

This study aimed to develop new nutritional formulations of palm-based powder using spray-drying and fluidised bed-drying techniques. We focused on developing food products that could conveniently be used by consumers, such as improved santan sawit powder, palm-based powder for beverages and palm-based dry soup-mix powder. Spray drying produces a dry powder from a liquid with a hot gas. When the samples are high in fat content, the spray drying process become inefficient. Products are sticky, clumpy and resulting in a poor flow ability and reconstitution properties. Fluidised bed dryer improves the glass transition temperature, stickiness and hygroscopicity of the final product. The use of emulsifiers, stabilisers and an anti-caking agent as aqueous binder solutions in the spray-drying and fluidised bed-drying techniques improves the handling and reconstitution properties of the powders. The palm-based powder consists of fat, proteins, emulsifiers, stabilisers, an anti-caking agent, water, and also contains appropriate natural or artificial flavour enhancers (Zaida *et al.*, 2012). This composition can be used directly or after reconstitution with water to prepare food such as palm-based *santan* powder, coffee whitener powder, instant dry soup mix, curries, gravies, *etc.* The product has good solubility and its viscosity can be increased at a high temperature when used in cooking applications. This palm-based powder can be conveniently used to develop other processed foods. The study successfully produced three types of products: (1) a new *santan sawit* powder by an improved process; (2) nutritional formulations of palm-based powder for beverages; and, (3) formulations of palm-based dry soup-mix powder.

## PRODUCT CHARACTERISTICS

### Physico-chemical Properties of the Products

The physico-chemical characteristics of the samples were analysed according to standard procedures (AOCS, 16<sup>th</sup> ed.). Data analysis was performed in triplicate.

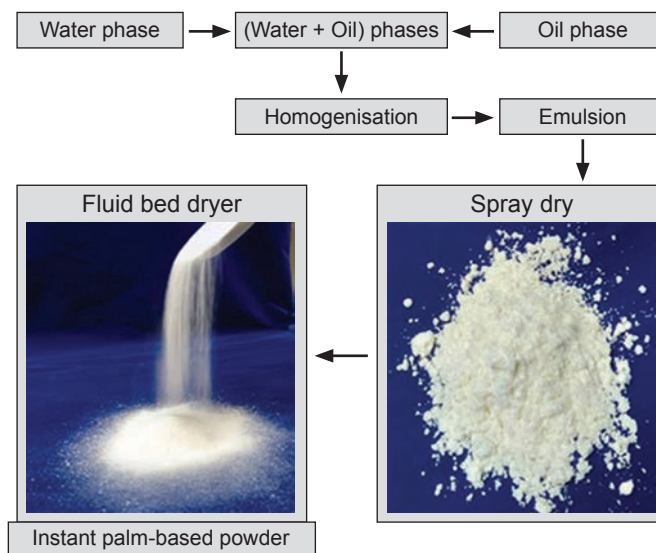


Figure 1. Flow diagrams of palm-based powder by an improved process.



(a) Improved *santan sawit* powder



(b) Palm-based powder for beverages



(c) Palm-based dry soup-mix powder

Figure 2. Products derived from instant formulations of palm-based powder by an improved process.

## Colour Analysis

The colour of the powder was evaluated using a sample volume of 30 ml in a test tube and a Minolta Chroma Meter (CR-200/CR-231; Minolta, Mahwah, NJ), which determined its  $a^*$  (green/red),  $b^*$  (blue/yellow),  $c^*$  (chroma),  $H^*$  (hue) and  $L^*$  (lightness) values.

Triplicate samples were analysed, and mean values were reported. The results of the colour analysis are presented in *Table 1*. All the powder products exhibited a whitish colour similar to commercial products. High values of  $L^*$ , signifying a whiter product, is desirable, while high values of  $a^*$  indicating a redder product, which is undesirable. High values of  $b^*$  signify a yellower product, which is also undesirable.

## Carr Index

The flowability of the powders was evaluated using the Carr index (CI) and the Hausner ratio (HR) (Jinapong *et al.*, 2008). Both the CI and HR were calculated from the bulk and tapped densities of the powders. CI of greater than 25 are considered to indicate poor flowability, while those below 15 indicate good flowability. As shown in *Figure 3*, all the products exhibited a good flowability after undergoing the fluid bed-drying process and were comparable to commercial products. There was a significant difference between *santan sawit* and improved *santan sawit* powder. Previous *santan sawit* powders and commercial coconut powders have shown poor flowability. The good flowability of the new *santan sawit* powder was obtained when two drying processes were used: spray drying and fluid bed drying.

