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Eco-design analysis for innovative bio-product from forest biomass assessment

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Abstract

The environmental impact of a product in different stages of its life cycle can be assessed using eco-design analysis methods. It is possible to research the environmental impact in the early stages of the product planning. In this assessment eco-design analysis was carried out using Pré Consultants computer program *ECO-it* to forecast environmental impacts during the production process of xylan. It is a chemical product extracted from wood. Previously conducted studies identified xylan as a product with high commercialization potential for Latvia's conditions. Innovative microwave assisted xylan production technology was assessed. Results reveal that depending on source energy powering the technological processes can create the greatest environmental impacts as xylan production is an energy intensive process. Another significant source of pollution comes from the use of chemicals in the production process. In comparison raw materials, transportation and water use environmental impacts are minor.

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Keywords: bioeconomy; eco-design; bioproducts; forest resources; *ECO-it*

1. Introduction

Beginnings of the eco-design concept can be found in Europe in early 1990s [1], but the first studies investigating the production and material life cycle aspects were carried out in nineteen sixties and seventies. They were focused

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on energy efficiency, raw material consumption and slightly on waste management [2]. When eco-design concept started its development focus was on design and material of product, but as time was passing the idea was expanding and attention was brought to production, use and end of life cycle of a product [3, 4], recently – on a corporate system perspective of products and services [5, 6].

In ISO 14006:2011 eco-design is defined as an inclusion of the environmental aspects into the design of a product and as a development process to decrease the environmental impacts of this product during the whole life cycle of product [7]. By taking into account the basic principles of eco-design the development process of the product, it can be achieved that product and its production process will be friendly to the environment and climate [8, 9] and also the product will be overall high [3]. For organizations the main challenges of eco-design principles implementation in real life are considered to be: strategy, tools, collaboration, management and knowledge [10]. Mastering all five categories will foster development of a sustainable society - knowledge transfer to real life actions will be achieved.

Currently the significance of ecodesign is extending beyond the context of consumption and its effects on climate and environment [11]. Eco-design is becoming significant in the context of bioeconomy and circular economy – ecodesign is acknowledged as an essential and irreplaceable component of sustainable production [8]. In this study eco-design analysis tools are used in the theoretical evaluation stage of a product – when there are possibilities to research a product and production processes according to the base principles of bioeconomy. Xylan was chosen for eco-design analysis, because in previously conducted studies it was identified as a product with high commercialization potential for Latvia's conditions [12].

2. Methodology

Eco-design analysis computer program *ECO-it* developed by *Pré Consultants* has been used in the study. Fig. 1 graphically displays the methodology algorithm which consists of 6 modules. The first module is the selection of bioproduct and its production technology. The second module is the research of the quantitative data about the production stages. Then gathered data is divided into division of flows (electricity, heat, chemicals, raw materials, water). The data is entered in the program. Concluding modules are the results and the analysis of results.

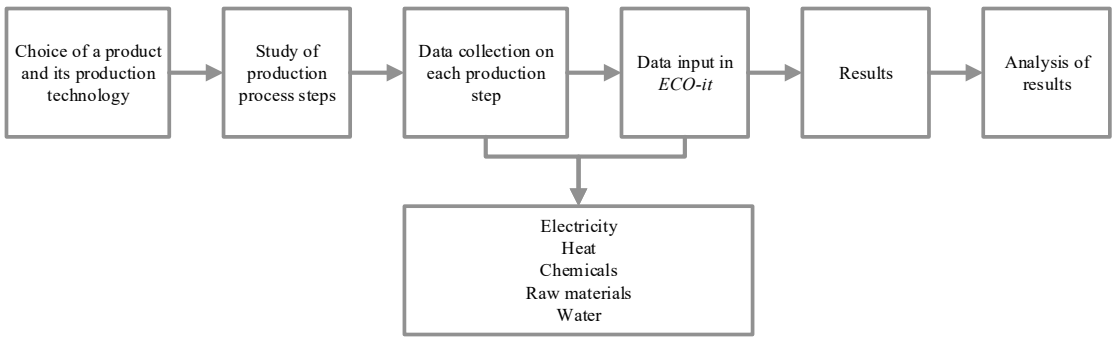

Fig. 1. Algorithm of methodology.

ECO-it program has been developed, based on *ReCiPe* environmental impacts characterization methodology [13]. It produces midpoint and endpoint environmental impact evaluations. Midpoint results represent specific indicators, however, it is not practical to mutually compare them (climate change; destruction of the ozone layer; acid effects on environment; fresh-water eutrophication; sea water eutrophication; toxicity to humans; genesis of photochemical oxidants; formation of aerosols; ecotoxicity of environment; fresh-water ecotoxicity; sea water ecotoxicity; ionizing gradation; agricultural lands; city lands; transformation of natural territories; water resource decrease; minerals resource decrease; fossil fuel resource decrease). With the endpoints, mutually easily comparable indicators are obtained (effects on human health; damage on environment; damage to resources) – they are also known as eco-indicators Pt [13].