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Lecithin biotransformation into various lysolecithin-fatty acid liposomes by Thermostable Phospholipase A2 from Sciscionella marina as a key enzyme

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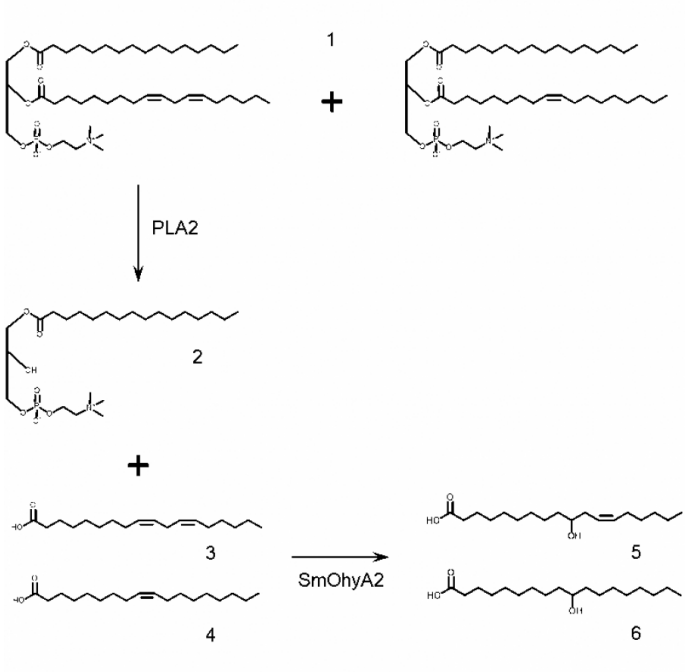
PURPOSE OF THE ABSTRACT
The phospholipase A2 (PLA2) hydrolyzes the sn-2 acyl bond of lecithin and phospholipids in a Ca2+-dependent manner [1]. The PLA2 from porcine pancreas, which is the most widely used in industry, is unstable at high temperatures. Herein, we investigated molecular characterization of PLA2 originated from marine bacterium, Sciscionella marina (SmPLA2). The X-ray crystallography study revealed that SmPLA2 is composed of five helixes containing two disulfide bonds and one Ca2+-binding site, which is similar to that of the PLA2 from Streptomyces violaceoruber (SvPLA2) [2]. Notably, the SmPLA2 was more thermo-stable than SvPLA2 and porcine PLA2, probably due to Ca2+-binding loop's anchoring by Trp41 into the rest of the protein body.

The lecithin biotransformation into lysolecithin-fatty acid liposomes by SvPLA2, SmPLA2, and porcine PLA2 was investigated. The SmPLA2 led to the production of the lysolecithin-fatty acids to the highest concentration due to greater thermal stability. The 200 g/L lecithin were transformed into lysolecithin and fatty acids to a conversion of over 80%. The resulting fatty acids in lysolecithin liposomes could be further transformed into various fatty acids derivatives such as hydroxy fatty acids, hydrocarbons, and secondary fatty alcohols in lysolecithin liposomes by combinatorial reactions of a fatty acid double-bond hydratase from Stenotrophomonas maltophilia (SmOhyA2) [3] and a photoactivated decarboxylase from Chlorella variabilis NC64A (CvFAP) [4] (Fig. 1 and 2). The resulting lysolecithin-fatty acid liposomes were approximately 100 nm in diameter, globular in shape, and monodispersed.

Comparing lysolecithin-fatty acids liposomes to lecithin liposomes, they had equal levels of emulsifying activity and encapsulation efficiency. The antibacterial effects against Porphyromonas gingivalis were also examined by measuring minimal inhibition concentration (MIC). Lysolecithin-fatty acids liposomes showed significantly greater antibacterial activity against P. gingivalis, compared to the free form of fatty acids and lecithin liposome. This study will contribute to lecithin and phospholipid biotransformations into various lysolecithin-fatty acid liposomes for food and cosmetic industries.

FIGURES



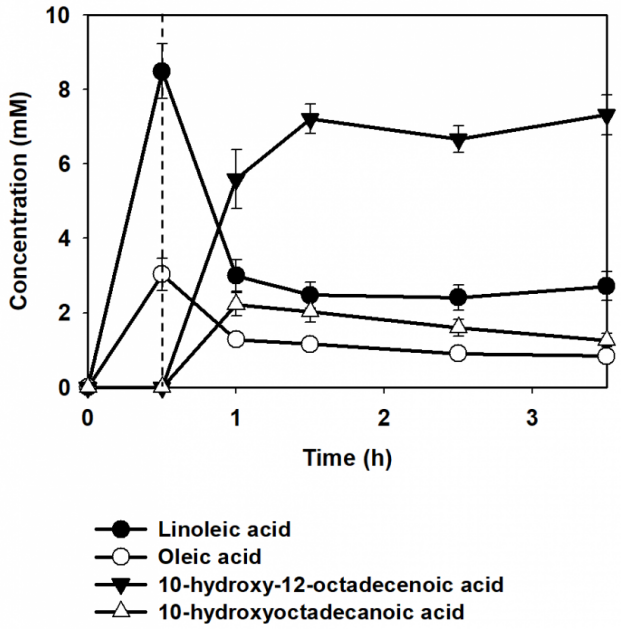


FIGURE 1

Biotransformation of lecithin (1) into lysolecithin (2) and free fatty acids (3 and 4) and into hydroxy fatty acids (5 and 6).

The cascade reactions were catalyzed by a phospholipase A2 (PLA2) and a fatty acid double bond hydratase from S. maltophilia (SmOhyA2).

FIGURE 2

Time course of soy lecithin (1) biotransformation into lysolecithin (2) and hydroxy fatty acids (5 and 6) via lysolecithin (2) and free fatty acids (3 and 4).

The biotransformation of soy lecithin (1) into lysolecithin (2) and hydroxy fatty acids (5 and 6) was carried out by the cascade reactions by PLA2 and SmOhyA2.

KEYWORDS

phospholipase A2 | Sciscionella marina | crystal structure | biotransformation

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