



دانشگاه زابل

University of Zabol

Graduate School

Faculty of Basic Sciences

Department of Food Science and Technology

The Thesis Submitted for the Degree of M.Sc

**Lactobacillus plantarum and Lactobacillus fermentum
endophyte in zein/polyvinyl alcohol/zein multilayer
nanofibers by sandwich method**

Supervisors:

Dr. Mahmoud Tavakoli

Dr. Mohammad Amin Miri

:Advisor

Dr. Siddiqa Soleimani Fard

Preparing and editing:

Shiva Rezaei Tavabe

۱۴۰۲ winter

Abstract:

Probiotics are live microorganisms when administered in adequate amounts confer a health benefit on the host. Probiotics must be metabolically stable and survive gastrointestinal tract passage in achieving the health-promoting effects on the host. In order to increase the viability of probiotics, the encapsulation of *L.plantarum* MT.ZH193 and *L. fermentum* MT.ZH893 in single-layer polyvinyl alcohol (pva) and multilayer (zein/pva/zein) nanofibers was done with an electrospinning machine in the Zabol University. The concentration of zein and pva solutions were 27% and 10% (w/v), respectively. Three voltages of 11, 18, and 25 kV were carried out for electrospinning. Then, the microorganism survival percentage, nanofiber diameter (nm), nanofiber structure by scanning electron microscope, atomic force microscopic (AFM) image analysis, infrared Fourier transform spectroscopy (FTIR), thermogravimetric analysis (TGA), X-ray diffraction, electrical conductivity, and determination of specific surface by the BET method were performed on the samples. The results showed that the survival percentage at voltages of 11, 18 and 25 for single-layer pva nanofibers containing *L. plantarum* was 0.000 ± 0.00 , 35.47 ± 1.33 and 48.78 ± 0.88 , and for pva containing *L. fermentum* was 0.00 ± 0.00 , 48.04 ± 1.57 and 55.56 ± 1.38 , respectively. Therefore, the highest survival rate was observed at 25 kv voltage ($p<0.05$). The survival percentage of *L. plantarum* and *L. fermentum* in zein/pva/zein multilayer nanofibers at 25 kV voltage was obtained, 73.78 ± 1.05 and 85.64 ± 1.22 , respectively. As the voltage increased from 11 to 25 kV, the diameter of nanofibers decreased ($p<0.05$). The electron microscope images proved the presence of bacteria in nanofibers. The atomic force microscopic (AFM) images showed that nanofibers containing bacteria had less surface roughness than the control. The Fourier transform infrared spectroscopy (FTIR) showed that the addition of bacteria into nanofibers had an effect on the secondary structure of pva. The thermogravimetric test showed that zein/pva/zein multi-layered nano fibers containing *L. fermentum* had higher thermal stability than the control sample. X-ray diffraction showed *L. fermentum* increased the crystallinity of nanofibers. By adding microorganisms to nanofibers, the electrical conductivity of the samples increased. Samples containing microorganism showed less porosity.

Key words: Native probiotics, Electrospinning, Survival percentage, Electrospun sandwich-structure, Zein, Polyvinyl alcohol