



**DEVELOPMENT OF INNOVATIVE ORAL
NUTRITIONAL SUPPLEMENT PREPARED FROM
BELIMBING DAYAK (*BACCAUREA ANGULATA*)
FORMULATION**

BY

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**A thesis in fulfillment of the requirement for the degree of
Master of Health Sciences (Nutrition Sciences)**

**KULLIYAH OF ALLIED HEALTH SCIENCES
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ABSTRACT

The aim of this study is to develop an innovative halal high calorie supplement by incorporating milk, yoghurt, banana, mango and belimbing dayak (*Baccaurea angulata*) juice. Three formulations with different main ingredients (F1-milk, F2-chocolate-flavoured milk and F3-soy milk) were subjected to sensory evaluation (appearance, odor, taste, mouthfeel and overall liking) to determine its acceptability by using 9-point Hedonic Scale. From the three formulations, the one with the highest Hedonic score was drum-dried for proximate analysis. The drum-dried formulation was stored for 3 months in room temperature to determine its shelf-life by peroxide value determination and microbiological testing. Proximate analyses, chemical and microbial testing were carried out monthly during the 3 months period. All formulations showed fair acceptability. The formulation with the highest hedonic scores was the F3 formulation (6.47 ± 1.77), ($p = 0.05$) and the calorie content determined was approximately 236.6 kcal/250 ml. The shelf-life study of powdered F3 formulation showed that in a period of 3 months, the peroxide value increased from 0.05 ± 0.00 meq/kg to 0.71 ± 0.00 meq/kg. In addition, there was a decreased in the total plate count ($1.25 \times 10^2 \pm 7.071$ cfu/g) and yeast and mould count (<100 cfu/g) at the end of 3 months storage period. From human study, group receiving F3 formulation showed higher weight gain (1.29%) as compared to group that received Enercal ® Plus (0.09%). But the subjects' Body Mass Index (BMI) values were still in the underweight range. However, there is no significant difference between the two groups ($p = 0.25$, $p > 0.05$). Thus, through the modification of functional food, it is possible to develop a high calorie supplement with the potential to be a weight gain and high energy supplement.

خلاصة البحث

والهدف من هذه الدراسة هو تطوير مبتكر الحلال تكملة عالية السعرات الحرارية من خلال دمج الحليب واللبن والموز والمانجو وعصير من الفاكهة النجمية. وتعرض ثلاثة تركيبات مع المكونات الرئيسية المختلفة (، وهي حليب للفورمولا 1، الحليب المنكه بالشوكولاته - للفورمولا 2 والحليب الصويا - للفورمولا 3) للتقييم الحسي (المظهر والرائحة والطعم، موثفيل وتروق العام) لتحديد قبوله باستخدام مقياس المتعة 9. ومن الصيغة الثلاثة، كان واحد وفقا لأعلى درجة تسعير المتعة لتحليل المباشر المجفف البرميل. وتم تخزين صياغة المجفف طبل لمدة ثلاثة أشهر في درجة حرارة الغرفة لتحديد عمرها التخزيني من تصميم قيمة البيروكسيد والاختبارات الميكروبيولوجية. وأجريت التحاليل الداني والكيميائية والجرثومية اختبار خارج شهريا خلال فترة ثلاثة أشهر. وأظهرت جميع التركيبات عدالة القبول. وكانت الصياغة وفقا لأعلى درجات المتعة بصياغة $F_3 (6.47 \pm 1.77)$ ، $(p = 0.05)$ وكان محتوى السعرات الحرارية تحديد ما يقرب من 236.6 كيلو كالوري 250 /مل. وأظهرت الدراسة العمر الافتراضي للصياغة الفورمولا 3 مسحوق أنه في الفترة من ثلاثة أشهر، زادت قيمة البيروكسيد من 0.05 ± 0.00 مل مكافئ /كجم 0.71 ± 0.00 مل مكافئ /كجم. وبالإضافة إلى ذلك، كان هناك انخفاض في العدد الإجمالي لوحة $(1.25 \times 10^2 \pm 7.071)$ وت م / ز والخميرة والعفن العد (<100) وت م / ز في نهاية 3 أشهر فترة التخزين. ومن دراسة الإنسان، وأظهرت المجموعة التي تلقت صياغة F_3 زيادة الوزن العالي (1.29%) بالمقارنة مع المجموعة التي تلقت (0.09) $Enercal \text{® Plus}$. ولكن مؤشر كتلة الجسم (BMI) القيم على المواضيع لا تزال في نطاق الوزن. ومع ذلك، ليس هناك فرق كبير بين المجموعتين ($p = 0.25$)، $(p > 0.05)$. وهكذا، من خلال تعديل المواد الغذائية وظيفية، فمن الممكن لتطوير تكملة السعرات الحرارية العالية مع احتمال أن تكون زيادة الوزن وارتفاع الملحق الطاقة.