## Moisture Content

The moisture content was evaluated by drying the samples at 105°C overnight (AOCS, 16<sup>th</sup> ed.) in a Memmert oven (Germany).

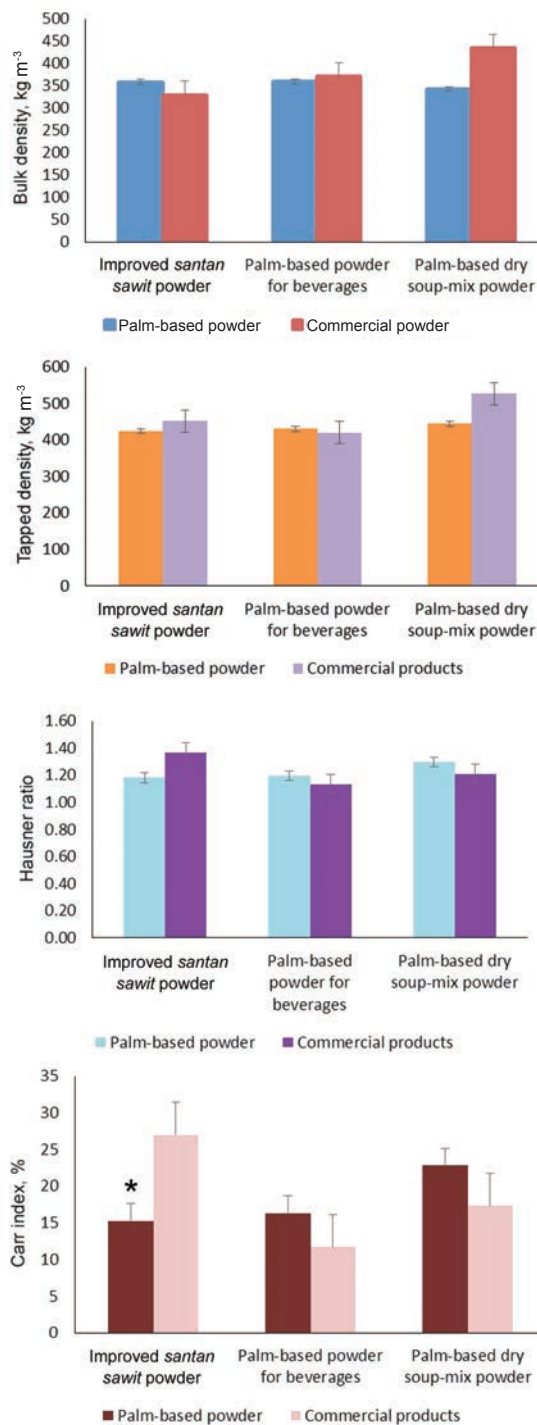


Figure 3. The bulk density, tapped density, Hausner ratio and Carr index (%) of the improved *santan sawit* powder, palm-based powder for beverages and palm-based dry soup-mix powder. \* Indicating significant differences at the confidence level of  $p < 0.05$  (mean  $\pm$  SD,  $n=3$ ).

TABLE 1. COLOUR PROPERTIES OF THE PRODUCTS

Material properties	Improved <i>santan sawit</i> powder	Commercial coconut powder	Palm-based powder for beverages	Commercial coffee whitener	Palm-based dry soup-mix powder	Commercial instant soup
Colour (L)	88.21 $\pm$ 0.81	80.30 $\pm$ 0.87	93.49 $\pm$ 0.37	91.8 $\pm$ 0.03	90.49 $\pm$ 0.68	79.5 $\pm$ 0.01
(a)	-0.40 $\pm$ 0.05	0.17 $\pm$ 0.01	-1.06 $\pm$ 0.02	-3.8 $\pm$ 0.05	-0.59 $\pm$ 0.04	1.3 $\pm$ 0.05
(b)	3.68 $\pm$ 0.16	6.02 $\pm$ 0.03	+6.33 $\pm$ 0.09	8.5 $\pm$ 0.06	+7.45 $\pm$ 0.20	9.3 $\pm$ 0.05

Note: The values for (a) (green/red); (b) (blue/yellow) and (L) (lightness).

