Structural study on the effects of poly- unsaturated and mono-unsaturated diacylglycerols on phosphatidylcholine bilayer membranes

Hiroshi TAKAHASHI*[1], Ichiro HATTA[2]
[1]Dept. Physics, Gunma Univ. Maebashi 371-8510, Japan
[1]Dept. Applied Physics, Nagoya Univ. Nagoya 464-8603, Japan

Introduction

In cell signaling processes, 1,2-diacylglycerol (DAG) is one of the most important lipid second messenger, as acting the activator of protein kinase C (PKC). In cell membranes, DAG is produced from the hydrolysis reaction of glycerophospholipid. Recent biochemical study [1] has revealed that the efficiency of activation of PKC by DAG depends on the kinds of source glycero-phospholipids. That is to say, the DAG produced from phosphatidylinositol 4,5-bisphosphate (PIP_2) has a higher ability to activate PKC than the DAG produced from phosphatidylcholine (PC). In eukaryotes, the acyl chains of PIP_2 are mainly poly-unsaturated and on the other hand, the acyl chains of PC are mainly composed of mono-unsaturated and saturated ones. In this connection, model system studies have shown that poly-unsaturated DAGs activate more efficiently PKC than mono-unsaturated DAGs [2,3]. It has been discussed that the higher ability of poly-unsaturated DAGs to activate PKC may reflect the physical effects of their poly-unsaturated acyl chains on bilayer structure [4].

In order to clarify the difference between the effects of poly-unsaturated DAG and mono-unsaturated DAG on the bilayer structure, we compared the structural effects of 1-strearyl-2-arachidonoyl-glycerol (SAG) and 1-palmitoyl-2oleoly-glycerol (POG) on the 1-palmitoyl-2-oleolyl-phohatidylchoine (POPC) bilayers by means of small angle X-ray diffraction. SAG and POG have four and one double bonds in their acyl chains, respectively. POPC is the first major component of the plasma membrane in animal cells

Materials and Methods

All diacylgylcerols and phospholipids used in this study were obtained from Avanti Polar Lipids, Inc (Alabaster, AL, USA) and used without further purification. The molar ratio of PC : DAG was 7:3. X-ray diffraction measurements were performed at the beamline 15A of the Photon Factory. The temperature of the samples was controlled using a modified calorimeter (FP84, Mettler, Hightstown, NJ)

Results and Discussion

Figure 1 shows small angle X-ray diffraction patterns of POPC-POG and POPC-SAG systems recorded during temperature scan at the rate of 2.0 °C/min. For both systems, the formation of cubic phases is observed above about 60 °C. Main difference is that the formation of inverted hexagonal phase is observed only for the POPC-POG system. Even at 40 °C, the diffraction peaks originated from inverted hexagonal phase appears for the POPC-POG system. Further detailed analysis is now in progress to determine the structural difference of the cubic phases for both systems.

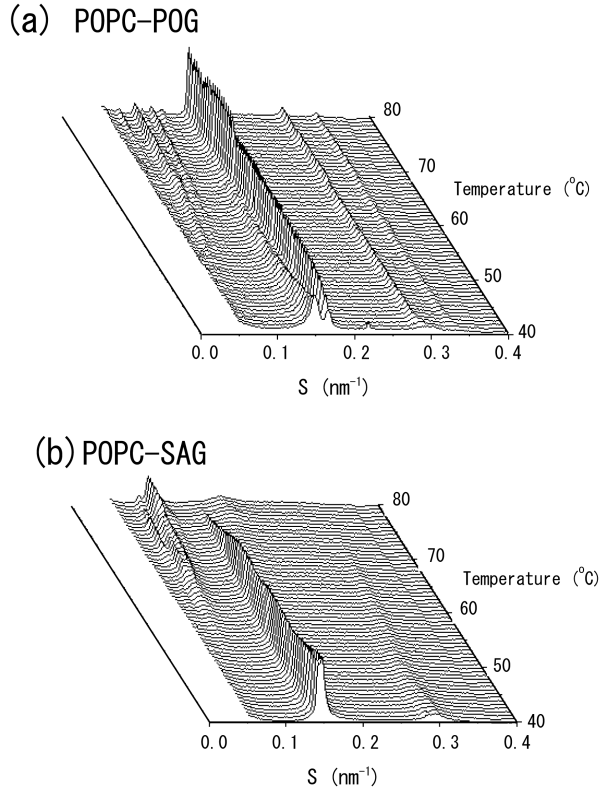

Fig.1 Three-dimensional representations of X-ray diffraction patterns of (a) POPC-POG and (b) POPC-SAG systems recorded during heating scan.

References

[1] T. R. Pettitt et al., J. Biol. Chem. 272, 17354 (1997).
[2] P. A. Marignani et al., Biochem. Biophys. Res. Commun. 225,469 (1996)
[3] J. B. Schacter et al. Biochim. Biophys. Acta 1291. 167 (1996).
[4] M. N. Hodgkin et al, Trend. Biochem. Sci. 23, 200 (1998)

* htakahas@fs.aramaki.gunma-u.ac.jp