ABSTRAK

Tujuan kajian ini dijalankan adalah untuk menghasilkan suplemen berkalori tinggi yang halal serta berinovatif dengan menggabungkan susu, yogurt, pisang, mangga dan jus belimbing dayak. Tiga formulasi dengan kandungan utama yang berbeza (F1-susu, F2 – susu berperisa coklat dan F3-susu soya) telah dinilai dan dijalankan ujian sensori (rupa,bau, rasa, rasa dalam mulut dan kesukaan secara keseluruhan) untuk menentukan tahap penerimaannya dengan menggunakan 9-poin skala Hedonik. Formulasi dengan skor Hedonik yang tertinggi telah dikeringkan melalui proses keringan-drum untuk analisis proksimat. Formulasi yang telah dikeringkan tadi juga telah disimpan selama 3 bulan pada suhu bilik untuk menentukan hayat simpanan formulasi itu. Analisa proksimat, analisis kimia serta mikrob telah dilakukan sekali sebulan sepanjang tempoh 3 bulan tersebut. Formulasi dengan skala hedonik tertinggi adalah formulasi F3 (6.46 ± 1.79), ($p = 0.05$) dan kandungan kalori yang telah ditentukan adalah 236.6 kcal/250 ml. Kajian hayat simpanan serbuk formulasi F3 menunjukkan sepanjang tempoh 3 bulan terdapat perubahan yang mendadak pada nilai peroksida dari 0.05 ± 0.00 meq/kg ke 0.71 ± 0.00 meq/kg. Selain itu, terdapat penurunan pada hitungan plat keseluruhan ($1.25 \times 10^2 \pm 7.071$ cfu/g) dan hitungan yis dan kulat (<100 cfu/g) di akhir tempoh simpanan 3 bulan. Melihat kepada kesan formulasi F3 ke atas berat badan, kumpulan yang menerima formulasi F3 menunjukkan peningkatan berat badan yang lebih tinggi (1.29%) berbanding dengan kumpulan yang menerima Enercal ® Plus (0.09%). Walaubagaimanapun, perubahan ini adalah tidak signifikan ($p=0.25$, $p>0.05$). Jadi melalui modifikasi ke atas makanan berfungsi, penghasilan suplemen tinggi kalori dan mempunyai potensi untuk digunakan sebagai suplemen menambah berat dan tinggi dengan tenaga adalah tidak mustahil.

APPROVAL PAGE

I certify that I have supervised and read this study and that in my opinion; it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a thesis for the degree of Master of Health Sciences (Nutrition Sciences)

.....
Norazlanshah Hazali
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I would like to dedicate my thesis to my beloved parents whose affection, love, encouragement and prayers make me able to get such success and honour.

