EFFICACY OF MANGOSTEEN JUICE CONCENTRATE MIXED WITH GARCINIA FOR WEIGHT LOSS IN OBESE FEMALES

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ABSTRACT

The aim of this study was to determine the efficacy of mangosteen juice concentrate mixed with garcinia for weight loss and body fat reduction in obese females. A repeated measures design was conducted with 42 obese females. This study provided nutritional therapy as the following: first 4 weeks (week 1 - 4) subjects received dietary advice for weight loss, weeks 5 – 8 subjects received the same dietary advice as week 1 – 4 and replaced 2 regular meals with 1 can mangosteen juice concentrate mixed with garcinia (MJ) with Garcinia biscuit barbecue (GB) for lunch and 1 can of MJ for dinner; and weeks 9 - 12 subjects also received the same advice as week 1 – 4. The body composition, 3 waist circumference sites, blood chemistry, 24-hr dietary record were followed up and evaluated every 4 weeks throughout the study.

After the obese female subjects drank MJ with GB with diet control for 4 weeks, the result showed that body weight, body mass index, body fat, segmental fat, and 3 waist circumference sites reduction were greater than the first 4 weeks of dietary advice. Moreover, the subjects who drank MJ with GB for lunch and 1 can of MJ for dinner gave them satiety, which then subsequently decreased their appetite. The study found that MJ with GB was able to help 10 subjects with uncontrolled diet; it helps them achieve their weight and body fat reduction more easily.

In conclusion, MJ with GB had better effects on weight loss and body fat reduction than diet control. It had an efficacy to reduce segmental fat and 3 waist circumference sites without any adverse effect.

KEY WORDS: OBESITY / WEIGHT LOSS / BODY FAT / MANGOSTEEN / GARCINIA

99 pages

ประสิทธิผลของน้ำมังคุดสกัดเข้มข้นผสมส้มแขกต่อการลดน้ำหนักในหญิงอ้วน

EFFICACY OF MANGOSTEEN JUICE CONCENTRATE MIXED WITH GARCINIA FOR WEIGHT LOSS IN OBESE FEMALES

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บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาประสิทธิผลของน้ำมังคุดสกัดเข้มข้นผสมส้มแขกต่อการลดน้ำหนักตัวและเนื้อเยื่อไขมันในหญิงอ้วน โดยการวิจัยเป็นแบบ repeated measures design ในกลุ่มหญิงอ้วน 42 คน นาน 12 สัปดาห์ โดยการศึกษานี้ทำการให้โภชนบำบัดดังนี้ ช่วง 4 สัปดาห์แรกของการศึกษา (สัปดาห์ที่ 1 - 4) กลุ่มตัวอย่างได้รับคำแนะนำในการควบคุมอาหารเพียงอย่างเดียว สัปดาห์ที่ 5 – 8 กลุ่มตัวอย่างได้รับคำแนะนำในการควบคุมอาหารเช่นเดียวกับสัปดาห์ที่ 1 – 4 ร่วมกับการรับประทานน้ำมังคุดฯ 1 กระป๋องพร้อมบิสกิตแทนมื้ออาหารกลางวัน และมื้อเย็น 1 กระป๋อง สัปดาห์ที่ 9 – 12 กลุ่มตัวอย่างได้รับคำแนะนำในการควบคุมอาหารเพียงอย่างเดียวเช่นเดียวกับสัปดาห์ที่ 1 – 4 การศึกษานี้ติดตามและประเมินผลทุก 4 สัปดาห์ด้วย สัดส่วนร่างกาย เส้นรอบวงเอว 3 ระดับ ค่าชีวเคมีในเลือด ข้อมูลการบริโภคอาหารใน 24 ชม.ซึ่งบันทึกตลอดการศึกษา

ผลการวิจัยพบว่า หลังจากรับประทานน้ำมังคุดฯร่วมกับการควบคุมอาหารนาน 4 สัปดาห์ กลุ่มตัวอย่างมีน้ำหนักตัว ดัชนีมวลกาย เนื้อเยื่อไขมัน เนื้อเยื่อไขมันตามส่วนต่างๆของร่างกาย และเส้นรอบวงเอวทั้ง 3 ระดับลดลงได้ดีกว่า ช่วง 4 สัปดาห์แรกที่มีการควบคุมอาหารเพียงอย่างเดียว และพบว่ากลุ่มตัวอย่างที่รับประทานน้ำมังคุดฯแทนมื้ออาหารรู้สึกอิ่มได้นานมากขึ้นส่งผลต่อการรับประทานอาหารปกติลดลง การศึกษานี้ยังพบว่าการรับประทานน้ำมังคุดฯสามารถช่วยให้กลุ่มตัวอย่าง 10 คน ที่ไม่สามารถควบคุมอาหารเพื่อลดน้ำหนัก สามารถลดน้ำหนักและเนื้อเยื่อไขมันลงได้ในสัปดาห์ที่ 8

สรุปผลการวิจัย น้ำมังคุดฯมีประสิทธิผลต่อการลดน้ำหนัก และเนื้อเยื่อไขมันได้ดีกว่าการควบคุมอาหารเพียงอย่างเดียว และส่งผลต่อการลดลงของเนื้อเยื่อไขมันตามส่วนต่างๆของร่างกายและเส้นรอบวงเอวทั้ง 3 ระดับ ได้อย่างมีประสิทธิภาพและไม่มีผลข้างเคียง

99 หน้า

CONTENTS

CONTENTS (cont.)

CONTENTS (cont.)

LIST OF TABLES

LIST OF TABLES (cont.)

LIST OF TABLES (cont.)

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASM	Anthropometric Standardization Reference Manual
ATP	Adenosine triphosphate
AUWC	Above umbilical line 5 cm waist circumference
BIA	Bioelectrical impedance analysis
BMI	Body mass index
BP	Blood pressure
BUWC	Below umbilical line 4 cm waist circumference
bw	Body weight
cm	Centimeter
cont.	Continued
DBP	Diastolic blood pressure
dL	Decilitre
DM	Diabetes mellitus
FBG	Fasting blood glucose
FFM	Fat free mass
g	Gram
GB	Garcinia biscuit barbecue
GERD	Gastroesophageal reflux disease
HCA	Hydroxy citric acid
HDL-C	High density lipoprotein
IFG	Impaired fasting glucose
kcal	Kilocalorie
kg	Kilogram
lb	Pound
LDL-C	Low density lipoprotein
m	Meter

LIST OF ABBREVIATIONS (cont.)

mg	Milligram
MJ	Mangosteen juice concentrate mixed with garcinia
mL	Milliliter
mmHg	Millilitre of mercury
n	Number
NCD	Non-communicable diseases
NHANES	National Health and Nutrition Examination Survey
NIH	National institutes of health
PCOS	Polycystic ovary syndrome
r	Pearson's correlation coefficient
RDI	Recommended Daily Intakes
SBP	Systolic blood pressure
SD	Standard deviation
SGOT	Serum glutamic oxaloacetic transaminase
SGPT	Serum glutamic pyruvate transaminase
SPSS	Statistical Package for the Social Sciences
T2DM	Type 2 diabetes mellitus
TBW	Total body water
Tsp	Teaspoon
UWC	Umbilical line waist circumference
WC	Waist circumference
WHO	World health organization

CHAPTER I
INTRODUCTION

1.1 Background and rationale

Obesity is generally caused by energy intake over energy expenditure. The excess energy intake is stored by the body fat. Situation of obesity were higher than in the several years ago. World health organization (WHO) reported more than 1.9 billion adults aged 18 years and older were overweight. Of these over 600 million adults were obese. In each year at least 2.8 million people die from overweight and obese. In 2014, the global adult populations 11% of men and 15% of women were obese. Overweight and obesity are major risk factors for non-communicable disease (NCD) including diabetes mellitus (DM), hypertension, dyslipidemia, cardiovascular diseases and cancer. Health benefits of weight loss improve nutrition status. It can be reduce risk factor of NCD and decrease mortality from obesity (1).

