SUMMARY

Oil droplets present in the palm oil mill sludge effluent were recovered and purified. The lipid composition of the oil droplets was systematically fractionated and characterised using various analytical and chromatographic techniques. Various plant lipids were found to be present. They were neutral lipids (84 wt %), phospholipids (10 wt %) and glycolipids (6 wt %). The lipids in total was determined to have surface activity comparable to that of lecithin. The major fatty acids present in the phospholipids and neutral lipids were the C16:0 and C18:0. From a comparison of the composition and quantity of the lipids, it is deduced that oil droplets found in the sludge were formed during the milling process and were not indigenous oil droplets of the palm fruit mesocarp. The accumulated surface active lipids at the oil/water interface could possibly be advantageously recovered as a source of natural emulsifiers from the palm fruit.

The surface activity of palm oil was studied with respect to its interfacial tension with water. The interfacial tensions of the refined palm oil/water system depend on the type of the refining process. The interfacial tension at the the palm oil/water interface was significantly different at various stages of

refining. Carotene, cholesterol, diglycerides and fatty acids added to the palm oil did not result in any significant changes in the interfacial tension of the palm oil/water system while phospholipids and monoglycerides decreased it significantly. For the monoglycerides, the chain length and degree of unsaturation of the alkyl chain in the molecule had a marked effect on the surface activity as follows: C12:0>C14:0≅C16:0>C18:0 while C16:1>C16:0 and C18:2>C18:3>C18:1>C18:0. These fundamental data obtained are important in understanding emulsion formation and stability.

Many natural and synthetic emulsifiers can possibly be used to emulsify palm oil. In this study an attempt was made to determine the Hydrophilic Lipophilic Balance (HLB) of palm oil by emulsifying palm oil using various mixtures of Span 40 and Tween 40 of various HLBs. There was no clear indication of an optimum HLB value for this combination of emulsifiers in enhancing emulsion stability although there were indications that mixture of HLB greater than 10 produced stable emulsions.

Tween 40 alone was found to be a suitable emulsifier for emulsification of palm oil in water. Very low concentration of as low as 0.15 wt % in oil is sufficient to produce relatively stable emulsions containing very fine oil droplets. The diameter of

the droplets range from 1 to 30 μm in the emulsions. The mean diameter of the droplets ranges from 10.8 to 8.9 μm for emulsions prepared using 0.15-5.0% Tween 40 in the oil at 23 wt % oil. At a fixed concentration of 1 wt % Tween 40 in oil, the mean droplet size decreased from 10.5 to 8.0 μm as the phase volume of the oil ϕ was increased from 0.15-0.57. There was no inversion of the oil-in-water emulsions even at phase volume,ϕ of 0.7. The stability of the oil droplets was attributed to the complete coverage of the droplet surface by the four well spread out hydrated hydrophilic hydroxyl polyoxyethylene chains of the Tweeen 40 molecule.

Emuldan, a commercial monoglyceride was found to form stable emulsions or mesophases with palm oil (olein) and water. Products ranging in consistency from liquid, paste and solid like were obtained. Their diversed viscous and viscoelastic behaviour were characterised. The rheological properties were not significantly different from those of the binary system of Emuldan in water.

At the low concentration regime of 3.3-7.7 wt % Emuldan in water 5-30 wt % olein could be incorporated in droplet form resulting in viscous emulsions in which stable oil droplets and dispersions of monoglycerides were formed as can be seen from the particle size distribution. The diameter of the oil droplets was

bigger (1-20 μm) than the Emuldan dispersions (<1 μm). The emulsions formed were pseudoplastic and its viscosity was found to fit the rheological model of Herschel Bulkley.

At the higher concentration regime of 12.5-27.3 wt % Emuldan in water, with incorporation of 5-30 wt % olein, viscoelastic products were formed. A critical stress value was noted for these samples indicating some form of structure formation. The critical stress value ranges from 5 to 300 Pa and were proportional to the concentration of Emuldan in water. At the linear viscoelastic region, the storage moduli G' was always higher than the loss moduli G", indicating that the samples were more elastic than viscous. The mechanical spectra showed that G' and G" were not strongly dependent on frequency indicative of the existence of some form of structures with small possibility of structure change within the corresponding frequency of 0.05-100 rad/s studied.

Samples of the binary system containing Emuldan in water showed different optical structures when observed under the polarising microscope. At low concentration of 3 and 5 wt % Emuldan in water optical texture typical of lamellar crystalline structure characterised by the appearance of Maltese crosses was observed. At higher

concentration of 15-30 wt % Emuldan in water a straited type of lamellar liquid crystalline structure was observed. However, no obvious optical texture was observed in the ternary system of Emuldan,water and olein.