



Digestion characteristics of structural lipid monomers rich in α -linolenic acid from silkworm pupae oil

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Introduction

Silkworm pupae oil (SPO) extracted from silkworm pupae is considered to be an important source of α -linolenic acid (ALA). As an essential fatty acid, ALA accounted for more than 35% of the total content of SPO, so it has good auxiliary functions of lowering blood lipid, lowering blood sugar and antioxidant. Therefore, the study on the digestion characteristics of TAG monomer of SPO in vitro is helpful to guide the intake and supplement of structural lipids rich in ALA. In vitro digestion model is to simulate human gastrointestinal environment in vitro under appropriate conditions, and reflect the bioavailability of absorbed substances by detecting the concentration change of target substances. The in vitro digestion model of pH-stat simulates the digestion process of oil in small intestine with short time, high efficiency, simple operation and easy control. the maximum digestibility of lipids and the first-order kinetic rate constant were used to study the digestibility of TAG monomers in SPO in pH-stat system.

Methods

The separation and preparation of TAG is one of the important steps in this study. According to the difference of polarity, reversed-phase high-performance liquid chromatography (RP-HPLC) was used to analyze and prepare different TAGs. In the semi-preparative liquid chromatography system, acetonitrile and isopropanol were used as mobile phases, and different TAG monomers were separated and purified from SPO by gradient elution. In vitro digestion model is to simulate human gastrointestinal environment in vitro under appropriate conditions, and reflect the bioavailability of absorbed substances by detecting the concentration change of target substances. The in vitro digestion model of pH-stat simulates the digestion process of oil in small intestine with short time, high efficiency, simple operation and easy control.

Results & Discussion

The results showed that seven kinds of TAGs were successfully separated from SPO by semi-preparative chromatography. As TAG monomers rich in ALA, LnLnLn, LnLnL and LnLnO can be used for the study of in vitro digestion characteristics in later stage.

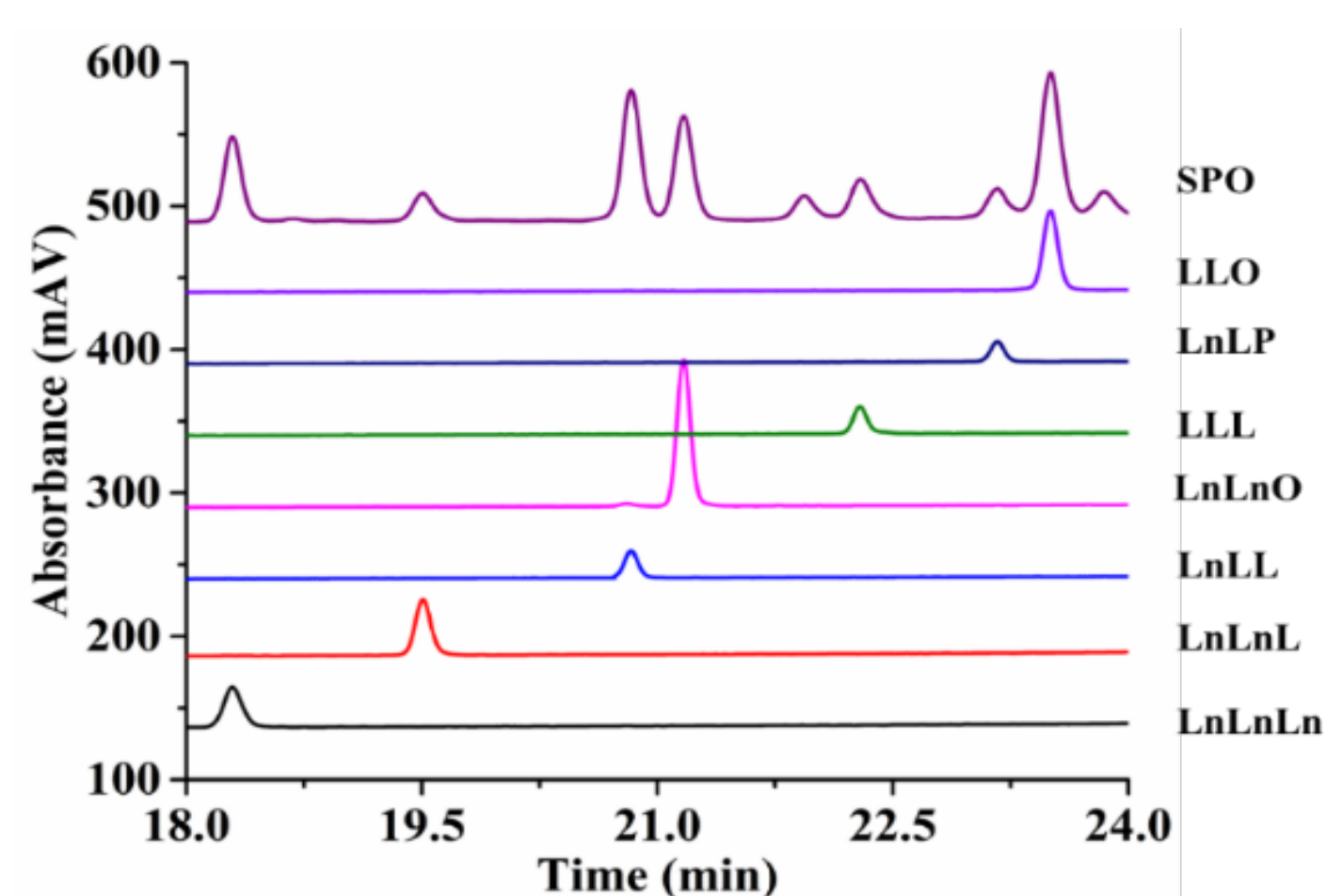


Fig. 1 HPLC-ELSD chromatograms of TAG monomers in SPO.