According to healthy diet plans, reducing caloric intake, and increasing in physical activity is the basis for success long term weight loss, but the major problem of many people are incapable of losing weight because dietary behavior and lifestyle changes are difficult, these obese people find out the alternative choices for losing weight such as health foods or natural supplement foods promoted for weight loss in the expect that these products will help them more easily achieve their weight reduction (2).

In currently a wide variety natural supplements claim for weight loss distribute on health market. Mangosteen has been used for weight management.

Mangosteen (*Garcinia mangostana* L.) is a queen of fruit because of its light green calyx of deep purple fruit similar to queen crown. Xanthone is major bioactive compound of mangosteen. The two most beneficial xanthones in the mangosteen were α-mangostin and γ-mangostin (3).

Liu et al. (4) reviewed the anti-obesity activity of xanthones from *Garcinia mangostana*. They concluded that action of xanthone lead to goal of anti-obesity composed three ways anti-adipogenic, anti-inflammation, and anti-oxidation. α-Mangostin and γ-mangostin have been inhibiting adipogenesis and reducing fat accumulation. Activity on anti-inflammation is adipocyte stimulate inflammatory cytokines. Moreover α-mangostin is anti-oxidative stress.

Garcinia (*Garcinia cambogia* Desr.), it is in the same specie of mangosteen. Activities of hydroxycitric acid on anti-obesity are various mechanisms. It suppresses appetite on serotonin increasing and stimulate fat oxidation (fat burning). Beside it decreases lipogenesis from inhibiting enzymatic pathway for converting carbohydrate into fatty acid (*de novo lipogenesis*) (5).

Several studies showed the benefits of *Garcinia mangostana* or *Garcinia cambogia* for weight management and reducing body fat accumulation (4, 5). Thus we are interested to study the synergy effects of combined *Garcinia mangostana* and *Garcinia cambogia* on weight loss and body fat accumulation.

Rationale of this study we aim to evaluate efficacy of mangosteen juice mixed with garcinia for weight loss and body fat reduction in obese females.

1.2 Objectives

1.2.1 To study efficacy of mangosteen juice concentrate mixed with garcinia on

1.2.1.1 weight loss and body fat reduction in obese females

1.2.1.2 dietary intake reduction or satiety improvement

1.2.1.3 lowering blood lipid and glucose levels

1.2.2 To study safety and side effects of mangosteen juice concentrate mixed with garcinia.

CHAPTER II
LITERATURE REVIEW

2.1 Obesity

2.1.1 Definition of obesity

Obesity is defined as an excessive or abnormal fat storage. Adipocyte dysfunction is a major cause of obesity. Under positive energy balance condition, preadipocytes in adipose tissue differentiate into adipocytes, and the excessive accumulation of lipids in adipose tissue (1). The amount of lipids in adipose tissue is the cumulative sum over time of the differences between energy intake and energy expenditure. Although very small energy imbalances over a long period can have a large cumulative effect. The current availability of highly palatable, calorically dense foods and a sedentary lifestyle promote weight gain (6). The majority of fat storage in the human body is present as subcutaneous body fat. Most of females, a high percentage of the subcutaneous adipose tissue surround the areas of the breasts, waist, and hips. Most of males have a high percentage of their subcutaneous adipose tissue distributed around the fat areas of the chest, and abdomen (7).

2.1.2 Causes of obesity

The major cause of obesity is an energy imbalance. Increasing high energy density, nutrient-poor foods with high levels of sugar and saturated fat consumptions combined with lack of physical activity lead to excess energy that was kept in adipocyte. Evidence to support the view that obese people slightly consuming yet gain weight due to a slow metabolism is not generally supported. On average, obese people have greater energy expenditure than their thin counterparts due to the energy required to maintain an increased body mass. Some hormone problems are cause obesity, underactive thyroid hormone (hypothyroidism), adrenal glands excess created cortisol hormone (Cushing's syndrome), and polycystic ovarian syndrome (PCOS). Genes and

family history also may affect the amount of fat accumulation. Family also shared diet and physical activity habits, a link exists between genes and the environment. Moreover other causes are age, medicines, lake of sleep, and emotional factors (8).

2.1.3 Classification of obesity

Body mass index (BMI) is a commonly determine body weight status but limitation of using BMI change may not be an indicator of fat accumulation or adiposity. Some individuals who are overweight are not over fat (eg, bodybuilders). Others have BMI within the normal range and yet have a high percentage of their body weight as fat. Although these misclassified persons are uncommon relative to the population as a whole. Fatima et al. (9) found subject group within normal weight for BMI individuals, 3% turned out to be underweight, 12% as overweight and 9% with obese when their body fat was measured. Obesity is classified by percentage of body fat, > 30%bw in female and > 20%bw in male (10).

2.1.4 Prevalence of obesity

The increasing prevalence of obesity in the United States and worldwide is a cause of great concern both for the health of individuals and for national health care systems. Obesity has reached epidemic proportions worldwide. This condition, and its related diet related chronic disease have become major public health. The prevalence of obesity is more than doubled between 1980 and 2014 in worldwide. WHO found 13% of the world adult populations were obese (11% of men and 15% of women) in 2014 (1).

Thailand health reports in 2013 found that the prevalence of obesity and abdominal obesity were 34.7% and 32.1% of the population respectively. In addition Thai females were found an excess BMI (40.7%) and risk of NCD (80.4%) more than Thai males who had excess BMI 28.4% and risk of NCD 67.7%. Prevalence of abdominal obesity in female increased from 36.1 % to 45% in 2013. Obesity has also been associated with an increased risk of morbidity in females (11).

2.1.5 Complications of obesity

The metabolic abnormalities induced by obesity frequently contribute to cardiovascular disease, T2DM, dyslipidemia, hypertension, fatty liver, gallstones, and PCOS. Obesity induces both quantitative and qualitative changes in adipose tissue macrophages that promote a state of chronic low-grade inflammation. Inflammation is an initiating factor in insulin insensitivity and disturbances in lipid metabolism including hypertensive (12).

2.1.6 Incapableness of losing weight

Many obese people were unsuccessfully achieve to weight loss by common factors such as uncontrolled energy intake, lack of exercise, their sedentary life style, and stress. Diet strategy for weight management failed before weight loss goals because many which they believed that people losing intention and they tried to use dietary supplements promoted for weight loss, that these products will help them more easily achievements (13).

2.2 Body composition

Body composition consist two compartments as fat and fat free mass (muscle, bone, and total body water). Measurement of body composition is anthropometrics assessment. Techniques for measuring body composition of fat and lean body mass include anthropometry and bioelectrical impedance analysis (BIA). Other techniques, including dual X-ray absorptiometry (DXA), hydrodensitometry, total body potassium measurement, and cross-sectional computed tomography or magnetic resonance imaging are available in research centers. Anthropometry, including waist-hip ratios, regional DXA, and cross-sectional imaging, is best for detecting morphologic changes associated with fat redistribution syndrome (14, 15).

