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PROCESO SELECTIVO POR EL SISTEMA DE ACCESO LIBRE PARA INGRESO EN LA ESCALA DE TECNICOS SUPERIORES ESPECIALIZADOS DE LOS ORGANISMOS PÚBLICOS DE INVESTIGACIÓN, CONVOCADO POR RESOLUCION DE 16 DE DICIEMBRE DE 2020 (BOE Nº 341 DE 31 DE DICIEMBRE)

TEXTO DEL TERCER EJERCICIO

(Idioma Inglés)

Perfil: Manejo de planta piloto en agroalimentación

Dairy-by-products: Valorization of whey

Despite the controversy about the impact of dairy products on health, the consumption of dairy products in the world is increasing steadily. In the EU, a total of 170 billion kg of milk was produced in 2017, 93% of which was converted into dairy products including cheese (37%), butter (30%), cream (13%), fresh milk (11%), acidified milk (4%), milk powder (2%), and other minor products. The development of new dairy products containing prebiotics and probiotics is also increasing based on their benefits for human health. Probiotic foods contain microorganisms that have therapeutic properties like antimicrobial activity, hypocholesterolemic activity, maintenance of gastrointestinal balance and anticarcinogenic activity. Industry has developed a large group of new, nutritionally improved products, which have been a success on the market. Therefore, traditional dairy products have changed and dairy industries need to evolve into the new generation of dairy products with differentiated characteristics regarding health and nutritional properties.

Dairy industries produce an average of 2.5 L of wastewater per L of processed milk, as well as about 9–10 L of cheese whey (CW) per kg of cheese produced, and resulting in approximately 400 billion L of wastewater per year. Due to the stringent environmental regulations, the management of food waste and by-products is a challenge for the agri-food industries that face demanding economic costs for their treatment and/or disposal.

Dairy effluents, and CW in particular, are characterised by a high organic load representing, at the same time, a severe hazard for the environment but and a huge opportunity for bioenergy and biochemicals production. Currently, a large share of dairy effluents, including about 50% of the CW produced worldwide, is discharged into the environment without any treatment.

CW has a high Biochemical Oxygen Demand (BOD) and a high Chemical Oxygen Demand (COD). When discarded into water sources, it reduces the dissolved oxygen, and poses a major risk to aquatic life, as well as to the environment and human health. As is the case of CW, second cheese whey (SCW) is considered a significant source of pollution, possessing high values of BOD and COD (ca. 50 and 80 g/L, respectively). Lactose (35–50 g/L) is the principal constituent responsible for the high COD values (>70%). SCW represents a considerable problem because its valorization is not a common practice and it is difficult to manage as animal feed, since most animals are not able to digest high amounts of lactose without suffering from digestive disorders.

Comparatively, the average BOD and COD values for urban wastewaters are 0.20 and 0.41 g/L, respectively, which represents around 1/150 of the pollution charge of both by products, CW and SCW.

Among the available treatment options, traditional activated sludge processing is economically not sustainable due to the high organic load of dairy effluents, and the consequent huge quantities of both oxygen required for aeration and excess sludge produced. Activated sludge treatment consumes an average of 900 $kWh_{(el)}$ /day, including 100 $kWh_{(el)}$ /day for dewatering (using a filter press) and 800 $kWh_{(el)}$/day for aerobic stabilization, accounting for 30% of the total energy required for aerobic treatment of dairy effluents. Thermo-catalytic treatment has also been proposed for CW valorisation but the high temperature required (450-600 °C) and the production of solids make such a process expensive.

CW is nowadays recognized as a source of functional and bioactive compounds, especially proteins and peptides. However, a large proportion of the whey produced worldwide is still not valorized. This results from the fact that small and medium size dairy industries lack dimension to make the necessary investments for CW valorization.

In some countries such as Portugal, Spain, Italy and Turkey, CW is employed in the production of whey cheeses (Requeijão, Requesón, Ricotta and Lor, respectively) and other products with nutritional and medical potential. Normally, these products are typically obtained from ovine, caprine, bovine or buffalo cheese whey. CW can be previously acidified, as is the case of Ricotta, followed by heating at temperatures around 85–90 °C for 20–30 min, to allow coagulation and subsequent precipitation of whey proteins and separation of whey cheese mass. Whey cheese yield is quite variable depending on the origin of the whey and the process employed but, unless whey is previously concentrated, it is lower than 4%. The liquid remaining after whey cheese separation represents more than 90% of the original whey and is called second cheese whey (SCW), Sorelho in Portugal or Scotta in Italy, are the major by-product of whey cheese production.

Lactose (4.8–5.0%), salts (1.0–1.13%), and proteins (0.15–0.22%) generally compose SCW resulting from bovine milk. However, the protein and fat contents of SCW resulting from ovine milk can represent 1–4%. SCW is a poorly studied by-product and there is little interest in its recovery. Some authors studied the use of SCW for conversion into biofuel and as a biotechnological substrate for fermented products while others studied its potential for the production of fermented drinks. Dried SCW protein concentrate was also evaluated for its usefulness as food ingredient, based on the functional properties of their proteins. However, the available literature and research works concerning SCW are very limited.