The biodegradable straw - Investigating how enzymes can be used to enhance desired product qualities of drinking devices.

The increasing ocean debris from single-use plastics has fatal consequences to marine life. As a response, the European Parliament imposed a ban on single-use products, such as straws, by 2021. The new regulations are making it essential to study alternative sustainable materials. Although paper straws have become a popular substitute, product qualities such as sogginess are reducing consumer satisfaction. Furthermore, little research has identified how enzymes can be used to enhance the desired qualities of straws. In this thesis, the possibilities of using enzymes to create a biodegradable and user-friendly straw are investigated.

Through interviews with experts in the packaging industry and biotechnology, challenges and opportunities in utilising enzymes for drinking devices are discussed. Mainly, the analysis suggests that there is a potential for using bioplastics as a surface treatment to a paper-based drinking device. Current paper straws quickly become soft and wet during use and a bioplastic surface treatment is a potential solution. Bioplastics have similar properties to fossil-based plastics but also offer additional advantages as they are biodegradable and biobased. A potential to utilise encapsulated enzymes in the surface treatment was identified to increase the rate of biodegradation before recycling.

To identify consumers' preferences about drinking devices, a survey was conducted with 308 respondents. Safety, moisture resistance and flavourless were identified as the most important features of a drinking device. In addition, recyclability and biodegradability are shown to be of high importance according to the respondents.

Based on the interviews and the survey responses, several designs and material proposals for environmentally- and user-friendly drinking devices are suggested and discussed. A theoretical mathematical model is developed as a proposal for how to model the biodegradation rate of the material combination. An outline is also given for how to use a mathematical model for analysing how much an enzyme can speed up the biodegradation process.

The study identifies the potential of using a PHB surface treatment on a fibre-based drinking device with encapsulated enzymes, see Figure 1. The suggested drinking device design is an ergonomic mouthpiece that creates control during use to prevent spillage. Once the drinking device touches the liquid, the encapsulated enzymes will start to biodegrade the bioplastic surface treatment.

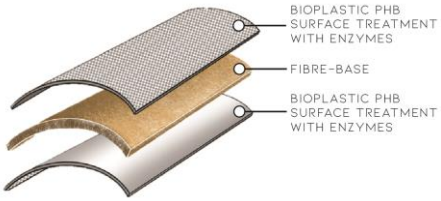

Figure 1. Final design proposal for the biodegradable drinking device

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