A sustainable approach: Production and Processing of whey

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Sustainable development is of utmost importance because it results in managing the natural resources for the generations to come along with the species that live worldwide. Our future is driven by sustainability, which impacts every aspect of life and will influence it in the future. Cheaper, more accessible, and clean energy are required by Sustainable Development Goals (SDG). To put it another way, by 2030 it will be required to provide energy efficiency and reduce carbon dioxide emissions to produce goods and services. More significantly, it decreases the cost of economy and lowers the demand for imported energy. Furthermore, energy efficiency benefits the construction, transportation, industrial, and energy generating sectors. 'Transforming our World', was the agenda for Sustainable Development UN summit which was held in New York, 2015. The 17 SDGs, which are broken down into 169 closely related sub-goals, which are related to the handling of waste in every part of the cycle, lowering the emissions to the three major resources such as air, water and soil. Also, reducing the amount of waste with higher rate of reuse and recycling.

Sustainability of dairy industry:

The proper handling of food waste materials and by-products poses a concern for the agriculture and food production sectors, as they must manage greater commercial costs for their treatment, process, recycle or dispose due to the rise in food consumption as well as strict environmental restrictions. As the dairy industry advances, enormous quantities of by-products are produced, primarily whey. In this regard, the concept of whey has transformed from being a waste to a dairy by-product, and numerous studies have been carried out to identify workable, ecologically acceptable whey usage alternatives rather than simply dumping of the whey in the field.

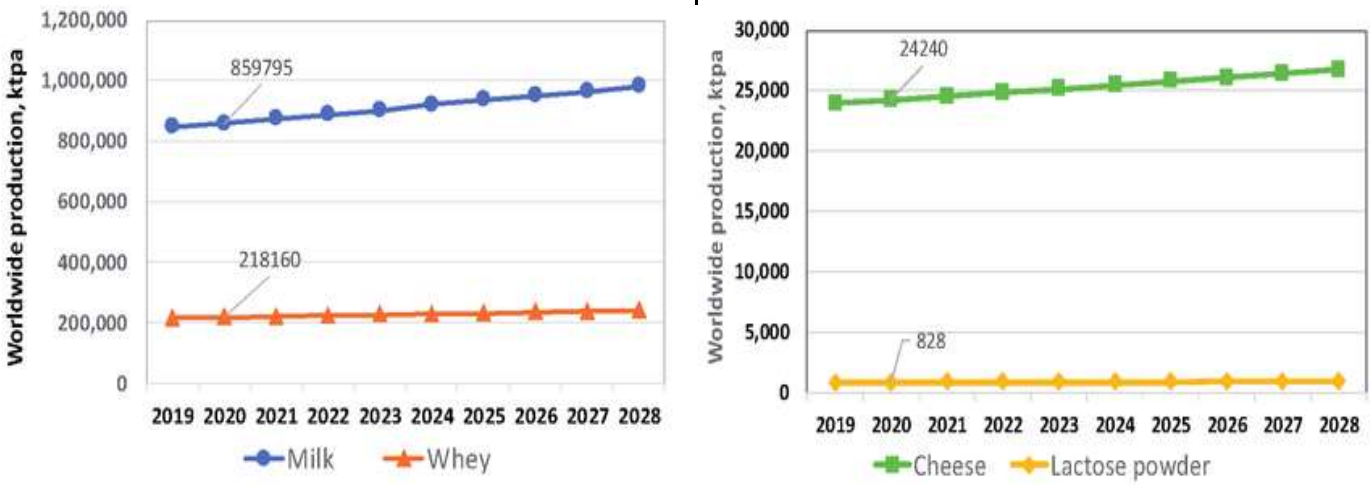

Fig.1. Worldwide production of milk, whey and cheese(in metric kilo-tonnes per annum)

Annually, the dairy industry generates millions of tonnes of by-products, cheese whey (CW) is one among the most important product, which is the net fraction left after milk coagulation while cheese processing. As depicted in the Fig.1. several millions of tons of whey are produced each year as a by-product as a result of the consistent increase in

milk and cheese production around the world in recent years. For every kg of cheese produced, around 9–10L of whey are produced. So, what happens if the whey without being treated is let to blend in the ecosystem? It results in a serious environmental issue. CW is high in the COD (Chemical Oxygen demand) and BOD (Biochemical Oxygen Demand). In similar to CW, second cheese whey (SCW), the liquid that remains after whey cheese separation containing 90% of the original whey or more. SCW is regarded as a significant source of pollution, having high BOD and COD values (an approximate amount of 50 and 80 g L-1, respectively), with lactose (35-50 g L-1) because it is relatively rare to process it, and also it turns out to be challenging to use as feed ingredient since animals lack the ability to breakdown lactose in high quantities.

