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Effect and key factors of byproducts valorization: The case of dairy industry

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ABSTRACT

Production of many consumer products results in byproducts that contain a considerably large part of nutrients originating from input materials. High production volumes, environmental impact, and nutritional content of byproducts make them an important subject for careful valorization. Valorization allows us to explore the possibility of reusing nutrients in the production of main products, and thus highlights the potential gains that can be achieved. The main aim of this study was to evaluate the added value of cheese whey valorization, and to determine the effect of integral valorization of main products and byproducts on the profit of a dairy producer. Several scenarios and cases were implemented and analyzed using a decision support tool, the integral dairy valorization model. Data originated from the international dairy processor FrieslandCampina (Amersfoort, the Netherlands). The outcomes of scenarios were analyzed with regard to profit and shifts in the production of nonwhey end products, and were validated by company experts. Modeling results showed that the valorization of byproducts is very profitable (24.3% more profit). Furthermore, additional profit can be achieved when 2 valorization processes (main products and byproducts) are integrated. This effect is, however, considerably affected by current capacity and market demand limitations. Significant benefits can be created if demand of whey-based products is increased by 25%.

Key words: byproducts valorization, whey, profit maximization, production

INTRODUCTION

As the global population is growing, significantly more food is needed to feed the world. This can be achieved, in part, by increasing farm production levels. It might, however, be more effective to reduce food waste in supply chains. Recent studies of the Food and Agriculture Organization of the United Nations (Gustavsson et al., 2011) estimate that globally 40 to 50% of fruits and vegetables, 20% of meat and dairy, and 30% of fish are wasted. This creates an enormous waste of resources and calls for research to reduce the problem.

Food waste is food that is discarded or lost uneaten. Food wastes take place at the production, postharvest, and processing stages in the food supply chain (Parfitt et al., 2010). In most European legislations, production residues are defined as wastes; however, scientists who investigate the potential of reusing food wastes define them as food byproducts (Galanakis, 2012). In this paper, we investigate valorization of byproducts in the milk processing industry. Valorization is defined as the optimal postprocessing of byproducts incorporated in the production of main milk products. Different ways of valorizing byproducts have been investigated in various industries; for example, citrus, fish, meat, cereals, roots and tubers, oil crops, and dairy (see Table 1 for references). Most of these studies are focused on biotechnological developments and investigate the possibility of extracting various nutrients from byproducts and the possibility of using (parts of) the byproducts in the production of end products. The main objective is usually to decrease the environmental impact and reduce costs related to byproduct processing technology (Galanakis, 2012; Mollea et al., 2013). Although the biology and technology aspects are well studied, to the best of our knowledge, no studies have evaluated the overall economic effect of postprocessing of byproducts on a food processor (see Table 1). The maximization of processor profitability, especially if processors reuse their own byproducts in the production of their end products, is not a key aspect of these studies. Furthermore, the effect of biotechnological developments in extracting and reusing nutrients contained in byproducts on the valorization of main products was not investigated.

In this paper, we focused on the dairy industry and analyzed the effect of byproducts valorization on the overall valorization of raw milk. We investigated how different levels of valorization of byproducts affect production planning decisions related to main end products

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Table 1. Literature on the valorization of byproducts (adapted from Galanakis, 2012)

Valorized byproduct	Reference	Objective of valorization
Citruses (e.g., orange peel as a byproduct of orange)	Chedea et al. (2010)	Characterization of carotenoid pattern in two varieties of orange waste (Valencia and Navel) using different analytical methods
	Farhat et al. (2011)	Optimization of operating conditions for the optimal extraction time of essential oil from orange peel
Fish (e.g., fish leftovers)	Gehring et al. (2011)	Review of isoelectric solubilization/precipitation (ISP) developments to recover proteins and lipids from fish byproducts
Meat (e.g., bovine blood as a byproduct of bovine production)	Darine et al. (2010)	Investigation of protein recovery and physicochemical properties of meat protein concentrates from beef lungs
Cereals (e.g., bran and straw as a byproducts of wheat)	Sun and Tomkinson (2002)	Investigation of the extractability of the wheat straw hemicelluloses using extraction method with and without application of ultrasonic irradiation
	Hollmann and Lindhauer (2005)	Development of an economically viable procedure for the isolation of the glucuronoarabinoxylans from wheat bran
Oil crops (e.g., olive pomace and wastewater as a byproduct of olive production)	Yang et al. (2010)	Investigation of a catalytic decomposition and effects of different solvents on the purity and yield of recover phytosterols from the waste residue of soybean oil deodorizer distillate
	Galanakis (2011)	Review of the compositional and structural characterization of olive dietary fiber, the modifications during olive fruit ripening and processing, the recovery and potential applications of dietary fiber from olive byproducts
Dairy (e.g., whey as byproduct of cheese production)	Koutinas et al. (2009)	Development of an integrated technology for starter culture production from whey for use in cheese ripening
	Guimarães et al. (2010)	Review of fermentation of lactose to ethanol with the focus on wild lactose-fermenting yeasts
	Patel and Murthy (2011)	Investigation of the recovery of lactose from partially deproteinated whey by the use of an anti-solvent
	Prazeres et al. (2012)	Review of four main cheese whey management practices: biological treatments without valorization, biological treatments with valorization, physicochemical treatments and direct land application