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Production of polyester-based bioplastics by *Bacillus megaterium* grown on waste cheese whey substrate under exogenous stress

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Bacterial polyesters, polyhydroxyalkanoates (PHA), are a group of hydroxyacid polyesters that are accumulated in the form of intracellular granules by a wide variety of bacterial strains that use PHA as carbon and energy storage material. PHA have received much interest due to their biodegradable nature and mechanical properties which are very similar to plastics produced from petrochemical routes. This is the reason why PHA appears to find many potential applications in medical, industrial and agricultural fields. However, the main factor preventing the large-scale production of PHA is their high cost as compared with that of plastics based on petrochemicals. Among the factors restricting the economy of PHA production the most important is the cost of carbon source. In PHA production, about 40% of the total cost is for raw materials. Thus, cheap waste substrates, for instance cheese whey, are very attractive because of possibility to reduce PHA cost.

In this work PHA production in lactose-utilizing bacteria *Bacillus megaterium* grown in batch culture on cheese whey substrate was tested. The amounts of accumulated PHA were analyzed using gas chromatography with flame ionization detector. Activities of PHA biosynthetic enzymes were estimated too. After optimization of cheese whey medium composition and cultivation conditions relative high biomass yields were obtained using whey as the only carbon source, but the biomass contained only about 30% of PHA. Thus, in addition to nutritional stress exogenous ethanol and peroxide stress were applied to enhance PHA yields. Both these stress types seemed to be very effective stimulating factors improving PHA production. The response of culture to stress depended on the concentration of stress factor as well as on the time of stress factor application. According to our results, the best effect on PHA production exhibited ethanol in concentration 0.5% (v/v) and 5 mM hydrogen peroxide, both applied at the beginning of stationary phase. Then after, PHA yields were improved about 20—30%. Use of waste whey substrate is one of the possible ways to enable broader use of bioplastics.

doi:10.1016/j.nbt.2009.06.574

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Vegetable wastes as suitable biomass feedstock for biorefineries

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According to a widely accepted definition biorefinery is 'the sustainable processing of biomass into a spectrum of value-added products (chemicals, materials, food and feed) and energy (biofuels, power and heat).' The main sources of biomass feedstock consist of sugar and starch crops, vegetable oils, grasses, lignocellulosic materials and different organic wastes such as municipal solid wastes and residues from the food production chain.

In recent years vegetable biomass wastes produced by food processing industry revealed their intrinsic value and potentialities as biorefinery feedstocks. Indeed many studies carried out worldwide showed that such biomass represents an interesting source of value-added products including either bioactive molecules or additives for biopolymer production.

As a matter of fact a significant fraction of vegetable components such as antioxidants, fibers and biopolymers are lost after processing being discarded in the residual matter. In this context several researches has been devoted to investigate vegetable biomasses as a potential source of energy and bioactive molecules. In this study some examples are reported concerning the reuse and recovery of biomolecules from tomato processing industry wastes besides some preliminary results on extraction of lemon 'pastazzo', the main residue remaining after lemon processing for liquors production.

Tomato wastes are constituted by about 50% fibers—polysaccharides, 18% proteins, 10% fats besides carotenoids and other substances with antioxidant activity. Attention is focused on some tomato-derived polysaccharides that possess significant anti-inflammatory properties, in addition to potential applicability in design of biodegradable plastic films. Moreover the ability of tomato wastes is reported in promoting and sustaining microbial growth of extremophlic microorganisms, namely thermophiles and halophiles.

Citrus by-products comprise as main components dietary fibers (including polysaccharides and lignin) and different bioactive compounds (i.e. flavonoids and vitamin C) with antioxidant properties. In this report we show the outcome of different extraction treatments performed to investigate the chemical nature of both polyphenol fraction and polysaccharide components of lemon processing wastes.

doi:10.1016/j.nbt.2009.06.575