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Synthesis of eco-friendly amino acid biosurfactants and characterization of interfacial properties for cosmetics and household products

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Highlights

- Amino acid biosurfactants were prepared from readily biodegradable coconut oil.
- Newly synthesized biosurfactants possess superior interfacial properties.
- Synthesized biosurfactants are nontoxic, non-irritating, mild, and biodegradable.

1. Introduction

Currently, most of the surfactants widely used in various areas of industrial applications are prepared from petroleum base. These synthetic chemical surfactants have been known to be non-biodegradable, irritating, not mild and also detrimental to aquatic organisms. Strict environmental restrictions and rising recognition for the requirement to preserve the environment have leaded to growing attention in biosurfactants as a potential substitute to petroleum based surfactants. Biosurfactants have been known to possess merits over petroleum based surfactants in uniqueness, variety, selectivity, convenience of production, mildness and high efficiency even at harsh operation conditions such as high temperature and extreme high or low pH. Amino acid based biosurfactants are frequently used in detergents, household products, cosmetics, pharmaceuticals, personal care products, food ingredients, and so on due to their extremely low toxicity and excellent biodegradability [1]. In this work, 2 types of anionic amino acid based biosurfactants such as potassium cocoyl glycinate CGK and sodium cocoyl glycinate CGN were synthesized using nontoxic and readily biodegradable coconut oil derived from natural resources.

2. Methods

The structure of the resulting products was elucidated by FT-IR, ^{1}H NMR, and ^{13}C NMR spectroscopies and environmental compatibility such as biodegradability and acute oral toxicity was evaluated. The interfacial characteristics of the synthesized surfactant including surface tension, critical micelle concentration, interfacial tension, wetting property, emulsification activity, viscosity and foam property have been examined. Biodegradability, acute dermal irritation, acute eye irritation and acute oral toxicity have been measured for the newly synthesized surfactants in order to investigate environmental compatibility for cosmetics application. Detergency tests were also carried out with synthesized amino acid biosurfactants to examine the possible uses in detergent application.

3. Results and discussion

The measurement results of interfacial properties for the newly synthesized biosurfactants indicated that the prepared surfactants have excellent interfacial properties. Detergency test has been performed with newly synthesized surfactants by using an agitation/mixing type detergency tester at room temperature. The results suggested that the newly synthesized surfactants show moderately good detergency. Acute oral toxicity (LD_{50}) measurement showed that newly synthesized surfactants are very mild compared with conventional nonionic and anionic surfactants used in detergent and cosmetic formulations such as polyoxyethylene (9) lauryl ether (PLA) and dodecylbenzene sulfonic acid (LAS). The primary biodegradability of newly synthesized surfactants has been found to be greater than 95%, suggesting that newly synthesized surfactants are acceptable for cosmetic and detergent applications. Both acute dermal irritation and acute eye irritation tests revealed that surfactants are mild. In particular, the prescription test in shampoo formulation prepared with synthesized biosurfactants indicated better sensory feeling and excellent foaming ability compared with conventional surfactants used such as silicon. The patch test also indicated no irritation during 48 hours, indicating potential applicability in cosmetic and household products.

4. Conclusions

In this study, 2 types of anionic amino acid based biosurfactants such as CGK and CGN were synthesized using coconut oil and the structure identification of the CGK and CGN was carried out by FT-IR, ^{1}H NMR, and ^{13}C NMR spectroscopies. The interfacial properties of CGK and CGN surfactant systems have been evaluated such as CMC, static and dynamic surface tensions, emulsification activity, wetting property and foam property. The results suggested that both CGK and CGN surfactant systems possess superior interfacial properties. Washing test carried out with a Terg-o-tometer indicated relatively good detergency when comparing with surfactants employed in detergent formulation. Acute oral toxicity evaluation indicated that both CGK and CGN surfactants are nontoxic compared with PLA and LAS. Both acute dermal irritation and acute eye irritation tests showed that both CGK and CGN surfactants are non-irritating and very mild and the primary biodegradability of CGK and CGN evaluated using an activated sludge test KSM 2714 has been found to be 99% in both surfactants. In particular, CGK surfactant can be considered as a strong candidate for the potential applicability in detergent products formulation since CGK surfactant is very effective in lowering interfacial free energy, nontoxic, non-irritating, mild, and readily biodegradable.

References

[1] S. Vijayakumar, V. Saravanan. Res. J. Microbiol. 10 (2015) 181-192.

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