The Arthrospira sp. (Spirulina) a cyanobacteria, contains a large amount of nutrients, which gives beneficial attributes for the human health. On the other hand, the mechanical milling has been used both to reduce the size of some materials and improve the potential in biological, chemical and physics systems. The aim of this work is to compare the properties of bulk Spirulina against nanostructured milled Spirulina to probe if their effects can be potentiated (Gershwin 2008).

The mechanical milling of Arthrospira maxima (Spirulina, Spex mill Sample PREP 8000D Dual Mixer) took 1 to 4 hours (named reference, 1HBC, 2HBC, 3HBC and 4HBC) the obtained Spirulina nanoparticles were carried out in 2 vials containing 3 g each. The nanoparticle characterization was divided in two stages (a) dry basis (powder) and, (b) wet basis, 0.01% dispersion of Spirulina was ultrasonicated for 20 min. The particles were characterized by scanning electron microscopy (SEM), atomic force microscopy (AFM), X-ray diffraction (XRD) and Fourier Transformed Infrared (ATR-FTIR). The XRD analysis of the powders showed a wide peak that could be inferring amorphous zones. In general, it is possible to observe a diminishing trend in the crystallinity index, with values between $X_C^{Ref} = 53.3$, $X_C^{1HBC} = 51.7$, $X_C^{2HBC} = 52.9$, $X_C^{3HBC} = 48.1$ y $X_C^{4HBC} = 49.1$ (Segal et al. 1959). However, more studies should be done to corroborate this. Otherwise, a 3 h test of FTIR was done; the peaks suggest a large exposition of functional groups such as OH, CH$_2$ and C-N Figure 1. (Dotto, Cadaval & Pinto 2012). Image analysis was made using AFM microographies; the kinetic curve described a minimum average particle size of 90 nm in the first 2 hours, using a bimodal distribution. The particles ranged between 20-370 nm with an average particle size of 90±62 nm. The SEM microscopy confirms the data obtained by AFM (Figure 2). In conclusion, it was possible to obtain Spirulina nanoparticles by mechanical milling and they had more functional groups availability than the bulk Spirulina according to the studies already done.


Acknowledgement: This research was funded through projects 20140387 and 20141662 from Instituto Politécnico Nacional (SIP IPN Mexico) and COFAA. The corresponding author would also like to thank CONACYT for the scholarship provided.
Fig. 1: FT-IR Spectrum for Spirulina, reference and milling time are indicated

Fig. 2: Spirulina’s nanoparticles microographies obtained by (A) Scanning electron microscopy, (B) and (C) atomic force microscopy.