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# The Genus Lysinibacillus: Versatile Phenotype and Promising Future

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**Abstract:** ***This critical mini review aims to summarize the current status of the genus Lysinibacillus research, and discusses several challenges in order to open new vision for future development.The wonderful world of bacteria does not even more reach surprises in the scientific community.Every year several bacterial species are discovered from a lot of sources and areas for their phenotypic diversities, therapeutic aspects, industrial and biopharmaceutical interest. Since ten years twenty six Lysinibacillus species were discovered with several exciting characteristics.***

**Keywords:** *Lysinibacillus*sp., *Lysinibacilluslouembei*, versatile phenotype, promising future, bacteriocins

## 1. The Genus Lysinibacillus

Initially designated as Bacillus spp, the genus *Lysinibacillus* are Gram positive, ubiquitous, motile, aerobic or facultative anaerobicbelonging to the family Bacillaceae of the phylum Firmicutes. Nomenclature was proposed for the first time by Ahmed et al. (2007). The genus *Lysinibacillus*is consistently characterized by rod-shaped bacillithat form endospores (Ahmed *et al.*, 2007)with an A4α (L-Lys–D-Asp) cell-wall peptidoglycan type (Zhu *et al.*, 2014; Zhu *et al.*, 2015)**.** Menaquinone MK-7 is the most predominant respiratory lipoquinone system among the genus *Lysinibacillus*, and major polar lipids found are diphosphatidylglycerol, phosphatidylglycerol and ninhydrin-positive phosphoglycolipid(Zhu *et al.*, 2014)**.**

At the time of drafting this review and together with *Lysinibacilluslouembei*, a novel spore-forming bacterium isolated from NtobaMbodi which is an alkaline fermented leaves of cassava from the Republic of the Congo (Ouoba *et al.*, 2015), the genus *Lysinibacillus* contains twenty six species (26). This number includes validate resultsand published namesin LPSN-bacterio-net (http://www.bacterio.net/lysinibacillus.html) and NCBI (http://www.ncbi.nlm.nih.gov/) (Table 1).

**Table I:** List of genus Lysinibacillus

| Species | Reference |
|---|---|
| ***Lysinibacillussphaericus, L. Fusiformis, L. Boronitolerans*** | (Ahmed *et al.*, 2007) |
| ***L. Parviboronicapiens*** | (Miwa *et al.*, 2009) |
| ***L. Xylanilyticus*** | (Lee *et al.*, 2010) |
| ***L. Mangiferihumi*** | (Yang *et al.*, 2012) |
| ***L. Macroides*** | (Coorevits *et al.*, 2012) |
| ***L. Sinduriensis L. Odysseyi L. Massiliensis*** | (Jung *et al.*, 2012) |
| ***L. Contaminans*** | *(Kampfer et al., 2013)* |
| ***L. Meyeri*** | *(Seiler et al., 2013)* |
| ***L. Chungkukjangi*** | *(Kim et al., 2013b)* |
| ***L. Jejeunsis*** | *(Kim et al., 2013a)* |
| ***L. Manganicus*** | *(Liu et al., 2013)* |
| ***L. Tabacifolii*** | *(Duan et al., 2013)* |
| ***L. Halotolerans*** | *(Kong et al., 2014)* |
| ***L. Composti*** | *(Rifat Hayat et al., 2013)* |
| ***L. Pakistanensis*** | *(AHMED et al., 2014)* |
| ***L. Varians*** | *(Zhu et al., 2014)* |
| ***L. Fluoroglycofenilyticus*** | *(Cheng et al., 2015)* |
| ***L. Alkaliphilus*** | *(Zhao et al., 2015)* |
| ***L.Acetophenoni*** | *(Azmatunnisa et al., 2015)* |
| ***L. Louembei*** | (Ouoba *et al.*, 2015) |
| ***L. Cresolivorans*** | (Ren *et al.*, 2015) |
| ***L. Xyleni*** | (Begum *et al.*, 2016) |

