

FUNCTIONAL FOODS INNOVATION: HIGH CALORIE LIQUID FORMULATIONS AND ITS ACCEPTABILITY AMONG IIUM KUANTAN STUDENTS

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ABSTRACT Nowadays, with the advancement of science and nutritional breakthrough, there are lots of methods can be applied to optimise energy and nutritional requirement. One of the approaches is through utilisation and modification of functional foods available. Some of these functional foods are high in calorie and nutrient dense. Therefore, the aim of the research was to develop simple formulations of healthy high calorie beverages derived from functional foods. Four formulations with different main ingredients were evaluated. The formulations were subjected to macronutrients analysis and sensory evaluation for measurement of the acceptability. The main sensory properties such as appearance, aroma, consistency, colour, after taste, and overall acceptance were evaluated using a nine point Hedonic scale. Nutritionist Pro™ software was used to compare the nutrient content. Based on the analysis performed, Enercal Plus® which was the control formulation shown the densest calorie for one serving (360 kcal/serving) followed by F2, F3, and F1 formulations. The results of hedonic rating proved that all formulations showed fair acceptability with the highest percentage and hedonic score goes to control formulation of Enercal Plus® followed by F3, F2, and F1 formulations. Their mean score ranged between 5- 6.6 in terms of general acceptability. From this research, it showed the development of high calorie beverage is possible through modification of functional foods.

Keywords: Functional foods, formulation, high calorie, sensory evaluation, hedonic score.

Abstrak Dengan kemajuan dalam bidang sains dan kejayaan dalam bidang pemakanan pada masa kini, terdapat pelbagai kaedah yang boleh digunakan untuk mengoptimalkan keperluan tenaga dan pemakanan. Salah satu pendekatannya adalah dengan penggunaan dan pengubahsuaian makanan berfungsi yang tersedia. Sesetengah makanan berfungsi ini tinggi kalori dan padat dengan nutrient. Maka, tujuan kajian ini adalah untuk menghasilkan formulasi mudah minuman tinggi kalori yang dihasilkan daripada makanan berfungsi. Empat formulasi dengan bahan utama yang berbeza dinilai. Formulasi-formulasi ini menjalani analisis makronutrien dan penilaian sensori untuk menentukan penerimaannya. Ciri-ciri sensori yang utama seperti rupabentuk, aroma, konsistensi, warna, rasa kesan dan penerimaan keseluruhan dinilai menggunakan skala Hedonik 9 titik. Perisian Nutritionist Pro™ digunakan untuk membandingkan kandungan nutrient. Berdasarkan analisis yang dijalankan, Enercal Plus® yang merupakan formulasi kawalan mempunyai kandungan kalori paling padat untuk satu hidangan (360 kcal/hidangan) diikuti dengan formulasi F2, F3 dan F1. Keputusan penilaian hedonik menunjukkan kesemua formulasi mencapai tahap penerimaan yang baik dengan peratusan tertinggi dicapai oleh Enercal Plus® diikuti dengan F3, F2 dan F1. Skor min kesemua formulasi adalah antara 5-6.6 berdasarkan penerimaan keseluruhan. Kajian ini menunjukkan pembangunan minuman berkalori tinggi melalui pengubahsuaian makanan berfungsi mampu tercapai.

(Keywords: Fuctional food, high calorie, IIUM, Nutritionist Pro™, Enercal Plus®)

INTRODUCTION

The increment in numbers of population with overweight and obesity problem whether in developed or developing countries cannot be denied. Based on American Heart Association 2011, 149.3 million of American adults aged 20 and above were categorized as overweight or obese. Besides, the prevalence of obesity in

Malaysian has increased considerably by 250% over the latest 10 years since 1996 and 70% increment for those categorized as overweight [1].

Instead of all these alarming statistics, there is still a segment of population experiencing calories and macronutrient deprivation particularly in developing countries. One study conducted in a developing country found that the overall

prevalence of underweight problem in Osun State, Nigeria was 20.1%, where 22.4% was from rural area and 18.7% was from urban area [2]. Even though these findings are not comparable to the prevalence of obesity, these populations should not be underestimated as underweight has their own complications such as malnutrition, multiple or single micronutrient deficiencies, and changes in body composition such as loss of lean body mass [3]. This statement is further supported by a study that emphasized underweight might increase the risk of infections, osteoporosis, and possible pregnancy complications [4].