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TABLE OF CONTENTS

Abstract	ii
Abstract in Arabic.....	iii
Abstract in Bahasa Malaysia.....	iv
Approval Page	v
Declaration Page	vi
Copyright Page	vii
Dedication.....	ix
Acknowledgements.....	x
Table of Contents	xi
List of Tables	xiii
List of Figures	xiv
List of Abbreviations.....	xv
CHAPTER 1: INTRODUCTION.....	1
1.1 Objective.....	2
1.1.1 General Objective.....	2
1.1.2 Specific Objectives	2
CHAPTER 2: LITERATURE REVIEW.....	
2.1 Low Body Mass Index.....	
2.2 Halal.....	
2.3 Oral Nutritional Supplements.....	
2.4 Calorie and Food Energy.....	
2.4.1 High calorie.....	
2.5 Functional Food.....	
2.5.1 Fruits.....	32
2.5.1.1 <i>Baccaurea angulata</i>	33
2.5.1.2 Banana.....	35
2.5.1.3 Mango.....	35
2.5.2 Milk.....	36
2.5.2.1 Yoghurt.....	37
2.6 Shelf-life study	38
2.6.1 Physical Testing.....	39
2.6.2 Chemical Testing.....	40
2.6.3 Microbiological Testing.....	41
2.6.4 Sensory Evaluation.....	41
CHAPTER 3: MATERIALS AND METHODS.....	
3.1 Formulation and Sample Preparation.....	46
3.2 Sensory Evaluation.....	48
3.3 Chemical Analyses.....	47
3.3.1 Protein Determination.....	
3.3.2 Fat Determination.....	
3.3.3 Ash Determination.....	

3.3.4 Moisture Determination.....	
3.35 Crude Fiber Determination.....	
3.36 Water Activity Determination.....	
3.4 Shelf life evaluation.....	55
3.4.1 Chemical Properties.....	
3.4.1.1 Peroxide Value Determination.....	55
3.4.1.2 Acidity Determination.....	56
3.4.1.3 pH Determination.....	57
3.4.1.4 Color Determination.....	57
3.4.2 Microbial Properties.....	57
3.4.2.1 Total Viable Count.....	58
3.4.2.2 Determination of Yeast and Mould.....	58
3.5 Human Study.....	59
3.5.1 Anthropometry Measurements.....	
3.5.2 Food Intake Record.....	
3.5.3 Physical Activity Record.....	60
3.5.4 Study Area.....	61
3.5.5 Sampling and study design.....	61
3.6 Statistical Analysis.....	61
CHAPTER 4: RESULTS AND DISCUSSION.....	
4.1 Sensory Evaluation.....	62
4.2 Proximate Analysis.....	65
4.3 Shelf-Life Study.....	69
4.3.1 Changes in nutrient content.....	69
4.3.2 Changes in chemical qualities.....	70
4.3.3 Microbiological Analysis of powdered beverage....	74
4.4 Human Study.....	76
CHAPTER 5: CONCLUSION.....	
5.1 Conclusion.....	83
5.2 Strength and Limitations.....	84
5.3 Recommendations.....	85
REFERENCES.....	86
APPENDIX.....	

LIST OF TABLES

Table 2.1	Types of ONS available in Malaysia
Table 2.2	Proximate composition and a_w of dried <i>B.angulata</i>
Table 3.1	Beverage formulations and its ingredients
Table 4.1	Sensory attributes of formulated beverages and control
Table 4.2	Proximate analysis of formulated beverages
Table 4.3	Proximate analysis of powdered beverage
Table 4.4	Comparison of macronutrients between F3 & Enercal® Plus
Table 4.5	Shelf life evaluation of powdered beverage for nutrient content
Table 4.6	Shelf life evaluation of powdered beverage for chemical qualities
Table 4.7	Shelf life evaluation of powdered beverage for microbiology properties
Table 4.8	Characteristic of study respondents
Table 4.9	Reported daily intake of subjects
Table 4.10	Weight gain and body weight difference between groups
Table 4.11	Body Mass Index (BMI) of subjects