## 2. The Versatile Phenotype of the Genus Lysinibacillus

**Bioremediation Interest**

Among the genus *Lysinibacillus*, *L.sphaericus* is the most documented. Many of the topics running through this genus are talking about Biopesticide, Bioremediation and antimicrobial peptide. Some bacterial species of the genus *Lysinibacillus* were recently the subject of whole genome sequencing such as *L. sphaericus*, strainC3-41 *and* B1-CDA(Zheng *et al.*, 2008; Rahman *et al.*, 2016), and *Lysinibacillusvarians* strain GY32(Zhu *et al.*, 2015). *L.sphaericus* is an attractive biological insecticide.Biotechnology efforts are being made and elaborated to optimize and to maximize its toxicity and manufacturing techniques (Berry, 2012; Allievi *et al.*, 2014). The protein responsible for the biopesticide effect isa binary toxin considered as biolarvicide that has been used worldwide for mosquito surveillance and especially against larvae from the *Culex pipiens* complex and Anopheles spp.(Regis *et al.*, 2001; Schlein and Muller, 2015).In addition, binary toxins of *L.sphaericus* IAB872 have been detected for anticancer activity against human lung cancer cell line A549 (Luo *et al.*, 2014).According to World Hearlth Organization (WHO), this is the most common cause of cancer death in menafter breast cancer in women.

This genus *Lysinibacillus*has been tested for potential bioremediation use in research including the ability to utilize heavy different metal for their metabolism such as nickel, iron and manganese compounds(Douterelo *et al.*, 2014; Prithviraj *et al.*, 2014; Barboza *et al.*, 2015)and metalloid including arsenics (Rahman *et al.*, 2014).It was reported that *L. sphaericus* G1(Bafana *et al.*, 2015)and *L. fusiformis* areable to clean up industrial effluent and areas contaminated with mercury (Gupta *et al.*, 2012).*L. sphaericus* was showed with mercuric reductase activity (Bafana *et al.*, 2015) and flavin-free NADH azoreductase for decreasing toxicity for nitro-aromatic compounds(Misal *et al.*, 2014). These biochemical advantagesallow bacterium for metal tolerance (Lozano and Dussan, 2013). *Lysinibacillus*sp. KMK-A and *L. fusiformis* ZC1 can reduce highly chromate (He *et al.*, 2011; Chaudhari *et al.*, 2013). Furthermore it was also demonstrated that *L. sphaericus* DMT-7 isolated from diesel contaminated soil can desulfurize dibenzothiophene (DBT) (Bahuguna *et al.*, 2011).

*L. fusiformis* produces biosurfactants, *Biosurfactants* were characterized on the basis of their emulsifying properties with petrol, diesel, mobil oil and petrol engine oil (Kumar G, Kumar R, Sharma A., 2015).

The use of microorganisms to biodegrade polymers have been boosted with notable interest because the chemical and physical disposal methods used pollutants and cause many problems the environmental areas. Consortium culture of *Lysinibacillus* and one of the most common species of the genus *Aspergillus*can degrade plastics. *L.xylanilyticus* and *Aspergillus niger* in soil have been showed biodegradation plastics of low-density polyethylene (LDPE) (Esmaeili *et al.*, 2013).In addition biodegradation of ethanethiol and dichloromethane was observed by using *L. sphaericus* RG-1 and wh22 strains (Wu *et al.*, 2009; Wan *et al.*, 2010).

Nitrilases (EC 3.5.5.1) are prompting significant importance in discovering a novel microorganism capable of hydrolyzing biotechnologically nitriles. *L.boronitolerans* was recently identified for nitrilase activity (Muluka *et al.*, 2016). Nitriles are highly toxic, mutagenic, and carcinogenic due to their cyano group (Chen *et al.*, 2009). *L.boronitolerans* could be the good model to degrade nitrile in order togenerate a broad range of useful amides, carboxylic acids, and other groups for several industrial and biotechnological applications, including the synthesis of industrially important carboxylic acids and bioremediation of cyanide and toxic nitriles(Chen *et al.*, 2009; Howden and Preston, 2009).