2.2.1 Body fat

Adipose tissue (body fat) is connective tissue composed of adipocytes. Its separate the two types are brown adipose tissue (BAT) and white adipose tissue (WAT). Brown adipose tissue put up body heat and stimulate metabolism. Role of white adipose tissue are energy storage and protect internal-organ from mechanical force. Adipocyte secretes adipokines (adiponectin, leptin, and resitin) as metabolism hormone. If those hormones imbalance it effect on health. **Figure 2.1** shows the relationship of 3 adipokines created from adipocyte on metabolism functions. Leptin is satiety hormone and stimulate energy expenditure. Adiponectin has potent effects on carbohydrate and lipid metabolism. Resistin reduce glucose uptake in liver and relate with insulin function (16).

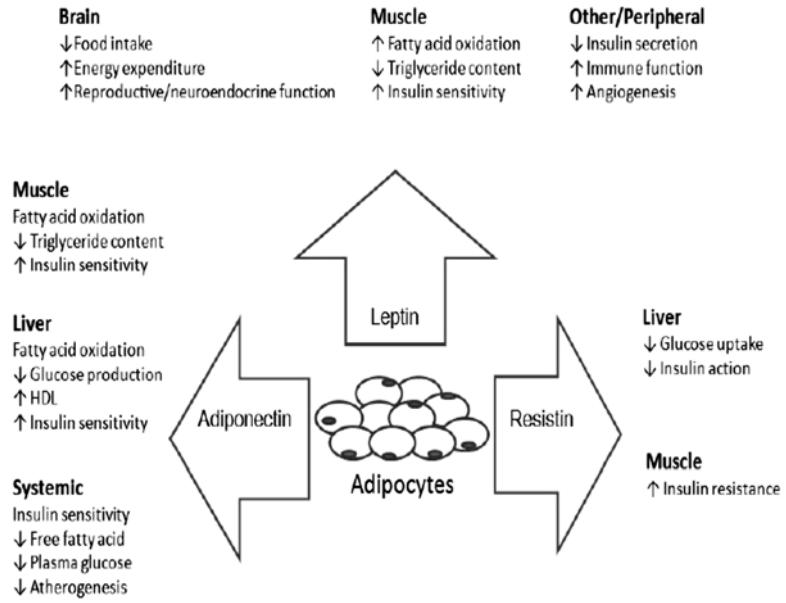

Figure 2.1 Relationship of 3 adipokines as leptin, adiponectin, and resistin on metabolism functions ↑= increase and ↓= decrease (16)

2.2.2 Fat free mass

Fat free mass (FFM) is composed of muscle, bone, and total body water. Bones are structure of body. Muscle mass includes the skeletal muscles, smooth muscles, cardiac muscle, and the water contained in these muscles. Muscles are the role of body movement and energy expenditure. Muscle tissue is the creation of body heat. In consequence of the high metabolic rate of contracting muscle, more muscle

contractions lead to increase in body temperature. The final part of fat free mass is total body water. It controls body temperature and get rid of waste. Moreover it contain in muscle mass (17).

2.3 Bioelectrical impedance analysis (BIA)

Bioelectrical impedance analysis (BIA) is a commonly used method for measurement body composition. A method is assessed body composition by electrical resistance. A very low, safe electrical signal is sent from four metal electrodes through body. In segmental models, the four hand-held electrodes will provide extra readings for each leg, arm and abdominal area. The electrical signal flow quickly through water that present in hydrated muscle tissue but finds resistance when it meets fat tissue. This resistance, known as impedance, is measured and input into scientifically validated equations to calculate body composition measurements. Body composition measurements are provided in less than 20 seconds. BIA method is advantage because it is safe, low cost, rapid and easy to perform (18).

2.4 Waist circumference

Waist Circumference (WC) is a simple method for assessing the central obesity (abdominal obesity). Because of WC is associated with the visceral fat. Visceral fat is independently correlated with risks of NCD as DM, hypertension, dyslipidemia, and cardiovascular disease etc. Midpoint between the lowest rib and iliac crest is commonly WC measurement but differences trunk fat storage and distribution depend on individual. This study selected 3 sites for WC measurement applied methods from the WHO, NIH and ASM (19). **Figure 2.2** shows sites of waist circumference were measured as above umbilical line 5 cm (AUWC), umbilical line (UWC), and below umbilical line 4 cm (BUWC). The cut-off points of WC for detecting abdominal obese follow as female: WC> 80 cm and male: WC > 90 cm.

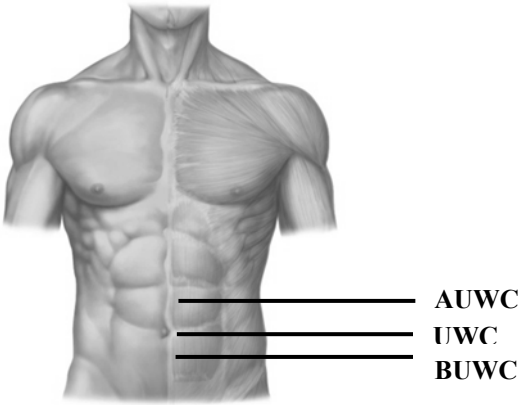

Figure 2.2 The 3 waist circumference sites

2.5 Mangosteen

Mangosteen is an economic fruits in Thailand, called Mangkhud. Its common name is mangosteen, scientific name is *Garcinia mangostana* L. (Family of CLUSIACEAE) **(Figure 2.3)** Mangosteen is a tropical fruit originated in Peninsular Malaysia. The southern regions of Thailand are the largest mangosteen cultivation area and the region produces good quality of mangosteen. Thailand is the top mangosteen exporter in the world and the sales revenue from mangosteen are more than 4,000 million baht per year. Thailand export statistics reports that in 2014 the amount of mangosteen export was 195,838 tons, which were fresh fruit and frozen fruit amounted to 195,108 tons and 729 tons respectively (20, 21, and 22).

Figure 2.3 Mangosteen fruit (*Garcinia mangostana* L.) (23)

United states department of agriculture reported that within 100 g of mangosteen the nutrient values provided are as follows: energy 73 kcal, carbohydrate 17.91 g, protein 0.41 g, fat 0.58 g, fiber 1.8 g ,vitamin C 2.9 mg, vitamin B1 0.054 mg, vitamin B2 0.054 mg, niacin 0.286 mg, vitamin B6 0.018 mg, and potassium 48 mg (24).

Obolskiy et al. (3) reviewed literature about the phytochemistry and pharmacology of mangosteen. The survey reveals that major phytochemical found in *Garcinia mangostana* L. are polyphenolic compound (xanthones) and other active compounds also found are flavonoids (epicatehin) and anthocyanins (chrysanthemin, cyanidin-3-o-sophoroside, cyanidin-3-o-glucoside).

Ibrahim et al. (25) found that bioactive compound of mangosteen has fifty xanthones containing in the pericarp. The xanthone which found most are α-mangostin and γ-mangostin **(Figure 2.4)**. Many studies both in vitro and in vivo investigate the pharmacological effect of α–mangostin (α-MG) about anti-oxidant, anti-inflammation, anti-proliferation, and anti-infection.

