-Green hotels -Use of food waste derived from hotels and restaurants for the production of sustainable and biodegradable consumables

2 authors:

Daniel Pleissner
Leuphana University Lüneburg

Joachim Venus
Leibniz Institute for Agricultural Engineering and Bioeconomy

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Use of food waste derived from hotels and restaurants for the production of sustainable and biodegradable consumables

Daniel Pleissner, Joachim Venus

Department of Bioengineering, Leibniz-Institute for Agricultural Engineering Potsdam-Bornim, Potsdam, Germany, Mail: dpleissner@atb-potsdam.de

Around 1.3 billion tons of food, which was originally produced under extensive use of energy, water and fertilizers, is wasted at production and consumption levels worldwide per year [Gustavsson et al., 2011]. In Near East and North Africa, 250 kg of food is wasted per capita annually. Along with the loss of food, 42 km^3 of water is wasted annually and this is in particular problematic in one of the most water scarce region in the world [FAO, 2015]. Food waste requires an effective treatment in order to avoid an accumulation and a negative impact on the life quality of citizen and attractiveness of regions. This is especially essential in regions where tourism significantly contributes to the income and where tourists expect an intact environment.

Alexander (2002) reported that ecotourism is growing rapidly and 43 million tourists consider themselves to be ecotourists in the United States. According to “The International Ecotourism Society”, ecotourists are responsible consumers interested in social, economic and environmental sustainability and minimizing the carbon footprint of their travel. It may be assumed here that ecotourists prefer hotels, which are engaged in activities tackling environmental issues, such as the accumulation of solid waste in tourist areas.

Research revealed that the food waste issue will not be solved in the near future. Therefore, in order to treat and utilize food waste in a socially responsible way, a material use of wasted food for the production of sustainable chemicals by biotechnological processes was proposed and investigated. This approach includes the recovery of carbon, nitrogen and phosphate compounds from waste material and enables a recycling of recovered compounds in order to close the nutrient cycle.

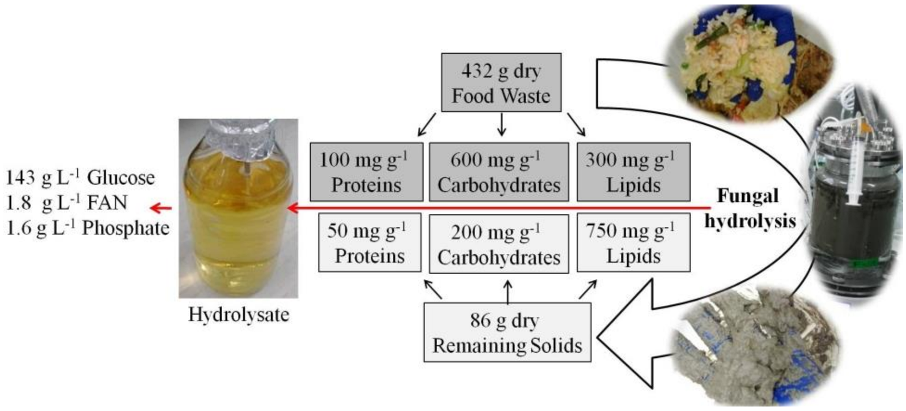

Figure 1. Fungal hydrolysis of food waste for the production of a nutrient-rich hydrolysate and lipid-rich remaining solids [Pleissner et al., 2014a].

Food waste consists of 30-60% carbohydrates, 5-10% proteins and 10-40% (w/w) lipids, and to a lesser extent of polyphosphates [Pleissner et al., 2013; 2014a; 2014b]. Carbohydrates, proteins and polyphosphates can be converted by biological and/or chemical methods into sugars, amino acids and phosphate, respectively (Figure 1). The recovered nutrients can then be used as feed for microorganisms in biotechnological processes. It should be emphasized here, that the metabolic versatility of microbes enables the production of a wide range of products from bio-plastic to bio-fuel (Figure 2). The solid waste generated by hotels is formed by more than 40% of food waste [Alexander, 2002]. Therefore, hotels and associated restaurants are predestinated to implement innovative food waste utilization approaches.

Utilization of food waste opens the door to the development of innovative and cost-efficient biotechnological processes, and innovative approaches are considered to particularly contribute to the economy of developing countries. The utilization of food waste would not only contribute to a reduction of waste material that needs to be handled, but also to the production of sustainable and environmental benign compounds, such as poly(lactic acid). Poly(lactic acid), also known as bio-plastic, is a material with similar properties to petroleum-based plastics. Interesting enough, bio-plastic is bio-based and may, in comparison to conventional plastics, not accumulate in the environment. Therefore, this material is interesting for the production of "green consumables", such as compostable bags.