Trend nowadays shows that the demands for increasing energy and gaining weight are not solely limited to those who encountered problems such as underweight and energy deprivation. The trend has shifted whereby these extra energy and lean muscle mass are essential for various reasons such as to improve appearance, to perform better in their active lifestyles and sports, to increase endurance, strength, lean muscle mass, and performance [5]. Besides, these high energy and protein are also immensely crucial for critically ill patient in clinical setting [6]. Therefore, as the end does not

justify the mean, the right energy estimation with proper eating habits is among the crucial element that should not be undervalued. It is soundly valid

as healthy weight gain, like healthy weight loss, requires strict scrutinization and determined effort in order to meet pre-determined target.

MATERIALS AND METHODS

The development of formulation began with food testing that was successfully carried out at the food analysis laboratory. The best formulations were found after undergoing assessment, modifications and alterations. The final formulations were chosen after considering some important criteria such as nutritional contents, taste, viscosity, and cost.

For experimental groups, three different formulations (F1, F2, and F3) were prepared. Banana, guava, strawberry flavoured yogurt were remained constant in this study. In all formulations, different types of milk were used as the main ingredient shown below (Table 1).

Table 1: List of formulations and the main ingredients

F1	Low fat milk + fruits + yogurt (Strawberry flavour)
F2	Soy milk + fruits + yogurt (Strawberry flavour)
F3	Low fat milk + Soy milk + fruits + yogurt (Strawberry flavour)

On the other hand, one commercial product (Enercal Plus®) was used as control and to be compared with the experimental groups.

All formulations were analysed to measure its nutritional information using Nutritionist Pro™ (Axxya System LLC., Stafford, Texas, USA). The main concern of analysis in this study was the macronutrients which are carbohydrate, protein, and fat. All these nutritional information were compared with Recommended Nutrient Intake of Malaysia (RNI) and also Enercal® Plus. Next the formulations and control were subjected to sensory evaluation. All panellists evaluated samples that have different codes to avoid bias.

Panellists were asked to evaluate the formulation attributes on a non-structural linear scale which was the 9-point Hedonic Scale. This 9-point Hedonic Scale was chosen because it is one of the Internationally recognized and accepted tools for sensory evaluation of foods. The sensory

evaluation data was analysed with the Repeated Measurement of ANOVA (RM ANOVA) test using SPSS version 12.0. The significant difference of the mean values were assessed at 5% level of significance ($\alpha=0.05$).

RESULTS AND DISCUSSION

Sensory Evaluation

The results of sensory evaluation by 30 untrained panellists on the formulated beverages are presented in the tables. The data shows average likeliness of the formulated complementary foods with respect to six main attributes which were appearance, aroma, consistency, colour, after taste, and overall acceptability. Results were expressed as estimated marginal mean values ranging from 1 to 9. Mean value of 1 was interpreted as 'extremely dislike' whereas the mean value of 9 was interpreted as 'extremely like'. Mean value of 5

which showed the beverages attributes were neither like nor dislike was considered as 'neutral'.

Appearance attribute results showed that the control formulation of F4 received the highest mean score with 6.7 and followed by F3 with mean score of 5.3 (Figure 1). There was a significant difference ($p < 0.05$) in appearance of formulations

between the control sample, Enercal Plus® (6.7 ± 1.79), F1 (4.6 ± 2.06) and F2 (4.8 ± 2.02).

Among the experimental group, the highest preference in terms of appearance was F3 (5.2 ± 1.97) which was a combination between soy and low fat milk. However, there was no significant different among the group ($p > 0.05$).

