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Enzymatic oxidation of plant oils to C18 trihydroxy fatty acids at high concentrations by lipoxygenase and epoxide hydrolase

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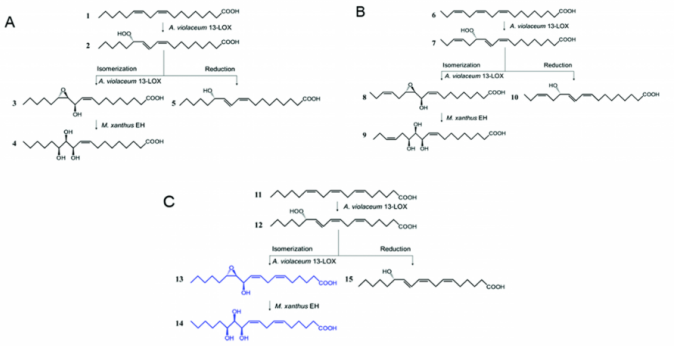
PURPOSE OF THE ABSTRACT

Plant oxylipins, including C18 Trihydroxy fatty acids (THFAs), use as antifungal agents and adjuvants for vaccine. They have been synthesized by chemical methods, which have disadvantages such as low yields by multi-step reactions and cause of environmental pollution. However, the synthesis of THFAs by microorganisms and plants show still too low concentrations and productivities for industrial synthesis. Here, recombinant Escherichia coli cells co-expressing bacterial linoleate (LA) 13-lipoxygenase with high isomerization activity and epoxide hydrolase converted 200 mM of LA, α-linolenic acid (ALA), and γ-linolenic acid (GLA), into 11R,12R,13S-THFAs via epoxy hydroxy fatty acids with high molar yields (>60%) in a baffled flask. In the conversion, GLA-derived 12S,13S-epoxy-11R-hydroxyoctadecadienoic acid and 11R,12R,13S-trihydroxyoctadecadienoic acid were identified as new compounds by NMR analysis. For the production of THFA from safflower oil as LA source, the content of LA in safflower oil hydrolyzate was increased by adding adsorbent resin SP207 to the hydrolysis reaction of safflower oil by lipase because palmitic acid and glycerol were removed through selective binding of the resin. The resin-treated safflower oil hydrolyzate containing 250 mM LA, which was obtained from 93 g L−1 safflower oil, was converted into 230 mM 11R,12R,13S-trihydroxyoctadecenoic acid in 24 h, with a productivity of 9.6 mM h−1 and a molar yield of 92% by the recombinant cells in a bioreactor. Therefore, we succeeded in the cost-effective, efficient, and environmentally friendly biotransformation of safflower oil into THFAs.

FIGURES



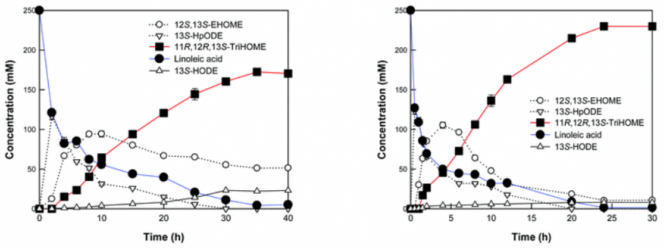


FIGURE 1

Fig. 1. Production of trihydroxy fatty acids by whole recombinant E. coli co-expressing A. violaceum LA 13S-LOX and M. xanthus EH.

(A) Production of 11R,12R,13S-trihydroxy-9Z-octadecenoic acid (11R,12R,13S-TriHOME) from linoleic acid (LA) via 12S,13S-epoxy-11R-hydroxy-9Z-octadecenoic acid (12S,13S-EHOME). (B) Production of 11R,12R,13S-trihydroxy-9Z,15Z-octadecadienoic acid (11R,12R,1

FIGURE 2

Fig. 5. Time-course reactions for the production of 11R,12R,13S-TriHOME from LA in safflower oil hydrolyzate by whole recombinant E. coli cells co-expressing A. violaceum LA 13S-LOX and M. xanthus EH under the optimized reaction conditions.

(A) Biotransformation of LA in safflower oil hydrolyzate obtained without absorbent resin into 11R,12R,13S-TriHOME. (B) Biotransformation of LA in safflower oil hydrolyzate obtained from absorbent resin treatment into 11R,12R,13S-TriHOME.

KEYWORDS

biotransformation | C18 trihydroxy fatty acid | lipoxygenase | epoxide hydrolase

BIBLIOGRAPHY