Original effects of sphingomyelin on liposomal properties clarified by comparing crude and highly purified sphingomyelin

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Sphingomyelin (SM) is expected to form rigid lipid bilayers due to its ceramide backbone and hydrophilic headgroup, having a high potential as a carrier for drug delivery systems and cosmetics in terms of its high water-retention ability and skin affinity property. However, previous studies have mainly focused on pharmacological studies of drug disposition in the body [1][2] , and detailed studies of the membrane structure and properties of liposomes remain limited. In our previous study, liposomes mixed with crude SM (purity: 70%) showed high dispersion stability and trapping efficiency while maintaining membrane fluidity. In this study, highly purified SM was used to clarify the original effects of SM on liposomal membrane properties.
Dipalmitoylphosphatidylcholine (DPPC) was used as a phospholipid, highly purified milk-derived sphingomyelin (SM, purity 99%) was used as SM. Dicetyl phosphate (DCP) and sodium β-sitosteryl sulfate (PSO_4) were used as charged additives. Liposomes (5 mM total lipid concentration) with DPPC/charged substance/SM molar ratios of 10 : x : y (x = 0, 1; y = 0, 1) were prepared by the Bangham method.
Visual observation showed that phase separation occurred after one week in the DPPC/ SM system, whereas homogeneous dispersion maintained in the systems containing charged additives. Dynamic light scattering measurements showed that the particle size of DPPC/SM liposomes increased over time, but it remained almost constant for one week when charged additives were added because the zeta potentials were largely negative. The addition of SM and charged additives to DPPC increased the trapping efficiency. In particular, the trapping efficiency in the DPPC/PSO_4/SM system was more than 10%.
Compared with the previously systems using crude SM, the highly purified SM systems showed lower dispersion stability, suggesting that negatively charged components in crude SM affected the dispersion stability. In contrast, the trapping efficiency of liposomes prepared using highly purified SM was higher than that of liposomes in the crude SM systems. This finding suggests differences in bilayer structure and bilayer numbers between liposomes containing crude SM and those containing highly purified SM.

Keywords:
sphingomyelin, liposome, bilayer membrane, stabilization

References:

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