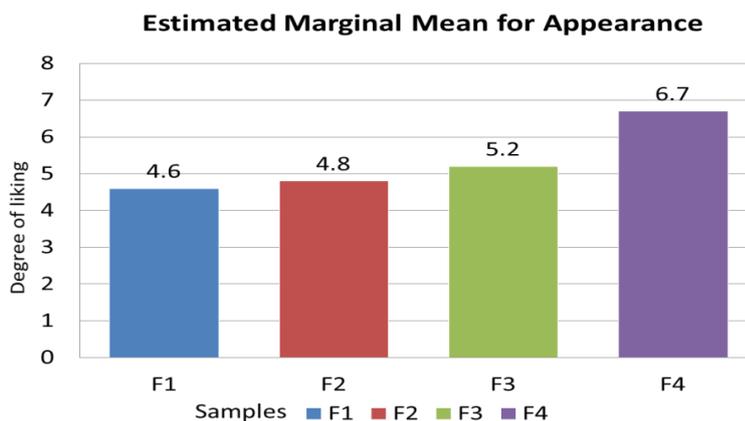


Figure 1: Estimated Marginal Mean for Appearance

Figure 2 shows the result of estimated marginal mean for aroma. Control (F4) received the highest acceptance with the mean of 7 followed by F1 which was 5.8. There was a significance difference ($p < 0.05$) in aroma attributes among these four. Enercal Plus® was preferred the most by respondents in term of its aroma due to the fact that this product has vanilla aroma in their formulation. Vanilla aroma can be easily accepted by customers compared to others due to its natural organoleptic properties.

The following study focused on the consistency of the beverage formulations with control (Figure 3). Consistency in this research is referring to the texture and viscosity of the formulations whether it is has smooth, coarse, thin or thick appearance. Untrained panellists have been explained carefully regarding this attribute to avoid any confusion between consistency and appearance.

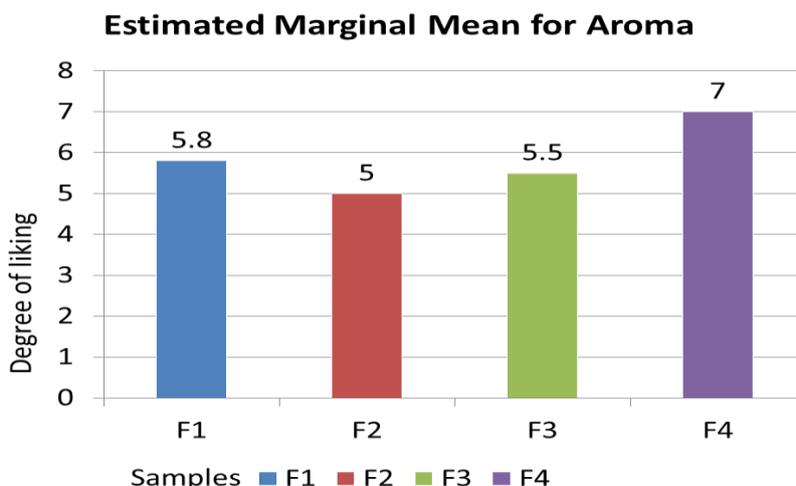


Figure 2: Estimated Marginal Mean for Aroma

However, there was no significant difference between controls with experimental formulation. Among experimental groups, F3 was the most preferable in terms of consistency compared to others. There was also a significant difference between F3 and F2 ($p < 0.05$). As mentioned previously, F3 consist of low fat milk and soy milk. Generally, soy milk was thicker compared to low

fat milk. By combining both milks, the final formulation becomes reasonably fine. On the other hand, F2 was prepared from soy milk and this formulation becomes quite thicker after combining with banana, yogurt, and green guava. Thus, it is hypothesized that F2 was less preferable due to its thick consistency and might interfere with tolerance and final taste.

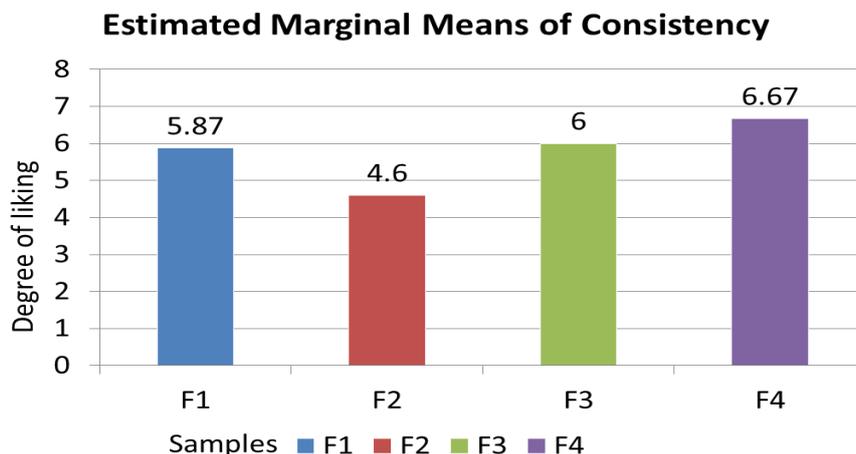


Figure 3 Estimated Marginal Mean for Consistency

From Figure 4, control group (F4) was found to have the most satisfactory and significant result for its colour attribute compared to experimental samples. The average score range from 5.4 to 5.5 for all three experimented formulations with F2 showed the highest mean compared (5.5 ± 1.80). However, there was no significant difference ($p > 0.05$) among experimental formulations. The high mean score of control could be explained by

its intensive cleared and white creamy colour. The experimental formulations contain the extract of banana and guava that would interfere with their final colour and might not be preferable for some people. From observation, the colour of all three samples ranged from light white-greenish (F1), light brown (F2), white-brown (F3). And through the finding, people like the colour of light brown (F2) more compared to other experimental samples.