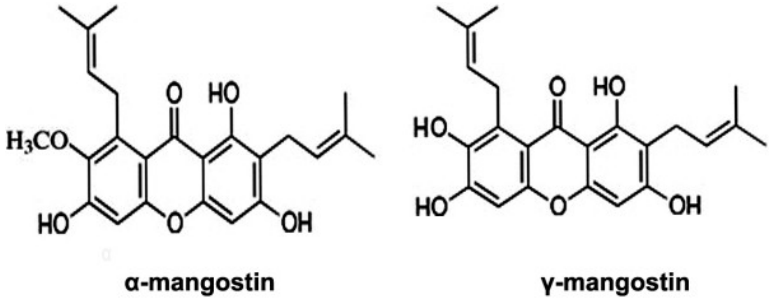

Figure 2.4 The structure of α–mangostin and γ-mangostin (26).

Chitchumroonchokchai et al. (27) studied the bioavailability of xanthones in mangosteen juice. Total xanthones in mangosteen juice as α–mangostin, garcinones, γ-mangostin, gartanins, and other xanthones were 58%, 2%, 6%, 4%, and 5% respectively.

Taher et al. (28) evaluated the effective of α-mangostin extract from bark of *Garcinia malaccensis* (plant which is similar to family of mangosteen). The α-mangostin could increase gene expression of leptin hormone in vitro study. Leptin hormone relate to satiety index, hence reducing appetite and improving energy expenditure influence for weight loss.

Udani et al. (29) separated obese subject into 4 groups. Each group received different dose of mangosteen juice blended with other berry juice. (Xango™) Three groups received different dose of mangosteen juice blend which were 6, 12, and 18 oz per day, and compared with the placebo group receiving juice compose of sucrose flavor, citric acid and caramel color for 8 weeks. They found that the subjects drank 6 oz per day significantly reduced BMI and body fat percentage.

Quan et al. (30) studied in vitro found that α-mangostin extracted from the trunk of mangosteen could inhibit fatty acid synthesis in 3T3-L1 preadipocyte cells. α-Mangostin concentrate 20 μM inhibits 50% of fatty acid synthesis (inhibitory concentration : IC_{50}) and suppress on 3T3-L1 preadipocyte cells function. Such suppression decreases fat accumulation and stimulates lipolysis in mature adipocytes.

Stern et al. (31) studied the efficacy of 7-hydroxyfrullanolide, the phytochemical in *Sphaeranthus indicus* and α-mangostin, the phytochemical in *Garcinia mangostana* on weight loss. Obese subjects received 2 capsules of herbal extract per day, each capsule is 400 mg consisting of 300 mg from the flower of *Sphaeranthus indicus* and 100 mg from the pericarp of mangosteen. After 8 weeks of the experiment the herbal blend group had significant net weight loss of 3.8 kg (4.6%) in comparison with the placebo group. In addition BMI, waist and hip circumferences are significantly reduced from baseline 1.6 kg./m^2 (4.6%), 5.9 cm (6.0%), and 3.2 cm (2.7%) respectively. Biochemical assessment which includes total cholesterol, triglyceride, and fasting blood glucose (FBG) also significantly decreased 13.8%, 41.6%, and 12.2% respectively.

A randomized, double-blind, placebo-controlled studied of the efficacy and tolerability of Meratrim® (*Sphaeranthus indicus* flower heads and *Garcinia mangostana* fruit rinds) controls body weight in overweight human. After 16 weeks the Meratrim® group had significant reduce anthropometric parameters as weight, waist and hip circumferences. Including biochemical assessment (total cholesterol, LDL-cholesterol (LDL-C), triglyceride, and FBG) were significantly reduced from baseline. This study no differences were seen in the liver and the kidney functions. It did not show adverse effects (32).

Saiyed. et al. (33) evaluated the safety of herbal extract (*Sphaeranthus indicus* and *Garcinia mangostana*) and they also assessed food consumption and body

weight in rats. The result showed significant decreased in food consumptions and weight loss in the male rat group received herbal extract 1000 mg/kg/day at week 1 and 3.

Researchers of operation BIM of the Thai mangosteen research and development centre studied effect of mangosteen concentrate 80% (mangosteen aril 80% and water 20%) in obese subjects for reducing excess body fat. Obese subjects drank mangosteen juice concentrate 1 bottle (300 ml) before meal per day for 4 weeks, both mean body weight and mean WC decreased from baseline 1.41 kg and 5.55 cm, respectively (34).

2.6 Garcinia

The common name of garcinia is Malabar tamarind. Its Thai name is SOM-KAK. Its scientific name is *Garcinia cambogia* Desr. (Family of CLUSIACEAE). Originated in India, it was in the same specie with mangosteen (35) **(Figure 2.5)**.

Figure 2.5 Garcinia fruit (*Garcinia cambogia* Desr.) (36)

The southern of Thailand is main cultivation area of the Garcinia give plant, sour flavor fruit which was used in cooking. Hydroxy citric acid (HCA) is an active compound which was found in garcinia. The acid has an effect on weight reduction **(Figure 2.6)**.

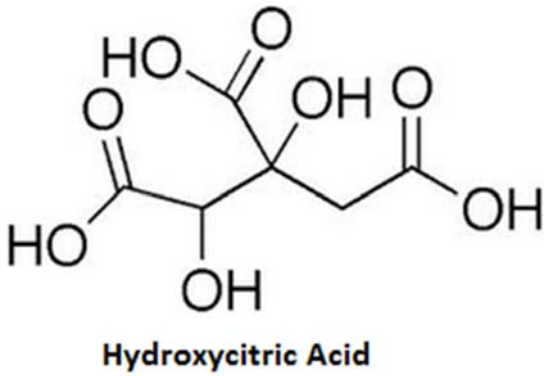

Figure 2.6 The structure of hydroxy citric acid (HCA) (37)

Chuah et al. (5) reviewed many clinical studies on the topic of HCA effecting for weight loss. They found that the HCA could stimulate the brain to increase serotonin secretion. Serotonin hormone helps to reduce appetite and effects to fat metabolism by reducing lipogenesis. Moreover, it could stimulate fat oxidation. They also found that HCA could inhibit ATP citratelyase enzyme in kreb'cycle. Without such inhibition, ATP citratelyase enzyme will change citrate into oxaloacetate and acetyl-CoA which then subsequently change into malonyl-CoA causing fatty acid synthesis **(Figure 2.7).**

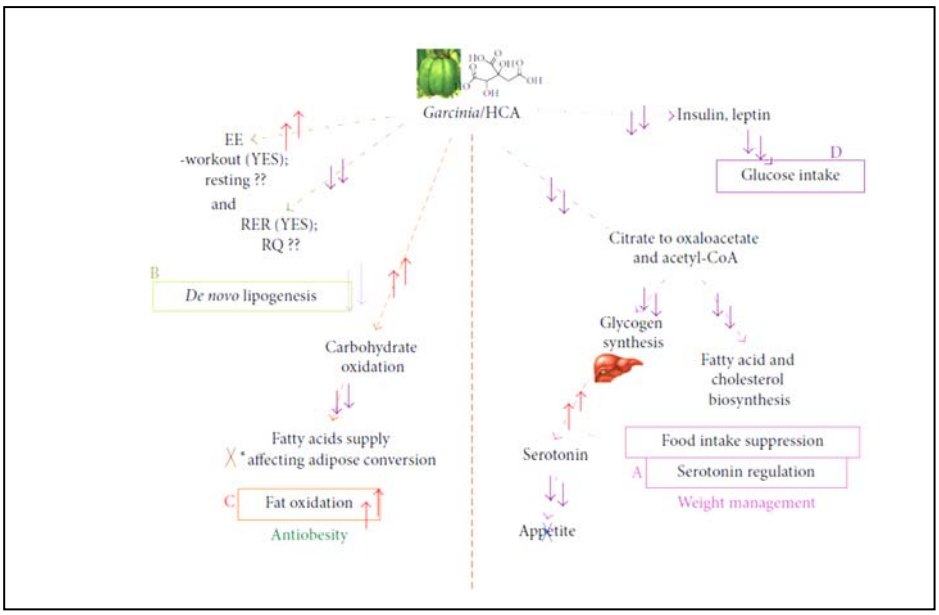

Figure 2.7 Effects of HCA on anti-obesity (5)

Kovacs et al. (38) studied effects of HCA on fat synthesis (i.e. *de novo lipogenesis*) in sedentary males after 10 days from high carbohydrate consumption and 500 mg HCA supplement 3 times/day compared with placebo. HCA group was significantly reduced lipogenesis 11% (*de novo lipogenesis*).

