CHEMURGY: COST-BENEFIT ANALYSIS OF THE USE OF AGRICULTURAL WASTE AS AN ADDITIVE FOR PLASTIC MATERIALS

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THE PARADIGM OF PRODUCTION

Plastic is one of the most widely used materials in the world. Thanks to its high machinability characteristics at low temperatures, it has revolutionized the industry, finding endless applications in any human activity. For several years now, it has pervaded every aspect of the lives of the majority of the world's population, and a world without it is unthinkable. The model under study is inspired by Henry Ford's studies on chemiurgy, that branch of chemistry that studies the integration of biomass as an input for secondary industry in the production of fuels, chemical compounds or materials.

This model of industrial symbiosis involves the integration of specific properties of certain plant materials to eliminate the use of petrochemical modifying agents. In this way, it is possible to produce plastic materials with particular properties deriving from the use of waste from the processing of agricultural chains (so-called biomass). Every precious waste confers chemical/physical properties exactly as additives and dyes would do; thus conferring characteristics such as tensile strength and elasticity as well as a strong visual and tactile identity that goes beyond the simple appearance. By replacing additives it is possible to make completely 'eco' biodegradable plastics and to bring a material like plastic closer to the green economy, both from a chemical and conceptual point of view. The model described has already demonstrated its virtuous character in the practical application so far carried out by Kanèsis.

The costs for the application of this model; i.e. transport costs, biomass processing costs and those of the plastics enrichment process; are largely covered by the economic value generated for thermoplastic companies even without considering the relative environmental benefits, and the economic and environmental benefits for the agricultural supply chains.

THE COMPANY

MICA iSrl operates in the thermoplastic sector and addresses different markets: on the one hand, B2B consultancy for the improvement of the production process of plastic materials, on the other hand, the development and production of filaments for 3D printing, service and production of 3D printers.

The Kanèsis project was born in 2015 is a container of eco-sustainable projects that bring together agriculture and industry. This "container", within MICA iSrl, collects all the projects ranging in various fields between plastics and construction that revolve around the core of the second raw materials derived from agricultural processes, with the aim of inserting them intelligently into existing industrial processes.

The company does not produce a specific material, but has been able to innovate the current process of production of plastics by proposing a completely new paradigm. For this reason, the range of materials potentially feasible is vast and is based on two main determining ingredients: the plastic matrix (biobased or petrochemical), and the agricultural waste (food, agricultural or non-food).

THE MATERIALS

HEMP filament: filament of natural and compostable origin containing hemp shives (from 15% to 25%) which gives a particular wood effect, and with a greater resistance to traction. This particular result cannot be obtained with any other biomass, not even with hemp fibre.

WEED filament: filament of natural and compostable origin, containing only waste powder from hemp inflorescences. This waste still contains cannabinoids (lipids) that within the plastic materials act as an emulsifier giving a lot of elasticity to the material and a characteristic natural green color.

TOMATO filament: Filament of natural and compostable origin containing waste from the agricultural production of Sicilian tomatoes (15%-25%) that gives a vivid red color.

CAROB Filament: Filament of natural and compostable origin, containing only waste carob flour. The carob flour contains more than 30% of sugars which, due to the high temperatures of the die, become caramel giving the final material a stunning elasticity: the PLA has a percentage of elongation at break of about 3%, adding 20% of carob flour this value reaches 31%. This great result is accompanied by a characteristic reddish/dark brown colour.

PRUNED Filament: Filament of natural origin, compostable, containing only waste from pruning of oranges. The material thus obtained, in addition to a characteristic brownish colour with a slight shade on the orange, has proved to be the material with the highest Young's modulus (resistance to plastic deformation) among those produced so far.

BENEFIT FOR THE SECONDARY SECTOR

The secondary sector is the one that benefits most from this model of symbiosis, enriching itself with agricultural waste, now precious inputs. At best, a normal plastic base can obtain new chemical-physical characteristics, a reduction in weight, a very strong identity, with lower production costs and also entering the European standards (20% biobased).

Replacing additives with agricultural waste gives a huge advantage to thermoplastic companies that can break their dependence on large producers by replacing them with a more innovative and environmentally friendly solution. As if this were not enough, waste biomass costs less than additives, is 100% Biobased and can therefore modify a plastic matrix without compromising its biodegradability or can make a 100% petrochemical material become 20-30-40% Biobased, paradoxically lowering the final price of the material. In addition to these benefits that can be seen directly, it is possible to observe others that accompany the material throughout the supply chain up to the final products and to the disposal of the latter.

Companies that use these materials can enjoy greater reliability for the production of products in the food, pharmaceutical, cosmetic and in general in all cases where the material will come into daily contact with humans, such as children's toys.

In addition to these, there are other advantages that unfortunately cannot be quantified except indirectly through, for example, the effects of marketing. Among these indirect advantages there is the approach of plastic materials to the concept of green economy, both for the chemical proximity and conceptual level thanks to the new visual and tactile identity of the material that transcends the simple appearance: An object made with materials of this type is visibly different.

The materials produced by the company are made from PLA (Polylactic Acid), a 100% biobased plastic to which about 20% of agricultural waste is added. These new materials, which are entirely biodegradable, are made from pellets and filaments for 3D printing. On average, they are extruded at temperatures about 30-40 degrees lower than the plastic matrices used, the agricultural waste significantly lowers the melting temperature, probably because microscopically the particles obtained from the processing of waste are established between the bonds of the polymer chains. This also allows a significant energy saving on large quantities.