**Biotechnological Dreams**

*L.sphaericus* CCM 2177 well known as mesophilic microrganisim produces SbpA, a surface (S)-layer protein, which after secretion completely covers the cell surface with a crystalline array exhibiting square lattice symmetry. These features on solid supports represents aappropriate applicant for genetically engineering to create a versatile self-assembly system for the development of a functionalized nanoarrays for nanobiotechnological applications (Badelt-Lichtblau *et al.*, 2009).

*Caenorhabditis elegans* is a small worm that represents a model organism in molecular biology; it allows many studies among others apoptosis and cellular aging embryonic development *L. sphaericus* was showed to extended longevity and robust early-stage development of *Caenorhabditis elegans*(Go *et al.*, 2014) .

High technology research with *L. fusiformis* has been demonstrated for the operating performance of a biotrickling filter. In fact filter associated *L. fusiformis* can remove high-loading gaseous chlorobenzene(Li *et al.*, 2014).Wastewaters from a variety of industrial processes have been treated in trickling filters. Using biotrickling filter associated with *L. fusiformis* could represent big challengesfor the bioremediation of wastewaters.

***Pathogenicity of Genus Lysinibacillus***

Besides all features discussing up on molecule biosynthesis, bioremediation and biocatalysts, the genus *Lysinibacillus* often regarded as environmental contaminants was isolated in the clinical microbiology laboratory.Its potential to cause human disease has been documented (Castagnola *et al.*, 2001; Wenzler *et al.*, 2015).Although Clinical relevant infections with *Lysinibacillus*sp. are still uncommon, a rare case of severe sepsisdue to *L. fusiformis* and *L.sphaericus* was reported. *L. sphaericus* was demonstrated to cause 2% episodes of bacteremia in children with cancer or those undergoing bone marrow transplant (Wenzler *et al.*, 2015).

***Bacteriocins secretion***

The multidrug resistance bacteria pose serious problems for the treatment of bacterial diseases. Antimicrobial peptides such as bacteriocins or bacteriocins-like molecules could be a comfortable solution to remedy the resurgence of antibiotics. Bacteriocins could also be important in food preservation. The genus *Lysinibacillus* produces a broad range of antimicrobial bacteriocins against foodborne bacterial and fungal pathogens, isolated from fruits and vegetable waste(Ahmad *et al.*, 2014; Ahmad and Khan, 2015). The sequencing of complete genome of *L.sphaericus* (strain C3-41) and *L. fusiformis*(strain ZC1)have been showed to contain gene encoding for bacteriocins (B1HTL7_LYSSC,B1HXT2_LYSSC and B1HSB6_LYSSC) and (D7WSU8_9BACI) respectively with activity against *Listeria*(Zheng *et al.*, 2008)**.**

*L. louembei* isolated from a traditional fermented food of Congo Brazzaville was also postulated to produce bacteriocins-like molecules. This novel exciting bacterium with unusual phenotypic, biochemical and genotypic characteristics has been tested for the ability to kill pathogenic bacteria such as *Samonella*, *staphylococcus* and *shigella*. This means that this bacterium could be also a candidate for probiotic features (personal communication) (Ouoba *et al.*, 2015).Excepting for classical lipids met in genus *Lysinibacillus*, two unknown lipids were identified this means that *L. louembei* may contain new clusters gene encoding new enzymes which could be biochemically involved in the biosynthesis and the selection of lipids.

## 3. Conclusion and Promising Research

The possibility for achieving novel bacteria with commercially desirable antibacterial activities and otherbiocatalyst molecules for interestmay offerexcellent bait for promising future. To contribute to sustainable development the genus *Lysinibacillus* could play a vital and undeniable role in their ability to biodegrade plastics. In the very close future scientific researches could be addressed toward the sequencing of many *Lysinibacillus* species such as *L. Louembei*genome. Researches could be oriented to experiment growing conditions according to different culture media. The optimization of growth (pH, temperature), the ability to tolerate and / or degrade hydrocarbons and plastics, and ability to secrete the biosurfactants and to biosynthesize biocatalysts molecules will be experienced.

## 4. Acknowledgments

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## 5. Conflict of interest

There is no conflict of interest.

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