Synthesis and characterization of novel biocompatible palm oil-based alkyds

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Novel alkyds of short, medium, and long oil length were synthesized using a two-stage alcoholysis-polyesterification method from bio-sourced starting materials. Alcoholysis reaction mixtures of palm kernel oil and glycerol underwent transesterification to convert triglycerides to monoglycerides within 3 h. Kinetic studies showed that the polyesterification reaction rates obeyed second order kinetics up to 15 min, followed by chain branching and crosslinking. The alkyd chemical structure was confirmed by nuclear magnetic resonance and Fourier Transform infrared spectroscopy. Gel permeation chromatography revealed that the average molecular weight of the alkyds was confined to <2,000 Da which is advantageous for the production of nanoscale drug carriers. Differential scanning calorimetry showed that the alkyds possess low glass transition temperatures within a very narrow range of −49.3°C—52.7°C. Thermogravimetric analysis revealed good thermal stability with alkyd degradation occurring above 200°C. Cell viability assay confirmed that the alkyds were non-toxic to 3T3 mouse fibroblasts following exposure of cell cultures for 24 h to solutions of concentration ranging from 3 to 100 μg/mL. These findings highly recommend consideration of the novel, bio-sourced alkyds for pharmaceuticals manufacture and controlling drug delivery.

Practical applications: A family of short, medium, and long oil length alkyds was synthesized as novel biomaterials from fully bio-sourced and renewable starting materials. The alkyds are characterized by molecular weights below 2,000 Da, low Tg around −50°C
and high thermal stability. The alkyds to exhibit favorable biocompatibility as demonstrated by non-toxicity towards to 3T3 mouse fibroblasts in cell culture. Thus the novel bio-sourced alkyds offer significant potential as excipients for pharmaceuticals manufacture and controlling drug delivery.

Novel biocompatible palm oil-based alkyds are investigated through synthesis reaction, kinetic study, and characterization tests. Alkyd synthesis involved two-stage alcoholsysis-polyesterification reactions to produce short, medium, and long oil length alkyds. In the kinetic study of polyesterification reaction, water released was collected and acid value was determined with the results indicating high yield of alkyds with 97–98% of extent of polyesterification. The characterization of alkyds are carried out using spectroscopic, end group, thermal, and chromatographic analysis, plus biocompatible assay. The proposed chemical structure of the alkyd chain is determined from FTIR and NMR spectroscopy analysis. End group analysis indicated low acid groups but high hydroxyl numbers. Thermal analysis revealed the Tg ranged from −49.3°C to −52.7°C (DSC test) and thermal stability up to 200°C (TGA test). Average molecular weight is found to be less than 2,000 Da from GPC measurement or chromatographic analysis. All alkyds exhibited non-toxic to 3T3 mouse fibroblast via biocompatible - cell viability assay.