarum* has been used in meat products, Sourdough bread, and wineas a starter culture, and its strains have several biotherapeutic applications and probiotic characters **[5]**. *L. Plantarum*is non-pathogenic, gram-positive, catalase-negative, able to form chains, homofermentative rod, and does not form spores **[3]**. The *Lactobacillus Plantarum* ferment hexoses, thus producing lactic acid. It also ferments gluconate and pentoses, which facultatively produce acetic and lactic acids referred to as heterofermentative *Lactobacillus* **[3-5]**.

According to **[5]**, *L. plantarum* also ferments citric acid to acetoin, carbon dioxide, and diacetyl. Lactic acid and carbon dioxide is produced when malic acid is fermented. *Lactobacillus Plantarum* shows a high tolerance and high rates of resistance to acidic conditions in low pH conditions **[6]**. Where the pH is below 4 in fermented foods with spontaneous lactic acid, it predominates frequently. In the human stomach, it also survives in acidic conditions. Usually, it also occurs spontaneously in foods fermented using lactic acidlike sauerkraut, capers, brined olives, salted gherkins, Nigerian ogi (made from sorghum or maize), sourdough **[3, 5, 6]**. This shows that individuals who consume products that are fermented in lactic acid consume large quantities of *L. Plantarum.*

Recently, *L. Plantarum* usage in health food applications has revealed much potential. In local resources dealing with health and food applications, greatattention is being paid to identifying and isolating potential strains. A combination of genotypic and phenotypic techniques forms the basis of identifying these strains. The identification and characterization of genotypes has been revolutionized bythe usage of various molecular tools due to difficulties encountered in identification and confirmation by phenotypic tests **[6]**.

L. Plantarum has been investigated in various molecular tools like sequencing of 16S rDNA, 16S rRNA-RFLP, oligonucleotide DNA probes, REP-PCR, RAPD, MLST, and ribotyping **[7]**. In genius-level identification, 16S rRNA - RFLP is typically used, although when the 16S rDNA sequence identity is more than 96% it is not distinguishable **[7]**. A higher resolution is produced by REP-PCR, which is used to differentiate strains of 16S rDNA that share a sequence identity of more than 99.5% **[7, 8]**.

REP-PCR is easy to conduct; however, it is easily contaminated and has low reproducibility. During sequences determination, an accurate and precise basis for phylogenetic identification and analysis is provided by 16S rRNA genes **[8]**. Accurate identification is achieved when the whole gene is analysed. However, most sequences of species-specific genes are found in the initial half of the 16S rRNA gene. 16S rDNA gene is, however, not sufficient for differentiating between LAB species because it is conserved. When sequencing a significant number of DNA that is unknown, expensive chemicals, long periods, and sequencers are required to obtain the sequencing results; therefore, it is not economical **[8]**.

LACTOBACILLUS PLANTARUM

Lactobacillus plantarum (widespread member of the genus Lactobacillus) is one of the most studied species extensively used in food industry as probiotic microorganism and/or microbial starter **[9]**. The exploitation of *Lb. plantarum* strains with their long history in food fermentation forms an emerging field and design of added-value foods. *Lb. plantarum* strains were also used to produce new functional (traditional/novel) foods and beverages with improved nutritional and technological features. *Lb. plantarum* strains were identified from many traditional foods and characterized for their systematics and molecular taxonomy, enzyme systems (α-amylase, esterase, lipase, α-glucosidase, β-glucosidase, enolase, phosphoketolase, lactase dehydrogenase, etc.), and bioactive compounds (bacteriocin, dipeptides, and other preservative compounds). This review emphasizes that the *Lb. plantarum* strains with their probiotic properties can have great effects against harmful microflora (foodborne pathogens) to increase safety and shelf-life of fermented foods **[10-12]**.

VEGETABLE SPOILAGE

As vegetable are good source of nutrients for human growth and metabolism, it also serves as nutrient herb for growth of different microorganisms which is listed in **Table 1**.

Table 1: Common vegetables and theirs pathogens [12]