LIST OF FIGURE

Figure 3.1	Formulation F1
Figure 3.2	Formulation F2
Figure 3.3	Formulation F3
Figure 3.4	Sensory Testing of sample
Figure 3.5	Drum dried F3 formulation before grounded
Figure 3.6	Grounded F3 formulation
Figure 4.1	Acceptability Factors (AF) for beverage formulations

LIST OF ABBREVIATIONS

NHMS III	National Health And Morbidity Survey III
ONS	Oral Nutritional Support
BMI	Body Mass Index
IWL	Involuntary Weight Loss
MDG	Malaysian Dietary Guidelines
CGAR	Compound Annual Growth Rate
KJ	Kilojoule
RNI	Recommended Nutrient Intake
KCAL	Kilocalorie
ADA	American Dietetic Association
RH	Relative Humidity
a_w	Water Activity
AOAC	Association Of Official Agricultural Chemists
PCA	Plate Count Agar
PDA	Potato Dextrose Agar

LIST OF APPENDICES

Appendix	Item
1	Approval letter from IREC
2	Research Information and Consent Form
3	Sensory analysis form
4	Published articles
5	Conference papers and posters

CHAPTER ONE

INTRODUCTION

Weight problems are often mentioned in media and other kinds of conversations, but we tend to focus only on obesity and overweight. However, there is another aspect of the question- there are some people who experience underweight problem. According to The Third National Health and Morbidity Survey (NHMS, 2011), the prevalence of underweight adults aged 18 and above was 8.3%. Even though the figure is relatively small compared to overweight and obesity, this excessive leanness or unintentional weight loss may disturb bodily functions or even worse, may lead to death especially among elderly. The management for underweight problems involve counselling and dietary change. The dietary change includes high-energy diets to gain weight where the person is encouraged to eat frequently, snacking, and also to eat in large quantity (Mahan & Escott-Stump, 2008).

Beside that, the usage of oral nutritional supplement (ONS) is also another viable option to gain weight. A review by Stratton and Elia (2007) showed there is increasing evidence that supports the usage of ONS especially among acutely ill and older patients besides only receiving dietary counselling. There are many types of ONS available that contain energy - with or without protein or micronutrients either in the form of liquids, powders or puddings. Its usage is not only limited to patients in hospital or elderlier, but to young people as well, for many young people, especially men, consume supplements daily for various reasons.

Because of current fast moving lifestyle, people tend to look for something that they can eat or drink on the go and the liquid form of ONS seems to be an excellent choice for those whom wanted to gain weight. According to Clark (2005), weight

gainers do not only need protein but also extra carbohydrates and calories. There are many food that can help in boosting calories intake, but the weight gainers have to choose wisely between the different quality of calories. Fruit smoothies that incorporate ingredients like bananas, yogurts, juices and milk can help escalate calorie intake and at the same time, may also increase body weight (Clark, 2005).

Even though these products are available in the market, they are very expensive due to the fact that the products are imported. Besides, the halal status of the products is questionable because of the food additives like emulsifiers that were added into the products . Thus, in this study we would like to formulate an alternative oral nutritional supplement from functional food available from the surroundings that consist as minimum as possible processed food. These standard formulations also are expected to be economically-effective and halal.

1.1 RESEARCH OBJECTIVES

1.1.1 General:

To produce an innovative oral nutritional supplement

1.1.2 Specific

- 1) To formulate an oral nutritional supplement from local fruits and functional food.
- 2) To determine the most preferable formulation of the oral nutritional supplement formulated.
- 3) To determine the chemical qualities and shelf life of the formulated oral nutritional supplement.

- 4) To compare and evaluate the effect of the formulated oral nutritional supplement with readily available weight gain product in the market for people with low Body Mass Index (BMI).