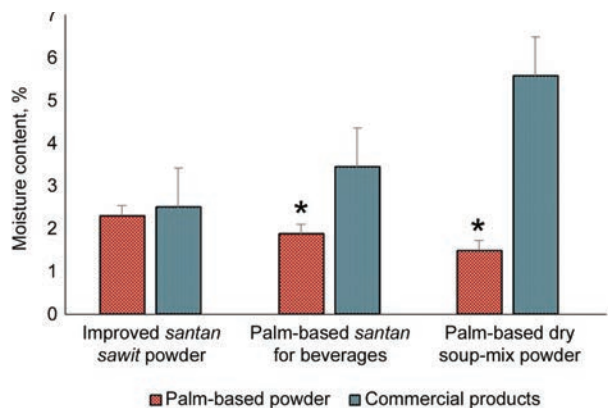


Figure 4. Moisture content of the products. \* Indicating significant differences at the confidence level of  $p < 0.05$  (mean  $\pm$  SD,  $n=3$ ).

### Solubility Testing

The solubility testing was adapted from Tulardilok (2009). The powder (3 g) was added to 250 ml of distilled water at room temperature. The solution was agitated at a speed level of 2 in a 400 ml glass beaker with a 1 cm magnetic stirrer. The time required for the powder to completely dissolve was recorded. The solubility of all palm-based powders varies from 39-105 s in cold water and 31-97 s in hot water. The products' solubility was found to be similar to that of commercial products.

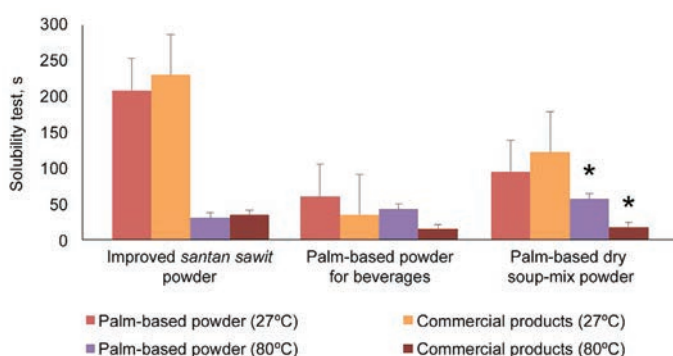


Figure 5. Results of the solubility test of the products. \* Indicating significant differences at the confidence level of  $p < 0.05$  (mean  $\pm$  SD,  $n=3$ ).

### Sensory Evaluation

The sensory attributes, including flavour, taste, texture, consistency, colour and overall acceptability, were evaluated by trained panellists using the 9-point hedonic-scale scorecard. Around 30 trained panellists were selected from MPOB's staffs. Each attribute was evaluated based on its intensity on the 9-point hedonic scale (9 = liked extremely, 8 = liked very much, 7 = liked moderately, 6 = liked slightly, 5 = neither liked nor disliked, 4 = disliked slightly, 3 = disliked moderately, 2 = disliked very much and 1 = disliked extremely). Sensory evaluations were conducted on the palm-based powder for beverages and the palm-based dry soup-mix powder in powder



Figure 6. The product samples as prepared before the sensory evaluation.

