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Balancing performance and sustainability in natural fiber-reinforced composites

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Natural and synthetic fibers have been used increasingly as matrix reinforcements in various applications. While the latter is popular for its generally superior mechanical properties, natural fibers are environmentally friendly and sustainable. As more businesses are inclining towards going green, natural fibers have been gaining increasing attention in recent years, often as a substitute or as a complementary to glass fibers. However, its utilization is usually bound to applications not requiring high mechanical performance. In this study, we investigate an extended use of natural fiber-reinforced polymeric composites to structural applications requiring higher mechanical performance, through hybridization with carbon fibers, aiming at a good balance between performance and sustainability. Having more than one fiber type in a polymer matrix can potentially give greater flexibility in achieving optimal material behavior and failure characteristics. Experimental investigation was carried out on various flax-carbon reinforced polymer hybrid systems fabricated using a custom-designed composites prepreg extrusion plant, suitable for large-scale industrial output, to impregnate fibers with a recyclable polymer, which are then hot-pressed, producing composite laminates with high fiber volume fraction. The hybrid composite's strengh and stiffness under tension and bending is assessed at various carbon fibre loadings to study the reinforcing effect of carbon in flax-polypropylene composite.

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Cheese whey valorization for polyhydroxyalkanoates (PHAs) production

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Polyhydroxyalkanoates (PHAs) are biopolyesters produced by different bacterial species as energy storage; with respect to common bioplastics they have thermo-mechanical properties similar to those of traditional plastics, that make them potential alternatives to plastics in the future. Nowadays, PHAs production is limited by high production costs due to the use of pure cultures and standard substrates. To reduce these costs, agro-industrial wastes have been started to be used as substrate to feed mixed microbial cultures (MMC). In Lombardy Region (North Italy) about 3.3 million Mg of cheese whey (data of 2013) are produced yearly, that is about 36% of total Italian production and the 2.75% of the global production. Cheese whey, being largely and continuously produced and easily available, could be an interesting substrate for PHAs production to sustain the high demand of plastics of the market. In this work two fermented cheese whey (FCW) were used to produce PHAs by using MMC. PHA accumulation given for fermented FCW1 a PHA yield (Y_{tot}) of 0.24±0.02 mg COD_{PHA} mg $COD_{Soluble\ Substrate(SS)}^{-1}$ and a total PHA production, referred to the substrate used, of 60 g PHA $kg_{cheese\ whey}$ total solids $(TS)^{-1}$. For fermented FCW2 results were: PHA yield (Y_{tot}) of 0.42±0.03 mg COD_{PHA} mg COD_{SS}^{-1} and PHA from substrate of 70 g PHA $kg_{cheese\ whey}$ TS^{-1}. Qualitatively, PHA from FCW1 was composed exclusively by polyhydroxybutyrate (PHB) contrarily to those obtained from FCW2 that were composed for 40% of hydroxyvalerate and for 60% of hydroxybutyrate.

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