Diffraction and X-ray morphology of bioplastics flexible cassava starch

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Abstract – The demand for high quality food, and concerns about the disposal of non-renewable packaging for food have been leading to searching alternatives to the traditional packaging, as well as the use of bioplastics. In this work, it was developed flexible composite films based on plasticized starch with crude glycerol prepared by thermoplastic extrusion process followed by blowing. Morphological (scanning electron microscopy) and X-ray diffraction were the techniques used to characterize the blown biofilms, which showed an amorphous structure, without crystalline peaks, and a rough and homogeneous surface, that may compromise some of their properties.

For the development the bioplastics, it is required some special characteristics of their components, such as a biopolymer matrix ability to form film, and an adequate plasticizer (CUQ [1]). According to Guilbert [2], at least one of the constituents of edible films must be a macromolecule capable of forming a continuous and cohesive matrix.

To obtain the pellets, it was used a twin-screw extruder Clextral Evolun 25 (Firminy, France) with 10 heating zones to process cassava starch, known as “polvilho doce” and the extrusion conditions were: 6 kg/ h solid flow rate, screw speed of 150 rpm, and liquid flow rate of 1.5 kg / h of plasticizer (water plus glycerol). The plasticizer was composed of 70% crude glycerol and 30% water. To obtain a flexible film, the pellets were blown in an single extruder EL-25 (BGM, SP, Brazil). The surface morphology of the films was observed using a Scanning Electron Microscope (SEM), model Leo 440i, LEO operated 10 kV. Before testing the samples were covered with a thin layer of gold to the thermal conduction. The diffractograms were obtained using a diffractometer X-ray model X'pert, Mark Philips (and the following conditions of analysis: voltage and current: 40kV and 40mA; scan range: 2θ from 5 to 30°; step: 0.1°; speed: 1°/min; with a secondary beam monochromator of graphite and a PC APD diffraction Software to determine the size range of crystals. The samples were stored at 25°C and ~50% of relative humidity.

The blown bioplastics (Figure 1) showed little expansion during the blow stage, however, they were visually homogeneous, opaque and without cracks, with slightly yellow particles as observed by with the naked eye. In the diffractogram of the film, shown in Figure 2, there is absence of crystalline peaks which confirms that the material is amorphous. The micrographs of blown bioplastics (Figure 3) show a rough surface, which may compromise its tensile strength. This roughness was also observed by Fakhouri [3], when working with bioplastics made of modified starch and gelatin plasticized with glycerol. Sakanaka [4] also noted an uneven surface, indicating the direction in which the film, prepared with cassava starch and polybutylene succinate co-adipate (PBSA), has been processed. It can also be observed in Figure 3 the direction of extrusion of bioplastics, a fact mentioned by Sakana [4] e Fakhouri [3].

Although the biofilm has presented some roughness on the surface, it showed itself homogeneous and without the presence of starch granular structure. This is an indirect proof that in the conditions of the starch processing it was completely changed by the action of shear, temperature and plasticizer, suggesting the formation of a cohesive matrix consisting of an amorphous material.

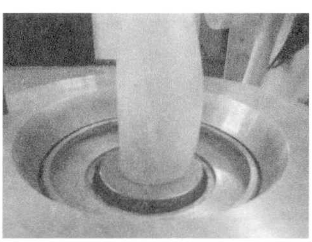

Figure 1:. Photographic image of blowing process.

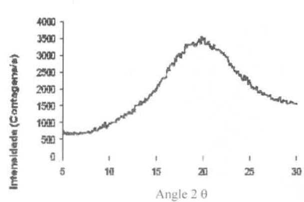

Figure 2:. Diffractogram of the starch and glycerol blown bioplastic.

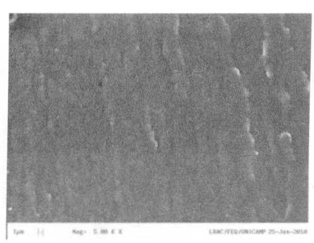

Figure 3:. SEM image the starch and glycerol blown bioplastic (5000x).

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