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Adhesive force between paired microdroplets coated with a lipid monolayer depending on the structure of sugar

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1. Introduction To clarify the effect of barrier recovery of skin with the addition of sugar as a “non-genomic effect”^[1], we conducted a study by using an artificial membrane system^[2]. Actually, we created pairs of adhering water-in-oil (W/O) microdroplets coated with lipid monolayers and studied the physicochemical interaction between sugar and lipid.

2. Experiments 1,2-dioleoyl-*sn*-glycero-3-phosphocholine (DOPC) monolayer was used as an artificial membrane. To obtain W/O microdroplets, water (or sugar solution) was added to the lipid-in-oil solution, and emulsification was performed by pipetting. The contact angle θ of pairs of adhesive W/O microdroplets was obtained by analyzing the shape of the droplets (Fig.1), and the interfacial tension γ was measured using the Wilhelmy method. The adhesive force ΔF was obtained from γ and θ based on the Young - Dupre equation ($\Delta F=2\gamma(1-\cos\theta)$). We measured the infrared absorption spectrum of the dry films of sugar /phospholipid by ATR FT-IR and performed molecular mechanics calculations (MM2).

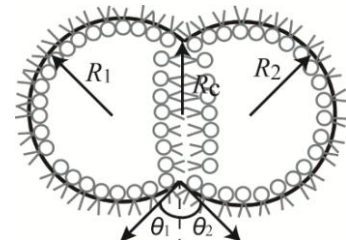


Fig.1. Schematic representation of adhering droplets.

3. Results and discussion The analyzed contact angle θ are summarized Fig.2. The average value for fructose was smaller than the others. The interfacial tension γ did not change with the addition of sugar. Therefore, the adhesive force ΔF for fructose droplets was weaker than those for disaccharide droplets. As a result of ATR FT-IR measurement, the peak around 1100 cm^{-1} , which corresponds to the ether anti stretching vibration of DOPC, changed with the addition of fructose. It suggests that fructose may exist in the hydrophobic group side of the membrane phospholipid and increase the intermolecular distance between phospholipids. On the other hand, disaccharide may be difficult to intrude into the lipid bilayer since the size of disaccharide is larger than that of fructose.

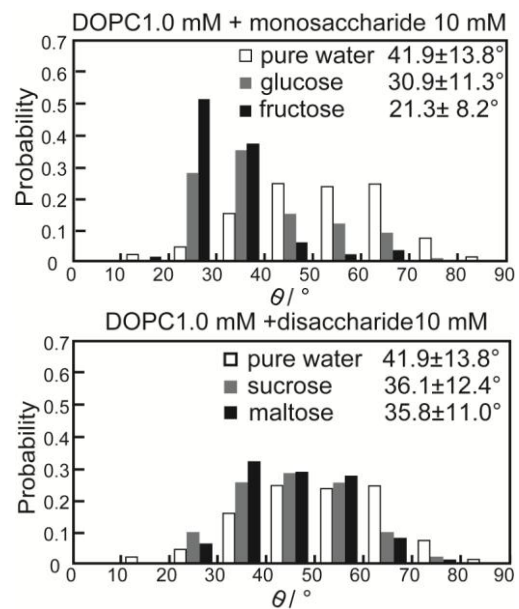


Fig.2. Histograms of the contact angle, θ .

References

- [1] M. Tsutsumi et al, *British Journal of Dermatology*, **157**, 776-779 (2011).
- [2] S. Nakata et al, *Colloids and Surfaces A*, **405**, 14-18 (2012).