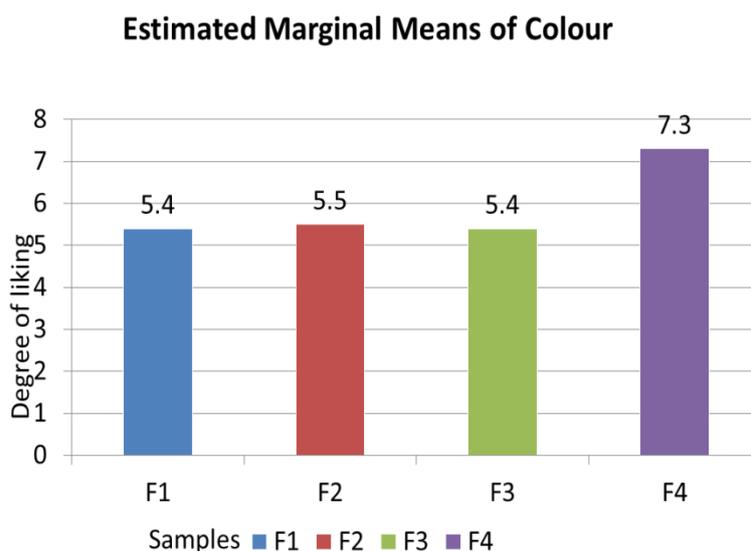


Figure 4 Estimated Marginal Mean for Colour

Figure 5 shows the formulations with the best results was F2 (6.3 ± 1.60) and F3 (6.3 ± 1.76) where both formulations obtained higher estimated

marginal means compared to control group. However there was a significant difference between control group and F1 ($p < 0.05$).

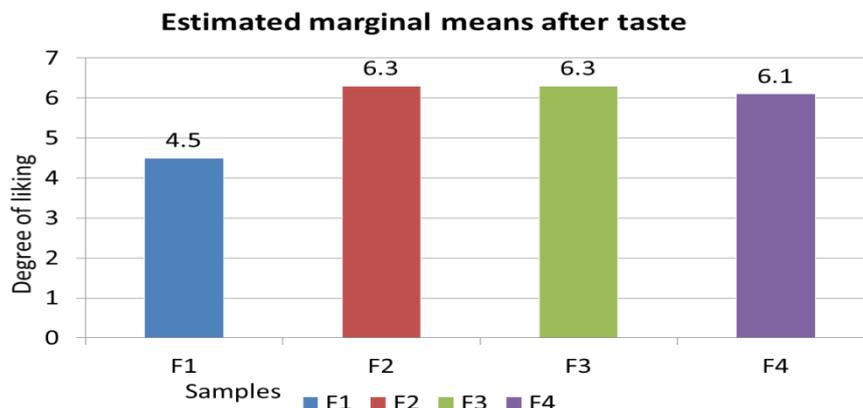


Figure 5 Estimated Marginal Mean for after taste

The distribution for the overall acceptance evaluation can be observed in Figure 6. All formulations passed the minimum requirement of mean for the acceptability which was 5. The control sample remained the best and finest sample

with the mean score of 6.6 followed by F2 (6.1 ± 1.78) and F3 (6.13 ± 1.78). However, there was no significant difference for this attribute between control and experimental group.

