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POLYHYDROXYALCONATE BASED COMPOSITES: DEVELOPMENT AND CHARACTERISATION OF PROPERTIES

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ABSTRACT

Microbially synthesised biobased and biodegradable composites attract interest as sustainable future materials for broad range of potential applications. In the current research attention is devoted to the development of melt plasticized polyhydroxybutirate (PHB) composites. Structure as well as rheological, thermal and mechanical properties before and after accelerated ageing of the laboratory synthesized PHB composites are characterized in comparison to those based on commercial PHB. Besides it, applicability of the PHB synthesis biomass is also evaluated.

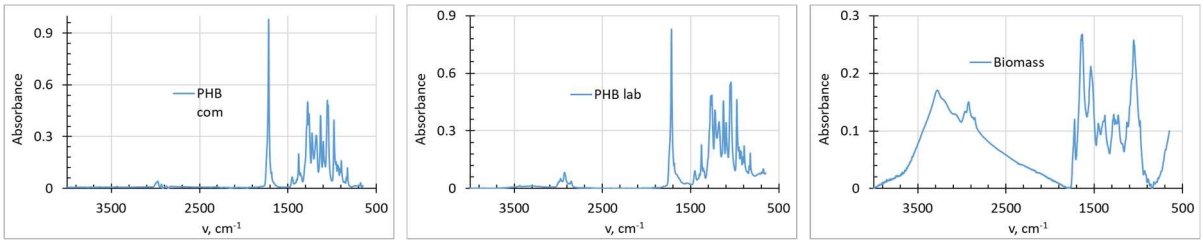
Keywords: polyhydroxybutirate, plasticization, biomass, melt compounded composite, rheological, thermal and mechanical properties.

INTRODUCTION

Development of sustainable products is based on purposeful selection of materials with minimized negative effects on health and environment. This is especially challenging in respects to the growing amount and diversity of the products made from synthetic plastics, considerably contributing to the global waste problem (Ragaert, 2017). Consequently, fossil-based materials are increasingly replaced by biobased and/or biodegradable counterparts whenever it is possible in the design of sustainable products. However, the use of biobased and biodegradable constituents in materials design for various consumer products still is low, less than one percent, in respects to global consumption of synthetic polymers (Garcia-Depraect, 2021). This is related to high manufacturing costs, reduced exploitation properties, as well as limited environmental stability of most of biobased and biodegradable products in respects to fossil-based counterparts. Besides it, many of presently available biobased and biodegradable materials are obtained from agricultural crops thus conflicting with sources demanded for food production. Solution for this problem is microbial synthesis of polymers and development of perspective composite materials on it bases to meet the requirements of various potential applications. Among the microbially synthesized polymers, members from polyhydroxyalconate group represent one of the greatest commercialisation potential. Consequently, the current research, carried out in co-operation with local healthy cereal producer SIA MILZU!, is devoted to melt plasticization of microbially synthesized polyhydroxybutirate (PHB) and evaluation of its application potential for manufacturing of environmentally friendly products for packaging applications and beyond.

RESULTS AND CONCLUSIONS

Laboratory synthetized PHB was melt compounded with triethyl citrate (TEC) as recognized plasticizer for polyhydroxyalconate group polymers. TEC content was changed within the range of 10 to 30 wt.%. Rheological, calorimetric, thermogravimetric as well as mechanical properties before and after accelerated ageing of the developed PHB/TEC based composites were characterised in comparison to the composites developed on the bases of commercial PHB. In addition, attention was paid to evaluation of potential applicability of untreated biomass from PHB synthesis. FTIR spectra of investigated polyhydroxyalconates as well as biomass are summarized in Figure 1 below.



(a) (b) (c)

Fig. 1 – FTIR spectra of commercial PHB (a), laboratory synthesized PHB (b) and biomass of PHB synthesis (c).

As a result of investigation technological approach for melt plasticization of PHB with TEC has been demonstrated. Rheological properties of the developed PHB based compositions have been thoroughly characterised. It has been shown that laboratory synthesized PHB, similarly to its commercial counterpart, demonstrates certain practical applicability for manufacturing of films, intended for packaging, although at somewhat lower property range. Besides, it has been shown that after purposeful modification untreated biomass can be also used for some practical applications. However, to extend application range of the laboratory synthesized PHB based composites beyond packaging sector reduction of brittleness via modification with TEC or other suitable plasticiser is required.

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