$$\eta = \frac{FF \times J_{SC} \times V_{OC}}{I_{in}} \times 100 \quad (1)$$

where J_{sc} is the short-circuit photocurrent density (mA cm^{-2}), V_{oc} is the open-circuit voltage (volts), I_{in} is the intensity of the incident light (W cm^{-2}) and FF is the fill factor defined as

$$FF = \frac{i_{max} \times V_{max}}{i_{OC} \times V_{OC}} \quad (2)$$

where i_{max} and V_{max} are the maximum photocurrent and voltage of the I-V characteristics and i_{oc} is the open-circuit current (mA).

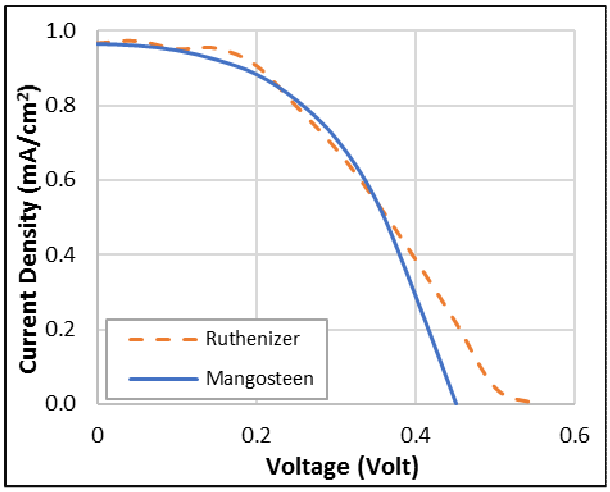

Fig. 8 Photocurrent-voltage characteristics of the DSSC with sensitizer from the commercial dye (dash line) and from the mangosteen extracted natural dye (solid line)

Based on the extrapolation of the graphs obtained from the photocurrent-voltage examination, the efficiency is found to be 0.23% and 0.18% for the device sensitized using the commercial dye and the mangosteen extracted dye, respectively. Detail of this calculation is given in Table 1. Although the efficiency is still low, the current result is still convincing and promising for the next development considering the abundant resources of this natural dye.

TABLE I
POWER CONVERSION EFFICIENCY (PCE) OF THE DSSC DEVICE SENSITIZED USING NATURAL DYE AND RUTHENIZER

	Natural Dye	Ruthenizer
V_{oc} (Volt)	0.45	0.55
I_{oc} (mA)	0.97	0.97
V_{max} (Volt)	0.20	0.25
I_{max} (mA)	0.89	0.92
FF	0.44	0.46
PCE (%)	0.18	0.23

IV. CONCLUSIONS

The results from infrared characterization showed that all of the mangosteen extracted dyes indicate have the same tendency with the characteristic of anthocyanin. However, the results from UV-Vis examination showed that HCl 1% acidified ethanol was found to have a visible light absorption at a wavelength of 533 nm, therefore it could the best solvent to extract anthocyanin from mangosteen pericarps. The activity from the photocurrent-voltage examination showed a power conversion efficiency of 0.23% and 0.18% for the device using the commercial dye and the mangosteen extracted dye, respectively. This result is convincing and promising for the next DSSC device development using natural dyes.

NOMENCLATURE

DSSC	dye sensitized solar cells	
FF	fill factor	
FTIR	Fourier transform infrared	
I_{in}	intensity of the incident light	mW cm^{-2}
I_{max}	maximum photocurrent of DSSC	mA
i_{OC}	open-circuit current	mA
J_{SC}	short-circuit photocurrent density	mA cm^{-2}
PCE	power conversion efficiency	
UV-Vis	ultraviolet visible	
V_{max}	maximum voltage of DSSC	V
V_{OC}	open-circuit voltage	V
η	efficiency of DSSC	%

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