Bacterial disease	Crops affected	Symptoms
Black rot (*Xanthomonascampestrispv. campestris*)	**Brassicas.**	**Light-brown to yellow V-shaped lesions on the leaf, which become brittle and dry with age. Vein blackening with the necrotic area.**
Bacterial canker (*Clavibactermichiganensispv. michiganensis*)	**Tomato; capsicum; chilli**	**Seedlings may die and older plants may wilt and die eventually. Older plants have leaves that turn yellow and wilt only on one side. Cankers on stems and fruit. Tissue inside stems becomes discoloured.**
Bacterial soft rot (*Pseudomonas spp., Erwinia spp.*)	**Wide range of vegetables, including lettuce; brassicas; cucurbits; tomato; capsicum; potato; sweetpotato; carrots;herbs.**	**Wet, slimy, soft rot that affects any part of vegetable crops including heads, curds, edible roots, stems and leaves. May have a disagreeable odour.**
Bacterial leaf spot/Bacterial spot (*Xanthomonascampestris* - various strains)	**Range of vegetables including lettuce; cucurbits; tomato; capsicum.**	**Lettuce – Large brown to black circular areas that start as small translucent spots; usually on outer leaves. Tomatoes and capsicums – Greasy spots on leaves and stems that go from tan to black; fruit may have circular spots with central scab. Cucurbits – Begin as small water-soaked/greasy spots on underside of leaves with corresponding yellowing on upper side; fruit may produce light-brown ooze from water-soaked markings.**

FERMENTATION OF VEGETABLES BY LAB: APPLICATION

Fermenting vegetables and fruits with lactic acid (LA) is a popular practise for preserving and improving the nutritional and sensory qualities of food products **[13, 15, 16]**. Various conventional naturally fermented foods yielded a large number of possible lactic acid bacteria (LAB) **[16]**. Asian traditional fermented foods are generally fermented by LAB like *Lactobacillus plantarum, L. pentosus, L. brevis, L. fermentum, L. casei, Leuconostoc mesenteroides, L. kimchi, L. fallax, Weissella confusa, W. koreenis, W. cibaria, and Pediococcus pentosaceus*, which are considered because the probiotic source of the food practice.

Probiotic is a relatively modern term that means "for life," and it is commonly used to refer to bacteria that have been linked to human health benefits **[17-18]**. Probiotics are live microbial feeds, such as *Lactobacillus plantarum, Lactobacillus* *casei, Lactobacillus acidophilus, and Streptococcus lactis*, that are supplemented with food and have a beneficial effect on the host by improving intestinal balance **[19]**. Adding probiotics to food has beenshown in many studies to have a variety of health benefits, including lower serum cholesterol, increased gastrointestinal function, a stronger immune system, and a lower risk of colon cancer. This review provides a summary on the present research prospects of fermentation of fruits and vegetables with reference to human nutrition and health.

MECHANISM OF LAB

Lactiplantibacillus plantarum (previously *Lactobacillus plantarum*) is a widespread *Lactiplantibacillus* species that can be found in a variety of fermented foods and anaerobic plant matter **[20]**. *L. plantarum* was first isolated from saliva, and it was classified as a nomadic organism because of its ability to survive for short periods of time in plants, insect intestines, and the intestinal tracts of vertebrate animals **[21-22]**. The bacterium *L. plantarum* is Gram-positive and bacilli-shaped. *L. plantarum* cells are rounded-end rods that are straight, 0.9–1.2 m wide, and 3–8 m long, and can be found singly, in pairs, or in short chains **[23]**. *L.plantarum* is a very flexible and versatile species with one of the largest genomes identified among lactic acid bacteria. It grows best in a pH range of 3.4 to 8.8. Lactobacillus plantarum can thrive in temperatures ranging from 12 to 40 degrees Celsius.

METABOLISM OF LAB

L. plantarum is a Gram-positive homofermentative bacteria that grows at 15 °C (59 °F) but not at 45 °C (113 °F) and produces all isomers of lactic acid (D and L) **[24]**. If heme and menaquinone are present in the growth medium, several lactobacilli, including *L. plantarum*, can breathe oxygen and express cytochromes. NADH-peroxidase consumes oxygen in the absence of heme and menaquinone, producing hydrogen peroxide as an intermediate and water as a final product **[25]**. It's thought that the peroxide is used as a tool to keep competing bacteria out of the food supply. This organism accumulates millimolar amounts of manganese polyphosphate in place of the defensive enzyme superoxide dismutase, which is found in virtually all other oxygen-tolerant cells. *L. plantarum* also uses manganese in a pseudo-catalase to reduce reactive oxygen levels. Since iron subverts the chemistry that protects manganese complexes from oxygen damage, these cells contain almost no iron atoms; in comparison, a cell of Escherichia coli of comparable volume contains over one million iron atoms. As a result, *L. plantarum* can't be used to make active enzymes that need a heme complex, like true catalases. *L. plantarum*, like many *lactobacilli*, are often cultured using MRS media.

CONCLUSION

The probiotic health effects of *Lactobacillus plantarum* is escalating day by day. Another function that needs to be underlined for the capabilities of *Lactobacillus plantarum* to produce diverse and potent bacteriocins, which are antimicrobial peptides with possible applications as food preservative or antibiotic complementary agents. All these characteristics design *L.plantarum* as a genuine model for academic research and viable biological agent with promising applications.

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