

Animal fats have been singled out as the cause of dietary diseases due to the saturated fatty acids and *trans* fatty acids content. However, animal fat is one of the major ingredients in processed meat formulations. In order to reduce the consumption of animal fats in daily intakes, fat substitution can be done. This is applied in many vegetarian food formulations.

Tofu, *tempeh* and seitan have been used in various vegetarian dishes. Tofu is made by coagulating fresh soya milk to form curds which then are pressed to remove excess liquid. It is a rich source of protein and calcium. *Tempeh* is a widely consumed fermented food in Asia. It is high in protein, fibre and vitamin B12. Seitan is made of wheat gluten and has been exploited in products such as bakery products, soups, extruded products and ready-to-eat snacks.

Plant proteins in these foods provide texture similar to the meat imitation products. The nutrition composition of tofu, *tempeh* and seitan is specified in *Table 1*. In this project, the meat imitation product is nugget. Tofu, *tempeh* and seitan were used to formulate three vegetarian nuggets. These vegetarian nuggets are alternatives to commercial chicken nuggets. Among the common menu that school canteens offer is chicken nuggets. It was reported that consumption of food containing high calorie, fat and sugar is one of the factors associated to obesity among children. Commercial chicken nuggets contain animal fats.

Palm oil emulsion was developed to substitute animal fat in these vegetarian nuggets because palm oil contains a balanced composition of saturated and unsaturated fatty acids, which provides functional and nutritional benefits to the formulations.

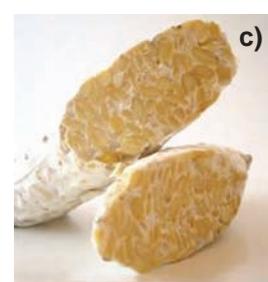
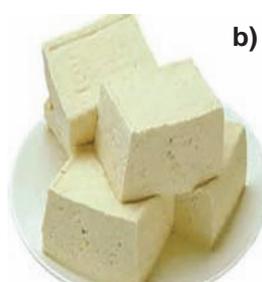
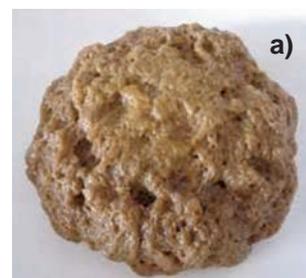


Figure 1. Sources of protein: a) seitan, b) tofu and c) tempeh.

TABLE 1. THE NUTRITION COMPOSITION OF TOFU, TEMPEH AND SEITAN

	Tofu (1/2 cup)	Tempeh (1/2 cup)	Seitan (1/2 cup)
Calories (cal)	88	160	240
Fat (g)	5	9	3
Sodium (mg)	15	7.5	705
Carbohydrates (g)	2	8	12
Fibre (g)	1	3.8	1.5
Protein (g)	10	15.5	36

OBJECTIVES

- To formulate palm-based vegetarian nuggets.
- To determine the physical characteristics of palm-based fried vegetarian nuggets.

METHODOLOGY

Product development started with the optimisation of formulation using the Response Surface Method. Three formulations were developed using tofu, *tempeh* and seitan.

The oil contents of the pre-fried and fried nuggets were determined. The texture of the nuggets was analysed for firmness and toughness. The protein and fibre content of fried nuggets were also evaluated. Sensory evaluation was carried out by two groups of panellist namely; children and adults.

NOVELTY OF PRODUCT

- Made from plant proteins. Contains more protein than commercial chicken nuggets.
- About 98.8% to 99.2% of the ingredients are plant-based (0.7% to 1.2% chicken flavour is added to enhance taste).
- Only 2% to 2.5% fats are used in formulations (the product absorbed 10% to 12% oil during open pan frying. A modification of the frying method would reduce oil absorption).
- Contains high fibre.



RESULTS

Product Properties

In addition to the animal fats and protein substitutions, these nuggets were also formulated to have a reasonably higher fibre content. The palm oil emulsion contained binding agents, which were able to hold the structure and improved firmness of the product. The nutritive composition of pre-fried vegetarian nuggets compared to chicken nuggets is shown in Figure 2.