Westerterp-Plantenga et al. (39) studied overweight subjects group consumed tomato juice 100 ml mixed with HCA 300 mg compared with placebo group consumed tomato juice 100 ml for 2 weeks. In tomato juice blends group both of 24-hr energy intake and energy from snack meals were significantly reduced 1670 ± 500 kcal and 380 ± 350 kcal compared with placebo, respectively. Due to this study was short time, this not showed statistically significant decreased body weight 0.5 kg from baseline.

Hayamizu et al. (40) studied in central obese subjects (visceral fat area >90 cm^2), separated into 2 groups. Comparison visceral fat in both of the garcinia extract group, 1000 mg/day, and placebo group after supplement for 16 weeks, they found garcinia extract group had significant reduced visceral fat area 86.4 ± 2.1 cm^2 (P =0.001) and subcutaneous fat area significantly reduced 85.4 ± 3.1 cm^2 from baseline (P <0.001).

Roongpisuthipong et al. (41) studied effects of water soluble calcium hydroxycitrate in *Garcinia atroviridis* for reducing body weight and body fat in obese subjects. Obese subjects were separated 2 groups. Group 1 received water soluble calcium contains HCA 1.15 g and group 2 received placebo (water soluble calcium). Both groups consumed 3 times/days for 2 months. After supplement in group 1 had significant reduced body weight 2.3 ± 0.1 kg and 2.8 ± 0.1 kg at week 4 and 8, respectively. At week 8 group 1 had significant decreased body fat from baseline 4.9% of body weight whereas, this group significantly increase muscle mass 1.3 kg.

Márquez et al. (42) has made a review literature about the safety and efficacy of hydroxycitric acid. Previous study reported of no adverse effects from garcinia supplement in subjects. But in rare case studies was found slightly adverse effect in experimental animals as testicular atrophy in Zucker rats received high dose HCA for long term, these related to the lactone content of HCA affecting its solubility.

CHAPTER III
MATERIALS AND METHODS

3.1 Study design

This study is a repeated measures design. The design was used for single group. The study repeated measurement to compare the same outcome under two or more different conditions (43). This study was a 12-weeks in obese females who had %body fat > 30 %bw. This study provided nutritional therapy as the following: first 4 weeks (week 1 - 4) subjects received dietary advice for weight loss, weeks 5 – 8 subjects received the same dietary advice as week 1 – 4 and replaced 2 regular meals with 1 can mangosteen juice concentrate mixed with garcinia (MJ) and garcinia biscuit barbecue (GB) for lunch and 1 can of MJ for dinner, and weeks 9 - 12 subjects also received the same advice as week 1 – 4.

3.2 Study place

Health Empowerment Ramathibodi Centre and Graduate Program in Nutrition Faculty of Medicine Ramathibodi Hospital, Mahidol University.

3.3 Duration of study

June 2015 – June 2016

3.4 Recruitment of subjects

3.4.1 Sample size calculation

This study used single group formula for sample size calculation (44).

Formula

$$n = \frac{\left[Z_{\alpha/2} + Z_{\beta}\right]^2 \sigma^2}{(\mu - \mu 0)^2}$$

According to Stern et al. (31) studied effects of herbal extract for weight loss. Obese subjects received 2 capsules of herbal extract per day, each capsule is 400 mg consisting of 300 mg from the flower of *Sphaeranthus indicus* and 100 mg from the pericarp of mangosteen. At week 4, herbal extract group had significant reduced weight 3.1 ± 1.4 kg, this figure was used for sample size calculation.

α = 0.05 (two-sided) 1- β = 0.2

μ = 3.1 (the average of body weight reduction at week 4 of Stern study)

μ_0 = 3.72 (the average of body weight reduction was expected of our study)

= 3.1 + (20% of 3.1)

6 = SD = 1.4

$$n = \frac{[1.96 + 0.84]^2 1.4^2}{(3.72 - 3.1)^2}$$

= 41 subjects

Expected drop out 10% of subjects thus the number of including subjects 41 - 46 subjects

3.4.2 Inclusion criteria

3.4.2.1 Adult females aged 20-70 years

3.4.2.2 Subjects had body fat > 30 % of bw (10).

3.4.2.3 Subjects did not use drug or supplements that affect on weight loss.

3.4.2.4 Subjects had no medical history of liver disease, kidney disease, thyroid disease, and infectious disease

3.4.2.5 Subjects were able to participate throughout the study.

3.4.3 Exclusion criteria

3.4.3.1 Liver disease, kidney disease, thyroid disease, and infectious disease were found in subjects from first blood examination.

3.4.3.2 Subjects were not able to participate throughout the study

3.4.3.3 Subjects reject or withdraw from study.

3.5 Diets for study

3.5.1 Mangosteen juice concentrate mixed with garcinia is considered as a healthy drink with, low energy, high fiber, fat free, no added sugar and can be for weight reduction. This juice is made from mangosteen aril, good texture, used as meal replacement, and no toxic from pericarp tannin. **(Table 3.1)** (Appendix A)

Table 3.1 Nutritional value of mangosteen juice concentrate mixed with garcinia (Goldshape drink®)

Juice	**Amount/250 ml (1 serving)**
Ingredients	
Mangosteen aril	70.0 %
Garcinia	4.0 %
Water	26.0 %
Nutritional values	
Energy	109 kcal
Carbohydrate	25.8 g
Sugar	22.5 g
Dietary fiber	1.7 g
Protein	1.7 g
Fat	0 g
Sodium	13.3 mg

®Asian Phytoceuticals Public Co., Ltd. (APCO)

Mangosteen juice concentrate mixed with garcinia (MJ)

3.5.2 Garcinia biscuit barbecue flavor is healthy snack, low energy, low sugar, low fat, low sodium and high fiber. This biscuit contains 22.7% of garcinia **(Table 3.2)** (Appendix A).

Table 3.2 Nutritional value of Garcinia biscuit barbecue flavor (Goldshape biscuit®)

Biscuit	**Amount/100g (60 sheets)** **serving size 10 sheets**
Ingredients	
Rice	68.3 %
Garcinia juice	22.7 %
Maltodextrin	1.75 %
Sugar	1.15 %
Palm oil	3.0 %
Seasoning	6.0 %
Tomato powder	1.05 %
Salt	0.66 %
Tocopherol	0.002 %
Nutritional values	
Energy	60 kcal
Carbohydrate	12.5 g
Sugar	0.14 g
Dietary fiber	0.50 g (2 % RDI)
Fat	0.75 g
Saturated fat	0.08 g (1.2 % of biscuit calorie)
Protein	1.0 g
Sodium	195 mg (8.1 % RDI)

®Asian Phytoceuticals Public Co., Ltd.

