

Globally, approximately 164 million tonnes of dry mass of oil palm fronds are produced each year (Sauvant *et al.*, 2015). At present, oil palm leaves are used as fodders or left to decompose in the field.

Recently, oil palm leaves have been proven to exhibit various nutraceutical and nutricosmetic properties such as:

- anti-hypertensive (Jaffri *et al.*, 2011b);
- anti-cancer (Vijayarathna and Sasidharan, 2012);
- kidney protective (Jaffri *et al.*, 2011a; Rajavel *et al.*, 2012);
- enhance bone calcium content (Bakhsh *et al.*, 2013);
- memory enhancing and neuroprotective (Mohamed *et al.*, 2013); and
- accelerates wound healing (Sasidharan *et al.*, 2010).

NOVELTY

There are no water-dispersible or water-soluble formulations of oil palm leaves based functional ingredient available in the market. Water solubility is one of the most important properties of food ingredient for the development of convenient, instant and functional foods. The current technology presents a novel process for the production of polyphenol rich powder from oil palm leaves (OPAL) where its water solubility could be adjusted. OPAL powder provides stabilised polyphenols (especially catechin) in a convenient form for better storage, formulations and delivery of active compound. OPAL polyphenols powder has also been assessed to be pleasant in taste and bear similarity with green tea. This technology has been patented in 2015 entitled *Methods for Producing Water Soluble Oil Palm Leaves Powder and Concentrate* (PI 2015000731, PCT/MY2016/000008).

ADVANTAGES OF THE TECHNOLOGY

1. Water solubility provides significant advantages and friendliness in food product formulation, incorporation and delivery of active compounds (Figure 1).

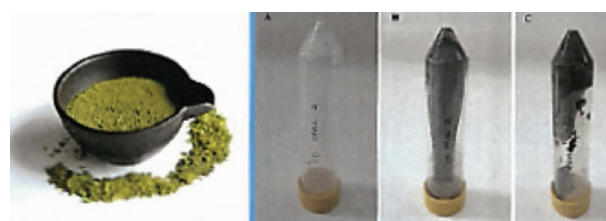


Figure 1. OPAL powder and its comparative water solubility. (A) Water soluble OPAL; (B) water dispersible OPAL; and (C) crude OPAL leaves powder.

2. Retains antioxidant activity in hot water preparation (95°C-100°C) indicates suitability in food and beverage preparations (Figure 2).

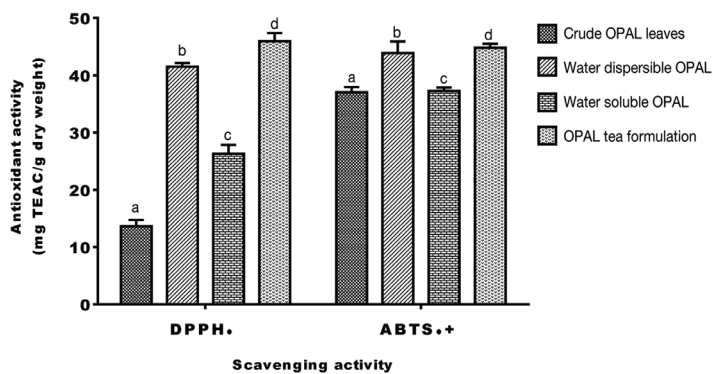


Figure 2. OPAL tea showed significantly higher ($p < 0.05$) radical (DPPH \cdot and ABTS $\cdot+$) scavenging activities compared to other teas of oil palm leaves prepared using different preparations. DPPH \cdot (2, 2-diphenyl-1-picrylhydrazyl radical) and ABTS $\cdot+$ [2, 2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) radical cation] are two representative chemical compounds representing free radicals. The ability to pursue (scavenge) free radicals is the basis of in vitro antioxidant tests.

3. High acceptability amongst non-trained panellists (n=82) showing good sensory properties (Figure 3).

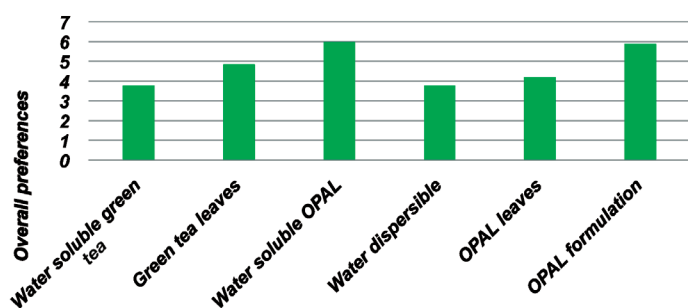


Figure 3. Water soluble tea preparations OPAL and formulation OPAL beverage showed significantly higher ($p < 0.05$) overall preference compared to other beverage preparations (n=82). Overall preferences were assessed using the nine-point hedonic scale, where 1 = dislike very much and 9 = like very much.

4. Rich in micronutrients and minerals.

TABLE 1. NUTRIENTS AND MINERALS CONTENT OF CRUDE OIL PALM LEAVES COMPARED TO OPAL POLYPHENOL POWDER

Element	Crude oil palm leaves	OPAL water soluble powder
N (%)	2.77	2.39
P (%)	0.135	0.116
K (%)	0.88	0.81
Ca (%)	0.33	0.55
Mg (%)	0.35	0.31
Zn (mg kg ⁻¹)	12.5	14.9
Mn (mg kg ⁻¹)	233.8	211.6
Fe (mg kg ⁻¹)	298.1	83.2

COMPETITIVENESS

Table 2 shows the competitiveness of OPAL powder in term of cost comparison with commercial green teas. OPAL powder is much cheaper than commercial green teas.

TABLE 2. COST COMPARISON OF OPAL POWDER AND COMMERCIAL GREEN TEAS

Product	Price (RM kg ⁻¹)
OPAL powder	160-200
Green tea powder	1 000
Matcha powder	720

ECONOMIC EVALUATION

Table 3 indicates the economic evaluation for the production of OPAL powder per kilogram at selling price of RM 160 and RM 180.

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TABLE 3. ECONOMIC EVALUATION FOR PRODUCTION OF OPAL POWDER

Indicators	Selling price (RM kg ⁻¹)					
	RM 160			RM 180		
Percentage production and sale	20%	30%	40%	20%	30%	40%
Return on investment	37%	47%	53%	54%	66%	73%
Net present value (NPV) @10% (million)	RM 46.72	RM 90.40	RM 13.41	RM 71.49	RM 12.76	RM 18.36
Internal rate of return (IRR)	59%	99%	139%	82%	133%	183%
Benefit cost ratio (B:C)	1.37	1.47	1.53	1.54	1.66	1.73
Total cumulative nett revenue for 5 years (million)	RM 11.53	RM 19.74	RM 27.95	RM 16.19	RM 26.73	RM 37.26

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