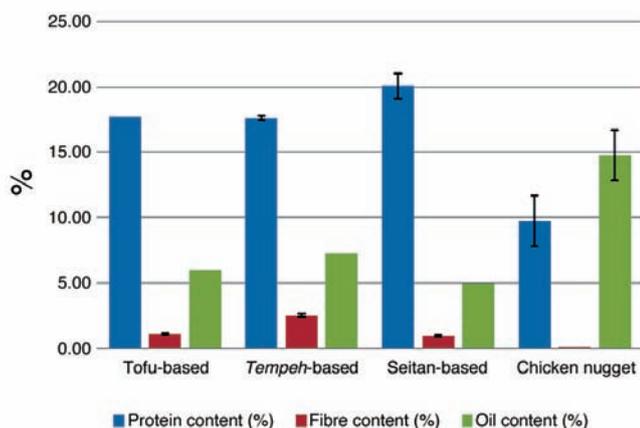


Figure 2. Nutritive composition of pre-fried nuggets.

A sensory evaluation was carried out at the Sekolah Kebangsaan Dato' Abu Bakar Baginda, Kajang to determine the acceptance of these nuggets among 180 students. Students (male and female) were randomly sampled representing standards 1 to 6. Students preferred seitan-based nuggets compared to tofu- and tempeh-based nuggets, as shown in Figure 3. The acceptance levels for seitan-, tempeh- and tofu-based nuggets were 92%, 82% and 73% respectively.

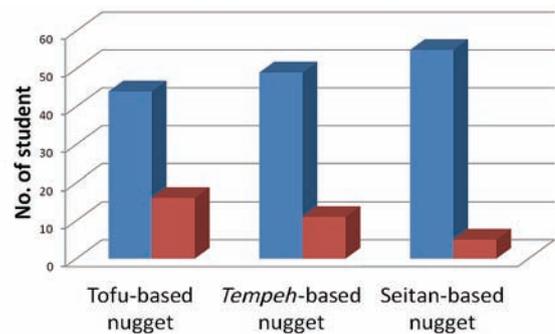


Figure 3. Student preferences of nuggets.

The sensory evaluation among 20 adults showed preference for tofu-based nuggets as illustrated in Figure 4.

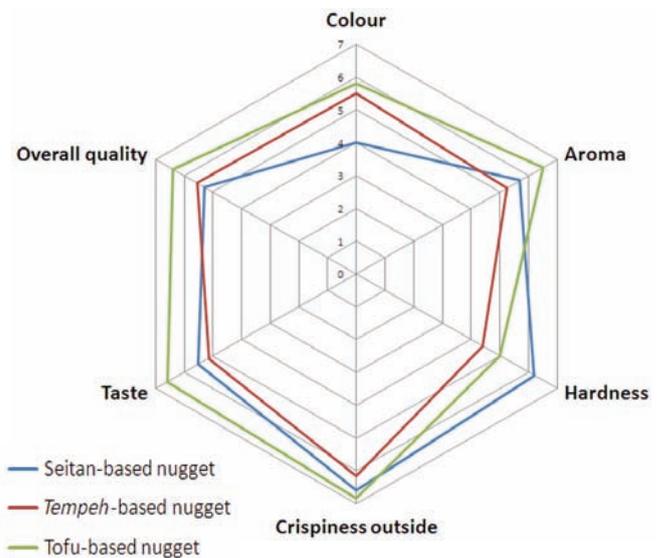


Figure 4. Sensory scores of nuggets among adults.

PRODUCTION POTENTIAL

Vegetarian nuggets can be mass produced using the same production line as that of the chicken nugget. Minor changes, however, in the preparation method and formulation are needed. It requires appropriate automated facilities to minimise labour cost and facilitate a good manufacturing practice throughout the production process.

ECONOMIC EVALUATION

The estimated expenditure and other economic evaluation is shown in *Table 2*.

TABLE 2. ESTIMATED ECONOMIC VALUES

Capital expenditure, RM	2 200 000
Benefit to cost ratio	1:1.10
Payback period	3 Years
Internal Rate of Return (IRR), %	36
Net Present Value (NPV), RM	4 563 256
Return on Investment (ROI), %	27.25

This economic evaluation is based on the assumptions that the nuggets are sold at RM 8 kg⁻¹ and the production capacity is 6 t per day with a

gradual increment in the sales over 12 years. The calculation is based on the formulation of seitan-based nugget since the cost of raw materials for tofu and *tempeh*-based nuggets are much cheaper. It can be manufactured using the same production line as chicken nuggets but with a slight change in the preparation process.

TARGET MARKET

Children and adults are the target consumer groups of the product. It is a nutritive alternative to chicken nuggets. The product has market potentials for both domestic and international markets.

CONCLUSION

This product is a healthier alternative to chicken nuggets and has a great market potential.

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