Garcinia biscuit barbecue (GB)

3.6 Process of study

3.6.1 At weeks 1-4 subjects received dietary recommendation for weight loss such as reducing a portion of daily food, fried foods, high saturated fat foods, and Trans fat consumptions. Drinking fresh water replaced sweetened beverages. Increasing fresh vegetables, fresh fruits, whole grains, and healthy sources of protein such as fish, chicken breast, tofu, and low-fat dairy consumptions.

3.6.2 At weeks 5-8 subjects received dietary recommendation combined with MJ consumption. The subjects consumed 2 cans of 250 ml MJ per day; one can with 10 pieces of GB for lunch and the other one with a few regular diets for dinner (Appendix B).

3.6.3 At weeks 9-12 subjects received the same dietary recommendation as week 1 - 4.

3.7 Nutritional assessments

3.7.1 General information

Collecting dietary behavior and health information from questionnaire at week 0 (Appendix C)

3.7.2 Anthropometric measurements

3.7.2.1 Tanita BC-418 Body Composition Analyzer

This measurement tool use to measure weight and analyzes body composition. The hand grips were added to allow the BC-418 model to assess segmental body composition. It use of 8 electrodes to detect body composition mass for the right arm, the left arm, the trunk, the right leg and the left leg.

3.7.2.2 Body composition

At weeks 0, 4, 8, and 12, subjects were assess body composition by Tanita BC-418 Body Composition Analyzer, Tanita Co.Ltd., Japan (45) and measurement 3 WC sites as above umbilical line 5 cm (AUWC), umbilical line (UWC), and below umbilical line 4 cm (BUWC) (19).

3.7.3 Blood pressure measurement

Blood pressure (BP) were measured at weeks 0, 4, 8, and 12

3.7.4 Biochemical measurements

At weeks 0, 4, 8, and 12, obese subjects have to fasting 8 - 12 hours prepared for biochemical blood test. Blood samples were collected total 10 ml for analysis including levels of serum uric acid, hemoglobin, FBG, total cholesterol, HDL-C, LDL-C, triglyceride, creatinine, BUN, SGOT, and SGPT which were detected by automated blood BS-400 Chemistry Analyser, Mindray bio-Medical Electronics Co.Ltd (46).

3.7.5 Dietary assessment

24 hr-dietary record is method for dietary assessment diet throughout the study. Subjects wrote 24 hr-dietary records throughout the study. Energy and nutrient intakes were calculated by INMUCAL-Nutrients version 3 (47) (Appendix D).

3.7.6 Evaluating the acceptability, safety and adverse effect

The acceptability, safety, and adverse effect of MJ and GB consumption were evaluated by questionnaire at week 5 – 8 (Appendix E).

3.7.7 Physical activity and exercise

Physical activity and exercise records were collected throughout the study (Appendix F).

3.8 Criteria for nutritional status assessment (Appendix G)

3.8.1 Body weight status was classified by BMI, criteria of WHO 2004 (48).

3.8.2 Body fat status was classified by Gallagher et al., 2000 (10).

3.8.3 Dyslipidemia was classified by criteria of NCEP III 2002 (49).

3.8.4 Blood pressure status was classified by criteria of Thai Guidelines on The Treatment of Hypertension 2012 (update 2015) (50).

3.8.5 Fasting blood glucose status was classified by criteria of Thai Clinical Practice Guideline for Diabetes 2014 (51).

3.8.6 Hyperuricemia was classified by criteria of Thai Rheumatism Association 2009 (52).

3.8.7 Anemia was classified by criteria of WHO 2011 (53).

3.8.8 Liver function test was interpreted by criteria of Liver Foundation of Thailand (54).

3.8.9 Kidney function test was interpreted by criteria of 2016 National Kidney Foundation (55).

3.9 Ethic

The study was approved by the Ethical Clearance Committee on Human Rights Related to Research Involving Human Subjects Faculty of Medicine, Ramathibodi Hospital, Mahidol University (ID 05-58-26) Written informed consents were obtained from all subjects. (Appendix H).

3.10 Statistical analysis (56)

3.10.1 Descriptive Statistic

General information, body composition, dietary data, biochemical data, nutritional status, and acceptability of MJ and GB data were shown as MEAN (± SD) or percentage.

3.10.2 Inferential Statistic

3.10.2.1 Repeated measures ANOVA, Wilcoxon signed-rank test, and Pair t-test 95% CI (Confidence interval) were used for analyze differences each period of body composition, biochemical, and dietary outcomes.

3.10.2.2 Pearson's correlation 95% CI (Confidence interval) is used for correlation analysis between body composition, dietary, and biochemical outcomes. SPSS statistics 18.0 program for windows was used for statistical analysis.

CHAPTER IV
RESULTS

This study aimed to evaluate efficacy of MJ for weight loss and body fat reduction in obese females for 12 weeks. We included 42 obese female subjects, whose characteristics are presented in **Table 4.1**. The subjects aged 44.0 ± 11.8 (22 – 66) years, BMI 28.6 ± 4.3 (23.0 - 41.8) kg/m^2, and total body fat 41.2 ± 5.5 (32.8 – 55.8) %bw. Subjects were 25 with office workers (59.5 %), 10 subjects with medical personal (23.8%), and 7 subjects with other occupational (16.7%). 9.5% of subjects had highest range of body fat (50.1 - 60.0 %bw) **(Table 4.2)**.

4.1 Health information and dietary behavior

Subject health information showed 31.0% of total subjects had underlying diseases including, hypertension 46.1%, hypercholesterolemia 30.8%, GERD 7.7%, migraine 7.7%, and osteoarthritis 7.7%. All subjects with hypertension, hypercholesterolemia received drug therapy. Only 21.4% of our subjects had regular exercise including walking or jogging, fitness, bicycling, arm swing, and 5 of them had daily 30-60 minutes of exercise **(Table 4.3)**.

The study found 21.4 % of subjects skipped meal, 44.4 % skipped breakfast, and 44.4% skipped dinner. Half of our obese female subjects ate fast foods 1-3 times/week and ate a buffet 1-3 times/month. Only 11.9% of them did not eat animal fat. However, 40.5% of them did not eat animal skin, and 23.8% did not eat organ meats. Most of our subjects (97.6%) had snack meals during a day and 40.5% also had snacks before bed. Their favorite snacks were sweetened beverage and sweet fruits. Half of them usually added sugar or fish sauce to their dishes. Coffee, cocoa, soy milk, tea, fruit juice, and soft drink are their favorite beverages (**Table 4.4**).