Acknowledgement

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References

- [1] Wan L T, Li L, Harro J M, et al. *Journal of Agricultural and Food Chemistry*, 2020, 68(26):7062-7071.
- [2] Ji C M, Shin J A, Hong S T, et al. *Nutrients*, 2019, 11(6783).
- [3] Hu B, Li C, Zhang Z Q, et al. *Food Chemistry*, 2017, 231:348-355.

Fig. 2A shows the FFA release curves of PPP, OOO, LLL and TOA in the pH-stat system within 30 min. The rate of digestion increases rapidly in the first 5 min of in vitro digestion, then gradually slows down and stabilizes at the maximum FFA release. The maximum degree of hydrolysis from PPP, OOO, LLL and TOA was $76.41 \pm 0.42\%$, $91.40 \pm 2.90\%$, $77.45 \pm 6.51\%$ and $94.01 \pm 3.37\%$. The maximum hydrolysis degree of OOO and TOA was higher than that of PPP and LLL, indicating that OOO and TOA were more easily hydrolyzed by lipase within 30 min of simulated in vitro digestion.

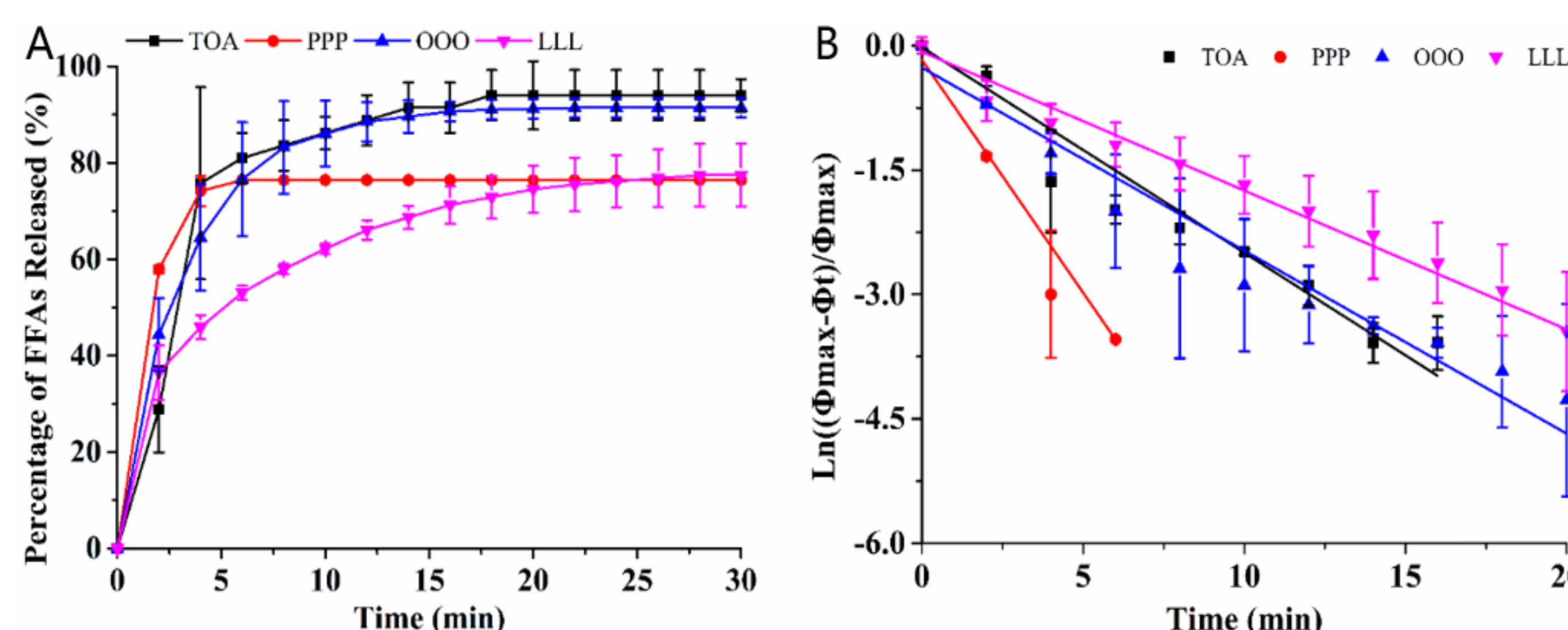


Fig. 2 Digestion of pH Stat system in vitro of silkworm pupa oil. (A) Levels of total FFAs released from PPP, LLL, OOO and TOA within 30 min. (B) The first-order linear shape of FFA release profiles as calculated from equation. (P, palmitic acid; O, oleic acid; L, linoleic acid; TOA, tricaprylin)

The first-order apparent rate constant k in Fig. 2B represents the rate of digestion hydrolysis, showing a good linear relationship over 20 min ($R^2 > 0.95$). The first-order kinetic apparent rate constants of PPP, OOO, LLL and TOA were 0.5615 s^{-1} , 0.2207 s^{-1} , 0.1673 s^{-1} , and 0.2475 s^{-1} . The hydrolysis rate of PPP is higher than the other three lipids, because PPP contains saturated fatty acid palmitic acid, and studies have shown that saturated fatty acids are easily hydrolyzed.

Conclusion

In summary, the digestion characteristics of TAG monomers with different fatty acid composition are significantly different. Therefore, the study of the digestion characteristics of different TAG monomers of SPO is very important to fully understand the function of SPO, and can provide necessary theoretical basis for the development of efficient supplement of ALA structural lipids.