ABSTRACT

Dairy products contain large amounts of cholesterol, ranging from 13.6 mg / 100 mL in whole milk and up to 248 mg / 100 g of butter, affecting consumer acceptability due to health concerns about cholesterol. The aim of this work was to develop environment friendly, economic and efficient method for cholesterol reduction from dairy cream with good nutritional and functional profile. The process technology for cholesterol removal by adsorption with β-cyclodextrin polymer (β-CDP) was successfully developed. The optimum conditions for synthesis of β-CDP was 2.47 citric acid (CA) to β-CD molar ratio; 0.2 sodium hypophosphite (SHP) to CA (molar ratio); 162 ^{o}C curing temperature and 20 min reaction time, which gave the purified yield of 64 % β-CDP with 26 % β-$CD_{(MO)}$. Presence of additional FTIR (Fourier transform infrared) peak at 1747 cm^{-1} indicated the formation of ester bonds and effective polymerization in β-CDP. X-ray powder diffraction pattern of β-CDP was markedly different from native β-CD, with no clear characteristic peaks, which indicated change from crystalline to amorphous crosslinked structure. The optimized process parameters for cholesterol extraction from cream using optimized β-CDP were 16 % β-CDP (w / v); 45 ^{o}C stirring temperature, 30 min mixing time and 970 rpm stirring speed, which yielded 74 % cholesterol reduction. Around 89 % of the β-CDP could be recovered after desorption of cholesterol from β-CDP-cholesterol complex at the end of 8th regeneration cycle. No significant difference in cholesterol reduction (74.2 - 74.1 %) was observed in cream when recycled β-CDP was applied for up to five times, which was identical to the unused crosslinked β-CD (74.2 %). No remarkable changes in the proximate composition and physico-chemical properties were observed in treated cream with respect to the control cream. Study of the rheological properties indicated that the dairy cream behaves as a non-Newtonian, shear thinning, pseudo-plastic fluid (gel like behaviour). The apparent viscosity of processed cream was higher than control with the values of 0.42 Pa.s and 0.34 Pa.s, respectively at the shear rate of 100 / s. Carreau model best explained the complex flow behaviour of cream (with $r^2 > 0.99$). Developed pasteurized product remained acceptable with respect to physico-chemical properties upto 10 days of refrigerated storage. The optimized supercritical fluid extraction (SCFE) conditions of 75 ºC, 204 bar, 3.5 h dynamic time and 5 L / min flow rate of CO_2 yielded 39 % reduction in cholesterol content and 10.6 % reduction in total fat content of the cream powder, with no significant changes in other physico-chemical characteristics. The FT-NIR (Fourier transform near infrared) second derivative partial least square (PLS) regression model in the spectral region of 6101.9 to 5446.2 cm^{-1} was the most robust for quantification of cholesterol from dairy powders with the best performance indicators (r^2 validation = 0.9998, RMSECV = 1.05 mg cholesterol / 100 g, rank = 6). Zeutec NIR (near infrared) chemometric analysis of fat content in milk and cream samples was completed using multiple linear regression (MLR) model using 6 factors (r^2 of 0.9988 and RMSECV of 0.799 g / 100 g).

Keywords: β-CD (β-Cyclodextrin), cholesterol, regeneration efficiency, supercritical fluid extraction (SCFE), NIR spectroscopy