Table 4.1 Initial characteristics of 42 obese female subjects

No.	Age, years	BMI, kg/m^2	Total body fat, %bw	Occupation
1	38	41.8	55.8	Office worker
2	59	40.5	55.6	Housewife
3	47	38.5	53.1	Medical technologist
4	46	35.7	50.2	Office worker
5	42	34.7	49.1	Nurse
6	66	32.4	46.7	Nurse
7	52	31.6	45.2	Medical technologist
8	54	29.5	44.5	Cleaner
9	37	31.2	44.3	Office worker
10	25	30.7	43.8	Practical nurse
11	51	29.5	43.6	Laboratory technologist
12	51	28.6	43.4	Office worker
13	42	30.3	43.4	Office worker
14	56	29.2	42.5	Cleaner
15	39	29.3	42.4	Office worker
16	39	29.6	42.2	Medical technologist
17	43	29.7	42.1	Office worker
18	49	26.9	41.7	Office worker
19	23	28.3	41.4	Student
20	26	27.8	41.0	Office worker
21	59	27.9	40.3	Housewife
22	41	28.0	40.2	Teacher
23	53	25.3	40.0	Office worker
24	46	27.7	39.3	Office worker
25	40	25.7	39.0	Office worker
26	34	26.1	38.3	Practical nurse
27	35	27.2	38.3	Office worker
28	47	25.5	38.2	Office worker
29	58	26.0	37.8	Nurse
30	22	27.2	37.8	Medical technologist
31	24	25.3	37.7	Office worker
32	56	26.9	37.7	Tailor
33	62	26.2	37.3	Office worker
34	31	24.8	37.2	Office worker
35	45	24.3	37.1	Office worker
36	52	25.8	36.2	Office worker
37	50	25.2	36.1	Office worker
38	28	23.3	35.1	Office worker
39	59	26.5	35.1	Office worker
40	50	24.8	34.1	Office worker
41	23	23.7	33.6	Office worker
42	47	23.0	32.8	Office worker

Table 4.2 Subjects classified by body fat

Total body fat, %bw	N	% of subject	Mean ± SD (range)
30.1 - 40.0 (Over body fat I)	20	47.6	36.9 ± 1.9 (33.6-43.8)
40.1 - 50.0 (Over body fat II)	18	42.9	43.2 ± 2.2 (40.2-49.1)
50.1 - 60.0 (Over body fat III)	4	9.5	53.7 ± 2.6 (50.2-55.8)

Table 4.3 Health information and exercise in 42 obese female subjects

Information	n	% of total
Underlying disease (n=13)		
Hypercholesterolemia	4	30.8
Gastritis/ peptic ulcer/GERD	1	7.7
Hypertension	6	46.1
Migraine	1	7.7
Osteoarthritis	1	7.7
Drug therapy		
Hypertension	6	100
Hypercholesterolemia	4	100
History disease		
Ovarian Cancer	1	2.4
Cardiovascular disease	1	2.4
Frequency of exercise or physical activity		
no exercise/physical activity	33	78.6
3-5 times/week	6	14.3
> 5 times/week	3	7.1
Duration of exercise or physical activity		
no exercise/physical activity	33	78.6
< 30 minutes	2	4.8
30-60 minutes	5	11.9
> 60 minutes	2	4.8
Type of exercise or physical activity (n=9)		
Walking / Jogging	4	44.5
Fitness	2	22.2
Bicycling	1	11.1
Arm swing	2	22.2

Table 4.4 Dietary behavior of 42 obese female subjects

Dietary behavior	n	% of total
Fast foods		
do not eat fast foods	7	16.7
eat fast foods1-3 times/week	24	57.1
eat fast foods1-3 times/month	10	23.8
eat fast foods1-3 times/year	1	2.4
Buffets		
do not eat buffets	4	9.5
eat buffets 1-3 times/month	29	69.1
eat buffets 1-3 times/year	9	21.4
Animal fat		
do not eat animal fat	5	11.9
eat all of animal fat in serving	9	21.4
eat some of animal fat in serving	28	66.7
Animal skin		
do not eat animal skins	17	40.5
eat all of animal skins in serving	21	50.0
eat some of animal skins in serving	4	9.5
Organ meats		
do not eat organ meats	10	23.8
eat all of organ meats in serving	5	11.9
eat some of organ meats in serving	27	64.3
Snacks during day		
yes	41	97.6
no	1	2.4
Snacks before bed		
yes	17	40.5
no	25	59.5
Added sugar		
no added sugar in dishes	20	47.6
added sugar in dishes (≤ 1 Tsp.)	18	42.9
added sugar in dishes (≥ 2 Tsp.)	4	9.5
Added fish sauce		
no added fish sauce in dishes	18	42.9
added fish sauce in dishes (≤ 1 Tsp.)	22	52.3
added fish sauce in dishes (≥ 2 Tsp.)	2	4.8
Beverage drinking (n=41)		
Tea	21	51.2
Coffee& Cocoa	31	75.6
Soy milk	27	65.9
Soft drink	18	43.9
Fruit juice	19	46.3

The study was divided 3 periods for 12 weeks: 1) weeks 1 – 4 subjects received dietary recommendation for weight loss, 2) weeks 5 – 8 subjects received the same dietary advice as week 1 – 4 and replaced 2 regular meals with 1 can MJ with GB for lunch and 1 can of MJ for dinner, and 3) weeks 9 - 12 subjects also received the same advice as week 1 - 4.

4.2 Dietary intake

Throughout the study, subjects had completely recorded their daily dietary intake. All energy and nutrient intakes were calculated by INMUCAL-Nutrients version 3 as shown in **Tables 4.5 – 4.8.**

Table 4.5 shows mean ± SD of daily dietary intake, their energy requirement at week 8 of MJ consumption and week 12 of dietary advice for weight loss were significantly lower than those at week 0 and 4.

At week 4 after receiving dietary advice for weight reduction their total energy, carbohydrate, and fat intakes were significantly lower than that at week 0. However their energy distributions were not significant difference from baseline.

At week 8 after receiving MJ and GB replaced 2 meals a day, their energy intake was significantly lower than those at week 0 and 4, 26.2 % of total energy was derived from MJ and GB. The amount of carbohydrate, protein, and fat at week 8 were significantly lower than that at baseline. Energy distribution of protein and fat were significantly decreased from week 4 with the exception of energy distribution of carbohydrate was significantly higher than those at week 0 and week 4.

At week 12 subjects also received the same advice as week 1- 4, energy intake, protein intake, fat intake were higher than that at week 8, however energy intake, carbohydrate, and fat intakes were significantly lower than that at baseline. Energy distributions similar to week 4 were significant difference from baseline except the highest of energy distribution of protein had significance.

At baseline the study found 16.0 % and 12.6 % of energy from sugar and saturated fat intakes respectively. After receiving dietary advice for weight loss at first 4 weeks, subjects were significantly decreased sugar intake and saturated intake from baseline. Next 4 weeks subjects consumed MJ for weight loss, both of the protein

sources as animal protein and vegetable protein intakes were significantly reduced from baseline and week 4. Subjects were also saturated fat intake and cholesterol intake significant lower than those at week 0 and week 4, whereas the highest of sugar intake was significance. Interestingly, fiber intake had significant higher than those at diet control periods. Their mean study sugar intake was the lowest at week 12 **(Table 4.6)**.

Table 4.7 shows nutrient and water intakes throughout the study. Sodium intake was the highest at baseline. According to week 4 and week 12 subjects received dietary advice for weight loss, their sodium intake was not significant difference from baseline. At week 8 after consuming MJ, sodium intake was the lowest and both of the iron source intakes as animal iron and vegetable iron were significantly decreased from baseline and week 4, moreover the average daily water intakes was not different throughout the study.

Table 4.8 shows daily nutrient intake compare with %Thai RDI. At baseline cholesterol intake were founded almost over %Thai RDI, their sodium and vitamin C intakes were also higher than % Thai RDI. At first 4 weeks and last 4 weeks, subjects remained sodium and vitamin C intakes higher than %Thai RDI. At week 8 after consuming MJ, cholesterol and sodium intakes had lower than %Thai RDI.