CHAPTER TWO

LITERATURE REVIEW

1.2 LOW BODY MASS INDEX

Body Mass Index (BMI) is an index used to determine whether a person is underweight or obese. The classification of BMI is different between the European and Asian populations. For Asian, the cut-off point for being underweight is having BMI of less than 18.5 kg/m² while for European the cut-off point is less than 20 kg/m² (Meier & Stratton, 2008). Having a low BMI is a health concern because there is an association between low BMI with greater mortality risk especially in those who are aging (Grabowski & Ellis, 2001). The term excessive leanness, unintentional or involuntary weight loss refer to being underweight. There is no standard definition for involuntary weight loss (IWL). However, it can be defined as an unintentional body weight loss of 5% or more within a 6-month period (Khan et al. 2002). According to Mahan and Escott-Stump (2008), those with body weight of 15% to 20% or less than the accepted weight standards are underweight.

Usually those with low BMI are malnourished. Saunders (2011) had listed several causes of malnutrition that are due to inadequate intakes, excess losses, altered nutrient processings, and malabsorption. Underweight problem is also a result of psychological and emotional stress like anorexia and bulimia nervosa that usually occur among teenagers.

The management for individuals with low BMI involves counseling especially among those who are anorexic or bulimic, along with nutrition support and dietary change. Based on the Malaysian Dietary Guidelines (MDG, 2010), it is important for weight gainers to eat consistently, have more frequent meals, eat larger portion than

the normal portion of food and do strengthening exercises like weight lifting or push-ups. Gaining weight does not mean to only focus on greater calorie intake as excess intake will be stored as body fat. For example, athletes who need to gain weight ideally should increase their lean tissue by consuming adequate carbohydrates and protein for tissue synthesis and also to do proper exercise regimen (McArdle, Katch, & Katch, 2005).

1.3 HALAL

Halal is an Arabic term that is translated as permissible. The Malaysian Halal Directory (2011) has described that the *halal* term as “originates from an Arabic phrase that means allowed or permitted by Islamic Law”. The Islamic Law, also known as Shari’ah had been interpreted by Muslim scholars over the years. The basic sources of the Islamic Law come primarily from the Holy Quran and also As-sunnah, the practices of the prophet Muhammad that were recorded in books of Hadith. In the Holy Book of Qur’an (*al-Baqarah*), it has been mentioned that:

O' mankind! eat of what is in the earth lawful(halal) and good (tayyib); and do not follow the footsteps of the devil, for he is to you an avowed enemy (168).

From this verse, it is very clear that the Muslims are required to consume food that are not only *halal* but also *toyyiban* (of good quality).

Food that are prohibited have also been mentioned in another verse of the same surah (*al-Baqarah*):

Verily, He has forbidden you only carrion, blood, swine flesh, and whatever has other (name) than Allah's been invoked upon it. But whoever is forced (by necessity), not desiring nor transgressing, no sin shall be on him; surely Allah is Forgiving, Merciful. (173).

In this verse, it can be summarised that the forbidden food or in another word, *haram* to be consumed, include carrion and dead animals, blood, swine, intoxicants

like alcohols and also incompliant methods of slaughtering or blessing. The main reason for such prohibition is due to impurity as well as having the potential to be hazardous to health. In addition, intake of alcohol and wine that are interpreted as substances that cause inebriety are harmful and poisonous to our body (Wahab, 2004).

In Malaysia, there are acts and regulations that help to make sure that goods meet certain standard for the consumption or usage once they reached the consumers which include the Trade Descriptions (Use of halal expression) Order 1975. This order, that comes under the Trade Description Act, has defined halal, in Section 3, as:

- 1) Neither is, nor consists of, nor contains any part or matter of any animal that a Muslim is prohibited by hukum syarak to consume or that has not been slaughtered in accordance with hukum syarak.
- 2) Does not contain anything which is considered to be impure according to hukum syarak.
- 3) Has not been prepared, processed or manufactured using any instrument that was not free from anything impure according to hukum syarak.
- 4) Has not in the course of preparation, processing, or storage, been in contact or close proximity to any food that fails to satisfy paragraphs (a), (b), (c) or anything that is considered to be impure according to hukum syarak.