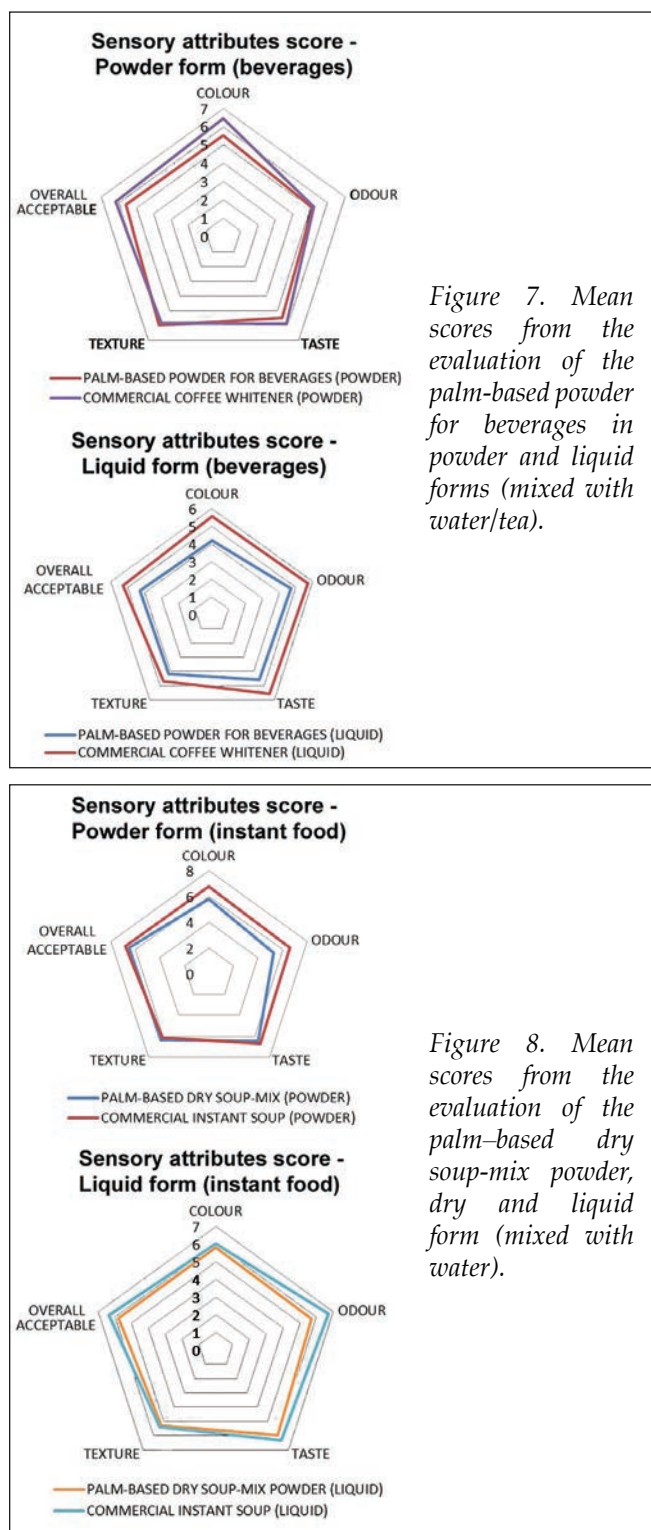


Figure 7. Mean scores from the evaluation of the palm-based powder for beverages in powder and liquid forms (mixed with water/tea).

Figure 8. Mean scores from the evaluation of the palm-based dry soup-mix powder, dry and liquid form (mixed with water).

**TABLE 2. ECONOMIC ANALYSIS ESTIMATE OF PALM-BASED POWDER**

Economic analysis	Value		
	Improved <i>santan</i> powder (if sold at RM 9 per kg)	Palm-based powder for beverages (if sold at RM 10 per kg)	Palm-based dry soup-mix powder (if sold at RM 0.80 per 50 g)
Cost (materials), RM	5.70	6.20	0.50
Capital investment, RM (million)	3 648 000	3 648 000	3 648 000
Net present value (NPV) @, RM (million)	5 901 277	4 039 018	4 280 687
Internal rate of return (IRR), %	33.25	28.17	24.32
Discounted payback period, years	3.3	3.3	3.3
Discounted BC ratio	1.13	1.11	1.01

and liquid forms. For beverages, the powder was dissolved in tea, and for soup, it was dissolved in plain water.

In this study, the sensory scores of the palm-oil powder for beverages and the palm-based instant dry soup mix in terms of flavour, taste, colour, texture and overall acceptability were found to be comparable to commercial products.

### NOVELTY OF THE PRODUCT

- The innovations successfully improved the production of palm-based powder with better properties and quality.
- Offers healthy and cholesterol-free.
- Contains vitamin E.
- The palm-based powder needs less transportation and packaging cost.
- Has a longer shelf life against oxidation.
- The product is convenient to be used in food preparations.

### ECONOMIC EVALUATION

The estimated expenditure and other economic parameters for producing palm-based powders are shown in *Table 2*. The prospects for palm-based powder are attractive, with a payback period of 3.3 years.

### CONCLUSION

The results show that both spray dryers and fluid bed dryers have a significant influence on the powder properties. Compared to other products, palm-based powders have better properties and quality, including a reasonably lower moisture content, higher yield and better bulk density, with a good flowability and moderate colour properties. These physical properties of the powders are very significant, ensuring the production of a higher quality final product and enhancing the shelf life of the products.

### REFERENCES

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