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Supply Chain of Bioethanol Production from Whey: A Review

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Abstract

Whey, a major byproduct of the cheese and dairy industry, has valuable nutritional constituents but poses a major environmental risk, if disposed off without prior treatment. Whey has a high organic content, its major constituent being lactose (4.5-5% w/v). With a very high BOD and COD load (30,000 – 50,000 ppm and 60,000 – 80,000 ppm respectively) and annual production of over 160 million tonnes, with an estimated growth rate of 1–2% yearly, fermentation of whey to bioethanol has proved to be a lucrative option, both for bioremediation of whey and production of ethanol from waste sources; reducing the costs incurred in otherwise advanced effluent treatment processes required for its disposal. Moreover, with increasing global demand for bioethanol as an alternative to scarce fossil fuels and advocacy by governmental institutions, due to its non-polluting nature aiding in reduced environmental pollution and global warming; conversion of whey to ethanol is progressively more desirable. The aim of this review is to discuss the supply chain involved in the production of ethanol from whey. The study will involve literature survey, experimentation and developing a model.

This study looks at the supply chain involved in the production and subsequent distribution of whey, for the purpose of valorization and extraction of valuable constituents, as well as its utilization in production of bioethanol. Based on existing studies, it has been seen that an initial lactose concentration of 200 gL⁻¹ in the whey permeate, provides the maximum yield for ethanol. Under such conditions, maximum ethanol obtained from fermentation of whey was found to be 80.95 kg m⁻³, proving the economic viability of the process. However, the supply chain of whey for bioethanol production is not well defined, making effectiveness and implementation of ethanol production from whey constricted. Thus, although the environmental risk posed by the vast production of whey, is mitigated by its conversion to ethanol, providing adequate bioremediation of its polluting components, this process is yet to be industrialized widely.

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1. Introduction

Dairy and cheese industries are an integral part of the food processing industry, producing considerable amounts of liquid discharges, having a high organic load. Whey, the liquid remnant subsequent to the precipitation and removal of milk casein during cheese-making, is a major by-product of dairy and cheese industries. The major constituent of whey is lactose (4.5-5 % w/v), contributing to the high BOD and COD content (Siso 1996). It also consists of lipids, proteins, minerals, and other nutrients, making it a nutritionally rich feedstock for production of various compounds (Siso 1996) (Panesar *et al.*, 2007). Thus conversion of whey to ethanol is a beneficial process for the reuse and bioremediation of this highly polluting industrial by-product. Ethanol production from whey also mitigates the need for complex and cost intensive effluent treatment processes required for the disposal of whey. This process is further fuelled by the growing demand for bioethanol, globally, as an alternative to fossil fuels which are both highly polluting, as well as of limited supply. Thus, bioethanol has emerged as a major alternative and environment-friendly fuel for the future, propelled by governmental incentives, all over the world. This is because ethanol doesn't produce any toxic emissions on combustion, making it effective in reducing pollution and global warming, and thus emerging as a greener fuel. In recent years, the focus has been on utilising industrial and agricultural wastes as the feedstock for the production of ethanol, as a means of waste reuse and bioremediation, as well as to prevent scarcity of food crops or land and other agricultural resources. Thus, the production of ethanol from whey, one such waste source, is a lucrative process.

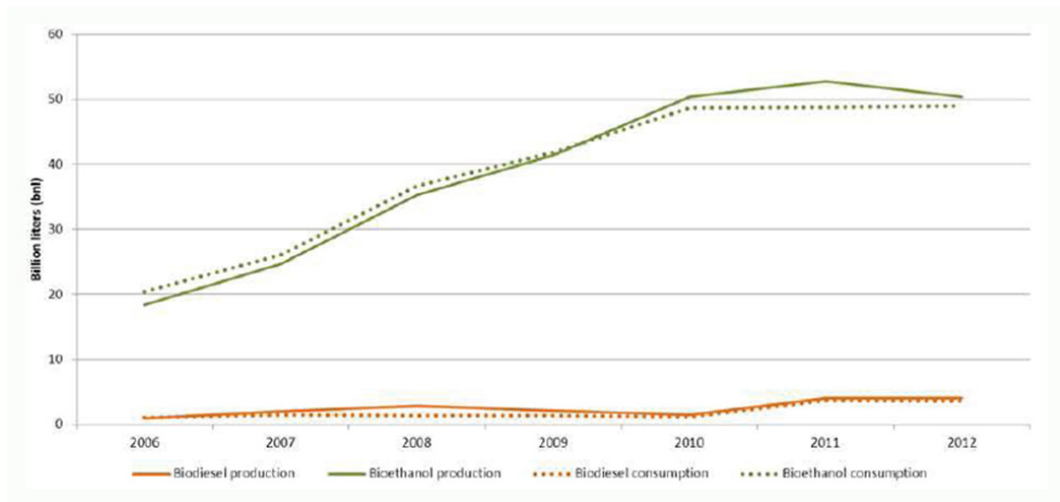


Fig. 1.a. Production and consumption of Bioethanol in the US (shown in green). (Source: UNCTAD/DITC/TED/2013/8)

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