RED PALM OIL-ENRICHED FUNCTIONAL COOKIES

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Dietary fat is crucial in food formulation, in the current context on bakery products, from the aspects on structural properties (aeration and lightness) to rheological properties (fluidisation and plasticisation) and sensory attributes (crispiness, creaminess, odour, *etc.*) properties (Pareyt and Delcour, 2008). Palm oil and its fractions in particular, are widely used in bakery goods in view of its thermal stability and functionality. This could be explained by the proportional ratio between saturated and unsaturated fatty acids (Mba *et al.*, 2015). Red palm oil on this respect has better advantage as it possesses high carotenoid levels compared to palm oil. It also has assortment of health-promoting phytonutrients such as vitamin E, phytosterols, squalene and co-enzyme Q10 (Loganathan *et al.*, 2017). Carotenoids in red palm oil is highly bioavailable in human plasma, which explains the potential disease counteracting effect regardless of age (Loganathan *et al.*, 2019). Red palm oil is effective as a source of pro-vitamin A in improving serum retinol concentrations in vitamin A deficient children, enhancing retinol level in maternal serum or breast milk, improving vision and conferring cardioprotective effects (Loganathan *et al.*, 2017).

THE TECHNOLOGY

Technologies offered are the formulation and process for the manufacturing of red palm oil-enriched cookies. The formulation can be catered following required macronutrient and micronutrient contents according to the Malaysian Dietary Guidelines (*Table 1*).

Carotenes are heat and light labile. Based on accelerated storage test, the production scheme and packaging material have been optimised to best retain the carotenes (>80%) and no changes were found on oxidative stability parameter nor microbial activity throughout 1.5 years (shelf-life) (*Table 2*).

NOVELTIES

Expertise in providing tailored formulation according to the Malaysian Dietary Guidelines. In addition, consultation can be provided to recce suitability of existing machineries/ premise and assist throughout production course from ingredient listing, nutrition calculation, baking conditions, packaging material, nutrient labelling, storage conditions *etc.*, to best retain the phytonutrients and wholesomeness of red palm oil.

BENEFITS AND ADVANTAGES

- Providing tailored-made formulation with reference to the Malaysian dietary Guidelines with specific nutrient enhancement targeting carotenes and vitamin E supplementation;
- Providing consultation on the formulation of red palm oil-enriched biscuits backed by science with clinical data;
- Providing suitable functional ingredients for targeted population in need of a boost of carotenes, such as children with vitamin A deficiency;
- Providing an engagement platform for potential clients to incorporate and commercialise their products to community

TABLE 1. NUTRIENT INFORMATION FOR 4 FLAVOURS OF RED PALM OIL-ENRICHED COOKIES

	Flavours			
	Vanilla	Vanilla oat	Chocolate	Chocolate oat
Energy (kcal)	216.6	216.4	218.3	217.5
Protein (g)	4.6	4.6	4.5	4.6
Carbohydrate (g)	23.0	23.6	23.1	23.6
Fat (g)	12.1	11.8	12.5	12.0

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TABLE 2. PHYSIOCHEMICAL AND MICROBIAL CHANGES DURING STORAGE OF RED PALM OIL-ENRICHED FUNCTIONAL COOKIES

Storage period (months)	Total carotenes (mg/mL)	Oil stability index at 110°C (hr)	Aerobic plate count (CFU/g)	Yeast and moulds (CFU/g)	Coliforms (CFU/g)	*Escherichia coli* (CFU/g)	*Salmonella* (in 25 g)
0	350.62 ± 0.13	30.87 ± 2.11	ND	ND	ND	ND	Absent
2	340.56 ± 0.10	31.36 ± 0.39	ND	ND	ND	ND	Absent
4	304.24 ± 0.13	31.12 ± 0.69	ND	ND	ND	ND	Absent
6	329.06 ± 0.14	30.84 ± 2.48	ND	ND	ND	ND	Absent
8	314.27 ± 0.19	29.84 ± 3.48	ND	ND	ND	ND	Absent
10	313.21 ± 0.13	30.75 ± 0.20	ND	ND	ND	ND	Absent
12	317.71 ± 0.39	30.35 ± 0.46	ND	ND	ND	ND	Absent
14	296.09 ± 0.23	28.55 ± 2.04	ND	ND	ND	ND	Absent
16	275.14 ± 0.20	29.67 ± 0.51	ND	ND	ND	ND	Absent
18	285.37 ± 0.22	29.79 ± 2.57	ND	ND	ND	ND	Absent

Note: ND- not detected; CFU- colony forming unit.

feeding programmes by public health related organisations or promotion as healthy door gift for any relevant activities/seminars;

- Providing consultation on appropriate manufacturing facility, packaging material and storage conditions to best retain the carotenes and quality of the oil; and
- Providing clinical data to show the health benefits of red palm oil-enriched cookies casing several aspects *i.e.*, nutritional status (retinol, iron and haemoglobin levels), ocular status, intestinal parasitic infections and intestinal microflora.

ECONOMIC ANALYSIS AND COMMERCIAL BENEFITS

Red palm oil-enriched cookies are cost friendly. It can be an addition to existing product lines albeit certain processing techniques and cleaning conditions to consider as red palm oil generally

stains. The estimated expenditure and other economic evaluation are shown in *Table 3*. This economic evaluation is based on the assumption that the product is sold at RM1.85 per pack, with an estimated production capacity of ~600 000 packs/year.

TABLE 3. ECONONOMIC ANALYSIS OF RED PALM OIL-ENRICHED COOKIES

Economic analysis	Value
Material cost (per unit)	RM0.43
Selling price (per unit)	RM1.85
Capital investment	RM80 000
Net present value (NPV) at 12%	RM395 415
Internal rate of return (IRR)	53.45%
Discounted payback period	3.46 years
Discounted benefit to cost ratio	1.16
Profitability index/ROI	494%
Annualised Project ROI	49%

CONCLUSION

Red palm oil-enriched cookies can be used to supplement kids with vitamin A deficiency or malnutrition; and also, as a healthy snack to general population. This cookie has a great potential to be commercialised as niche product with its unique phytonutrient content as its selling point. Moreover, the production technique is rather straightforward without a need for major modification to the existing plant.

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