Hence, the order clearly indicates that the meaning of halal is not only restricted to animal slaughtering and food consumption but also the whole process of food preparation. In addition to products, it is the duty of Muslims to ensure services made, sold, prepared or provided by non-Muslims are also halal. Among the examples are banking and insurance products where the more appropriate term that is used is Islamic-compliant or syariah-compliant (Shafie & Othman, 2006).

Normally, Muslims consider the food and products with the halal label or sign as fit for consumption and are prepared in compliance with Islamic rules and guidelines (Zalina, 2008). In Malaysia, the halal logo was introduced by Malaysia's Department of Islamic Development (JAKIM) made available not only for food products but also food outlets, indicating the products meet the Islamic standard. The issuance of Halal certificate can be done by any individual Muslim, agency or organization. However, the acceptability of the certificate depends on the country of import or related bodies. Almost half of organizations that issue halal certificate which were previously approved are now delisted (Hanzaee & Ramezani, 2011).

A study by Abdul, Hashanah, Haslina and Juliana (2009) showed that there is a significant relationship between respondents' religion and their preceptions towards halal logo and ingredients. Beside that, the main feature for Muslim consumers in selecting halal food is trust and confidence hence they would like to see the monitoring of genuine halal certification to become more proactive and fierce enforcement against non-halal food's false labeling as halal are to be carried.

1.4 ORAL NUTRITIONAL SUPPLEMENTS (ONS)

Oral Nutritional Supplements (ONS) is a part of nutritional support. They are dietary food consumed in addition of normal food for special medical purposes (Lochs et al., 2006). ONS are energy dense and contain both macronutrients and micronutrients usually ready-made in the form of liquid (Stratton & Elia, 2007). Lochs et al. (2006) has defined high energy formula as a formula that provides more than 1.2 kcal per ml while based on a review by Baldwin and Parsons (2004), usage of ONS may give benefits in a short term management of weight loss. The findings from a meta-analysis also suggested that mortality risk is reduced when ONS were given to patients (Meier & Stratton, 2008). Most of these ONS are used among hospitalised patients.

People tend to misunderstand the concept of weight gaining or muscle building because many believe that to build muscle all they need is a high protein diet or supplement. A study among people exercising in gym showed more than half of the subjects consumed protein and amino acids supplements while only 23% consumed supplements rich in carbohydrates (Goston & Correia, 2010). From the same study, among the reasons supplements were consumed are to restore nutrients (42.4%), to increase strength or muscle mass (22.7%), to cover for nutritional deficiencies (16.3%) and to prevent future diseases (8.6%). Adequate protein is important for muscle growth but calories from carbohydrates and fat are also needed to fuel the muscle growth (Malaysian Dietary Guidelines, 2010). Weight gainers need to have adequate protein, extra carbohydrates, extra calories preferably from carbohydrates while any protein supplements are in fact not needed (Clark, 2005).

There are many types of ONS available that contain energy, with or without protein or micronutrients either in the form of liquid, powders or puddings. Since beverages do not take time to be consumed and emptied from the stomach rapidly compared to solid food (Kissileff, 1985), liquid form of ONS are usually convenient choices. Types of ONS available in Malaysia are summarized in Table 2.1.

From the table, the range of energy the ONS provided is between 300-450 kcal/100g. Among the ONS, Enercal Plus ® (Wyeth Nutrition ®) and Peptamen ® (Nestle ®) both contain the highest energy content, but only Enercal Plus ® is available for adults with underweight problem. In terms of macronutrients content, the carbohydrate content of all the ONS is between 50-90 g/100g. Majority of the energy content is contributed by carbohydrate (95g/100g) for Carborie® (Valens®) while the content of protein and fat are 0g/100g. The range of protein content for the ONS is between 16-30g/100g while for fat is between 10-18g/100g.