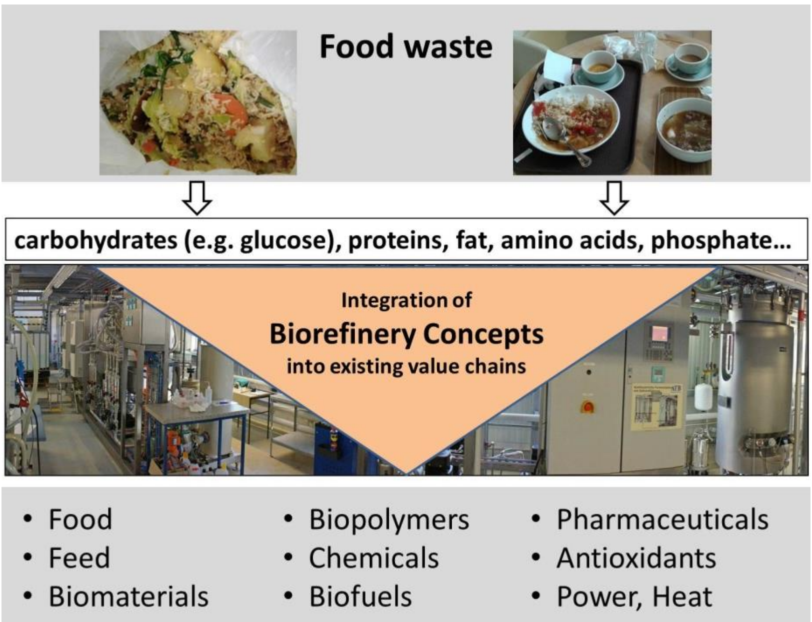

Figure 2. Integration of food waste treatment in biotechnological processes for the production of various bio-based products.

However, the potential of a food waste hydrolysis and utilization process to contribute to the sustainability of hotels and regions is not enough to ensure its successful implementation. In addition to the expected positive environmental impact, the economic feasibility, as the most important criterion for its technical realization, needs to be considered. In order to evaluate the economic potential, a techno-economic study of a process (Figure 3) that includes 1) the hydrolysis of food waste in submerged fermentation using carboxylic and proteolytic enzymes secreted by fungal biomass, 2) the use of hydrolysate as nutrient source for the production of algal biomass, 3) the extraction and use of lipids from algal biomass and solids remaining after hydrolysis for bio-plasticizer synthesis and 4) the use of defatted algal biomass and remaining solids as nutrient source in lactic acid fermentation was carried out. The techno-economic study is based on the current market value of bio-plasticizer and lactic acid, and revealed that such a food waste hydrolysis and utilization process is economical feasible in urban areas with promising annual revenue, return on investment, payback period and internal rate of return (unpublished results). Interesting enough, this process did not even reduce the amount of food waste that needs to be treated by 90%, but also results in two sustainable products, namely bio-plasticizer and lactic acid.

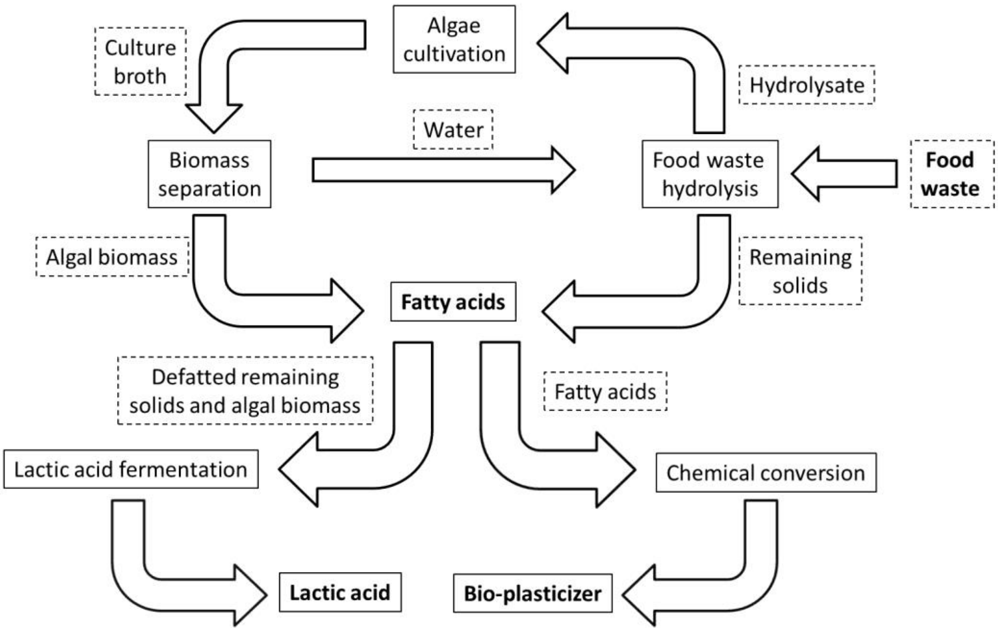

Figure 3. Bio-plasticizer and lactic acid productions as integrated processes in food waste treatment.

Bio-plasticizer and lactic acid can be applied in the production of bio-plastic consumables, which can potentially replace petroleum-based plastic consumables in hotels and restaurants. Therefore, hotels and restaurants supporting this approach would not only contribute to a sustainable food waste treatment, but also to a substitution of persistent petroleum-based plastic by bio-plastic. Furthermore, a hotel that tackles the problem of accumulating organic and plastic wastes may be called "green hotel", and may particularly interesting for ecology-minded guests, who prefer to stay in sustainable operating houses.

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