Valorisation of whey

An ideal ecological and cost-effective option for using whey is the simultaneous incorporation of multiple working units into a single process, which minimizes the environmental impact of whey. Let us see how the cheese whey can be valorised, what technologies are being used and the methodologies for valorisation. The food industry has benefited from the development of membrane separation techniques as they are relatively simple to scale up and are less expensive than preparative chromatographic methods. The benefit of using membrane separation techniques is that the bioactive chemicals do not undergo excessive heat treatments during processing. Proteins from various whey-based ingredients have been concentrated and separated using a variety of techniques, which includes Ultrafiltration (UF), Diafiltration (DF), Nanofiltration (NF), Ion exchange chromatography, precipitation, electrophoresis, and crystallisation.

In fact, fermented whey can be used to extend the shelf life of some foods in addition to fortifying them. For instance, when some authors added fermented whey to poultry feed as a supplement, they saw an increase (2-4-fold) in the antifungal activity when compared to the control diet. Also, it was discovered that using whey powder that had undergone lactic acid fermentation caused *Penicillium expansum*, a toxigenic fungus, to be slightly inactivated (0.5–0.6 log cfu/g) in bread loaves. There are numerous approaches to sustainable whey management, most of which are focused on the creation of value-added products such lactic acid, bioethanol, bioplastics, biogas, whey powder, and functional foods and beverages. While whey in large quantities can be converted to bioethanol, whey in smaller amounts is most effective when utilised to make fermented or unfermented beverages.

Another method used is the generation of bioethanol from whey. According to estimations, raw products such wheat, sugar, beets, and oil seeds are fermented to produce 93% of the world's ethanol (biodiesel), known as first generation bioethanol. The production of bioethanol from second and third generation sources, which primarily consist of agricultural residue, has shown to be an essential approach in minimizing the food-related issue connected with first-generation bioethanol, which seeks to address the food and energy paradox. Therefore, different microorganisms and enzymes are used for fermentation to generate bioethanol. It can also be produced from cheese whey as well as in combination with organic matter.

The liquid whey can be made into whey powder, a most commonly used method. It comprises of the processing steps: whey clarification,

cream separation and pasteurization, concentration of whey, lactose crystallisation and the drying of whey (mostly spray drying is used). Whey contains over half of the vitamins (A,D,E,K) and minerals along with 70% lactose of the total solids found in whole milk and contains 20% protein. Whey proteins and peptides, has most advantageous applications for dealing with chronic diseases, nutritional deficiency, and for body mass gain, as well as in elderly people to address loss of muscle mass due to age caused by sarcopenia. Thus, it is a ground breaking additive in food supplements.

Whey protein films emerges as a biodegradable replacement to the commonly used polyester films and nylon due to their highly effective oxygen barrier qualities. Additionally, compared to films made from polysaccharides, proteins from whey can generate transparent films as well as coatings with better barrier properties, and they could possibly provide surface sterility. Such films and coatings also biodegrade quickly in addition to having superior barrier qualities. However, whey proteins must be combined with glycerol, xylitol, mannitol, or any appropriate plasticizers, in order to create new environmentally friendly food packaging that are flexible and resistant to moisture transfer.

Conclusion

In conclusion, the Sustainable Development Goals are applicable in the field of food industries by reusing and recycling the by-products, proper treatments of the effluents, etc., In the case of whey, it can be used in numerous fields as raw materials, various products, additive in pharmaceuticals and food, and so on. At the same time, over processing of a product can damage its properties, thus the quality of the processed whey should be analysed before introducing it to the market. Awareness should be created regarding SDG's not only in the field of whey processing but also in other food products also which can be helpful for achieving the SDGs in shorter period of time.

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