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Record level productivity of lactate from a century-old cellulosic deposit on the lake bottom in Tampere, Finland

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Globally, the number of the so-called zero fibre sediments on the bottom of waterways is supposed to reach thousands of environmental deposits. These by-products of the industry are usually considered as waste causing significant ecological, health and urban development problems. However, these by-products can be processed to produce valuable chemicals, such as lactic acid, which is a common food additive. The residual fraction could be converted into methane biogas and biohydrogen as well as recycled fertilizers.

The construction plan for an urban area for about 25 000 dwellers has necessitated the need for the removal of about 1.5M tons of cellulosic fibre waste ("zero waste") from the lake bottom in Tampere, Finland, 2-3 km from the city centre. Microbial processes funded by the City of Tampere and the Finnish Ministry of Agriculture and Forestry were shown to produce about 9.2% of lactate during the earlier pilot studies conducted by Finnoflag Oy. The first pilot unit of 5-15 cubic meters was manufactured by Nordautomation Oy, Finland. The maximum product level was reached in about 100 hours. In the process, the UMC (Unidentified Mixed Culture) principle was applied, and the catalytic microbial strains thus derived from the up to 10-meter-thick sediment of fibrous wastes accumulated between 1913-2008 during the factory operating ashore. Until the 1960s, the side streams were placed into Lake Näsijärvi without limitations. There they formed a thick “mattress”, preserved in the cold, dark, acidic (pH 4.5) and anoxic conditions for decades. The removal of it is estimated to take 5-10 years. The bioprocessing facilities could handle the material (dry weight 10%) straight after the delivery.

At the beginning of December 2021, the City of Tampere invited Finnoflag Oy to provide additional evidence about the productivity of biorefinery technologies. We started a five-week intensive lab and field testing period. The final yield of lactate was elevated to a concentration of more than 10% in 70-80 hours starting from an enzymatically pretreated zero waste hydrolyzed overnight and preliminarily matured in lower temperatures. The starting lactate concentration of the pretreated biomass was then between 2-3.5%. Consequently, the Consolidated Bioprocessing (CBP) was performed with lactic acid bacteria and cellulolytic enzymes as the biocatalysts. The net

product increase in the bioprocess was 4-5 fold. The downstream process for lactate has been preliminarily tested by the University of Tampere, and the Mälardalen University of Technology, Sweden.

The other products of the process included additional chemicals, biogas, and organic fertilizers. All biomass was converted into products which make this endeavour an example of sustainable and economically feasible ecosystem engineering industries.