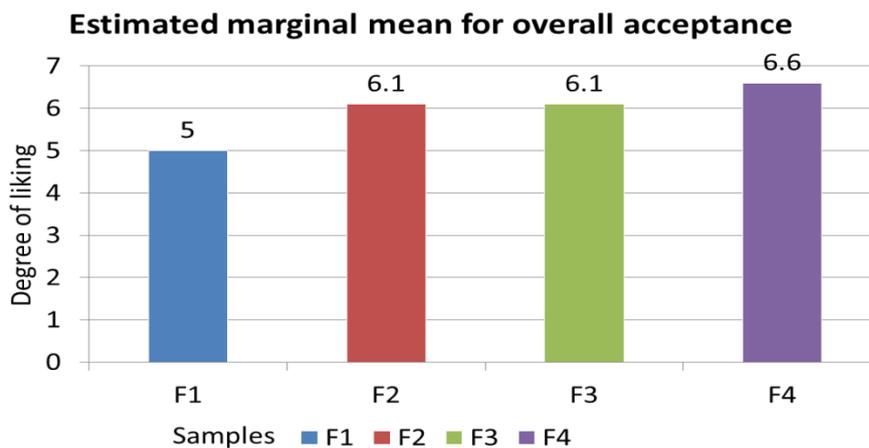


Figure 6 Estimated Marginal Mean for Overall acceptance

5.3 Comparison with commercial product (Enercal Plus®)

Since 2005, Malaysia has successfully produced the standard nutritional reference specifically for a local citizen which is the Recommended Nutrient

Intake or RNI. RNI is basically a revised version based on Recommended Dietary Intake (RDI) from United States. According to RNI for Malaysia 2005 [7], the recommended macronutrients intakes are as follow:

Table 2: Recommended macronutrients intake based on RNI (2005)

Macronutrients	Percentage
Carbohydrate	50% to 60%
Protein	15%
Fat	20%-30%

As the main concern in this study is the total calorie of formulation, the macronutrients of carbohydrate, protein, and fat were critically analysed in this study using internationally recognized dietary's software Nutritionist Pro™.

Table 3 Macronutrients distribution of formulations

	Calorie	Carbohydrate	Protein	Fat
F1(Milk based)	263	67%	22%	11%
F2 (Soy based)	314	63%	13%	24%
F3 (Milk-Soy)	288	65%	17%	18%
F4 (Enercal)	*240	55%	16%	29%
	**360	**55%	**16%	**29%

*1.0 kcal/ml (4 scoops) **1.5 kcal/ml (6 scoops)

In clinical setting, high energy formulation would contain above 1.2 kcal/ml [3]. From Table 3, all formulations exceeded 200 kcal for each serving (approximately 250 ml). Above all formulations, the control group (Enercal Plus®) have the highest calorie with 360 kcal per serving (1.5 kcal/ml). Besides, its macronutrient distributions were within the RNI recommendation with 55% of carbohydrate, 16% of protein, and 29% of fat. Carbohydrate rich foods can spare protein from being used for fuel and subsequently able to focus on its primarily task for internal maintenance including build muscles [8]. In addition, it also supplied approximately 18% energy from the total of 2000 kcal of energy requirement.

Among all experimental samples, F2 of Soy-based formulation has the highest energy with the total calorie of 314 kcal for each serving with the distribution of carbohydrate is 63%, 13% of protein and 24% of fat. The protein percentage in this formulation is quite low due to the natural properties of soy that contains less protein compared to others.

On the other hand, F1 of milk based formulation contains the lowest calories among the experimental samples (263 kcal). The protein percentage in this formulation is quite high (22%) compared to others. Overall, all the formulations are high in calorie and within the RNI recommendation.

It appeared that, in addition to a sufficient energy density of the formulations, sensory qualities are the most important. Sensory evaluation is easy in its principle but its implementation in the field is often complicated because of time constraint and the urgency to preserve the quality of beverages.

.Beverage formulation of Enercal Plus® was found to be tastier, appealing, and have good consistency than the rest of formulations. Generally, the mean scores of formulations with 5.0 and above were considered acceptable. Table 4 shows, that only F3 and F4 achieved marginal mean 5.0 and above for all its attributes.

Table 4: Mean scores of sensory evaluation of beverages

	Appearance	Aroma	Consistency	Colour	After taste	Overall Acceptance
F1	4.6	5.8	5.87	5.4	4.5	5
F2	4.8	5	4.6	5.5	6.3	6.1
F3	5.2	5.5	6	5.4	6.3	6.1
F4	6.7	7	6.67	7.3	6.1	6.6

CONCLUSION

This research tried to formulate a healthy and high calorie beverage formulation from functional foods prepared from locally available functional foods that were commonly consumed in Malaysia. Based on the findings, the finest formulation with balance in calorie and acceptability was F3 with 288 kcal per serving. Therefore, this formulated beverage prepared from functional foods is potentially suitable to be use as a supplementary intake in Malaysia and other areas.

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