The subjects were instructed to consume assignment drink MJ 2 cans/day (total MJ = 56 cans). The acceptability of compliance ≥90% of assignment, the average of our subject compliance was 98%.

Table 4.5 Mean (± SD) of daily dietary intake in 42 obese female subjects throughout the study

Intake	Week 0	Week 4	Week 8	Week 12
Energy requirement, kcal	1540 ± 161	1533 ± 156	1506 ± 159^{a1b1}	1507 ± 158^{a1b1}
Total energy, kcal	1533 ± 227	1317 ± 184^{a1}	1037 ± 189^{a1b1}	1288 ± 215^{a1c1}
Energy from MJ, kcal	-	-	213 ± 6	-
Energy from GB, kcal	-	-	50 ± 12	-
Regular diet, % of energy	100 ± 0.0	100 ± 0.0	73.8 ± 4.9	100 ± 0.0
MJ + GB , % of energy	-	-	26.2 ± 4.9	-
Carbohydrate, g	187.7 ± 38.5	153.8 ± 27.2^{a1}	149.6 ± 25.0^{a1}	151.5 ± 33.0^{a1}
, % of energy	48.9 ± 7.3	47.6 ± 4.7	58.0 ± 4.6^{a1b1}	47.3 ± 4.5^{c1}
from regular diet, % of energy	48.9 ± 7.3	47.6 ± 4.7	56.0 ± 5.0	47.3 ± 4.5
from MJ + GB , % of energy	-	-	2.0 ± 0.0	-
Protein, g	64.9 ± 17.2	58.8 ± 8.8	40.7 ± 10.1^{a1b1}	59.8 ± 9.6^{c1}
, % of energy	16.9 ± 3.3	18.4 ± 2.4	15.7 ± 2.2^{b1}	18.8 ± 2.3^{a1c1}
from regular diet, % of energy	16.9 ± 3.3	18.4 ± 2.4	10.3 ± 2.4	18.8 ± 2.3
from MJ + GB , % of energy	-	-	5.4 ± 1.3	-
Fat, g	57.9 ± 13.4	49.4 ± 8.6^{a3}	30.8 ± 8.5^{a1b1}	48.5 ± 8.3^{a3c1}
, % of energy	34.2 ± 6.2	34.1 ± 3.6	26.5 ± 3.6^{a1b1}	33.9 ± 3.3^{c1}
from regular diet, % of energy	34.2 ± 6.2	34.1 ± 3.6	25.9 ± 3.6	33.9 ± 3.3
from GB , % of energy	-	-	0.6 ± 0.2	-

Significant difference from week 0 $^{a1}p<0.0001$, $^{a3}p<0.001$

Significant difference from week 4 $^{b1}p<0.0001$

Significant difference from week 8 $^{c1}p<0.0001$

Table 4.6 Mean (± SD) of sugar, fiber, animal protein, vegetable protein, saturated fat, and cholesterol intakes in 42 obese female subjects throughout the study

Intake	Week 0	Week 4	Week 8	Week 12
Sugar, g	60.7 ± 32.4	46.4 ± 18.0^{a2}	71.8 ±12.0^{a2b1}	45.0 ± 20.9^{a2c1}
, % of energy	16.0 ± 8.8	14.0 ± 4.6	28.0 ± 3.4^{a1b1}	13.7 ± 4.7^{c1}
Sugar from, regular diet, % of energy	16.0 ± 8.8	14.0 ± 4.6	10.4 ± 3.6	13.7 ± 4.7
, MJ + GB , % of energy	-	-	17.6 ± 3.3	-
Fiber, g	9.1 ± 4.7	7.3 ± 2.8^{a2}	8.6 ± 2.5^{b2}	7.2 ± 2.5^{a4c2}
Fiber from, Regular diet , g	9.1 ± 4.7	7.3 ± 2.8	4.8 ± 2.5	7.2 ± 2.5
, MJ + GB , g	-	-	3.7 ± 0.2	-
Animal protein, g	46.1 ± 16.2	43.3 ± 8.3	27.4 ± 8.6^{a1b1}	43.8 ± 8.2^{c1}
, % of total protein	69.6 ± 13.8	73.3 ± 5.3	66.6 ± 6.7^{b1}	73.2 ± 5.3^{c1}
Vegetable protein, g	18.8 ± 7.8	15.5 ± 2.9	13.3 ± 2.8^{a2b2}	15.9 ± 3.8^{c1}
, % of total protein	30.4 ± 13.8	26.7 ± 5.3	33.4 ± 6.6^{b1}	26.8 ± 5.3^{c1}
Saturated fat, g	21.5 ± 6.6	16.5 ± 3.4^{a2}	10.8 ± 3.5^{a1b1}	16.4 ± 3.5^{a2c1}
, % of energy	12.6 ± 3.6	11.3 ± 1.8	9.2 ± 1.7 ^{a1b1}	11.5 ± 1.8 ^{c1}
Cholesterol, mg	287.5 ± 114.5	267.1 ± 68.1	159.3 ± 56.0^{a1b1}	258.8 ± 59.4^{c1}

Significant difference from week 0 $^{a1}p<0.0001$, $^{a2}p<0.0005$, $^{a4}p<0.005$

Significant difference from week 4 $^{b1}p<0.0001$, $^{b2}p<0.0005$

Significant difference from week 8 $^{c1}p<0.0001$, $^{c2}p<0.0005$

Table 4.7 Mean (± SD) of nutrient and water intakes in 42 obese female subjects throughout the study

Intake	Week 0	Week 4	Week 8	Week 12
Vitamin A, RE	486.5 ± 540.3	338.2 ± 127.7	186.4 ±152.5^{a1b1}	343.9 ± 124.9^{c1}
Sodium, mg	3153.4 ± 1221.6	2837.8 ± 560.7	1905.4 ± 568.8^{a1b1}	2735.0 ± 675.7^{c1}
Iron, mg	11.0 ± 3.3	10.6 ± 3.4	6.8 ± 3.7^{a1b1}	10.3 ± 2.2^{c1}
Animal iron, mg	5.1 ± 2.8	5.3 ± 2.9	3.8 ± 3.4^{a3b1}	5.1 ± 1.8^{c1}
% of total iron	44.8 ± 15.2	48.6 ± 11.3	50.9 ± 13.4	49.0 ± 10.1
Vegetable iron, mg	4.8 ± 1.2	3.8 ± 0.9^{a2}	2.4 ± 0.9^{a1b1}	3.7 ± 1.0^{a2c1}
% of total iron	45.8 ± 16.5	38.0 ± 9.5^{a6}	37.9 ± 11.7^{a6}	37.2 ± 9.6^{a5}
Vitamin C, mg	85.1 ± 92.3	66.8 ± 58.7	46.1 ± 43.1^{a1b1}	73.7 ± 59.9^{c1}
Calcium, mg	389.5 ± 125.7	372.3 ± 109.9	213.7 ± 70.4^{a1b1}	354.7 ± 92.7^{c1}
Phosphorus, mg	718.3 ± 178.7	655.7 ± 121.8^{a4}	390.6 ± 97.5^{a1b1}	643.3 ± 107.5^{c1}
Thiamin, mg	1.1 ± 0.3	1.0 ± 0.2 ^{a5}	0.6 ± 0.2 ^{a1b1}	1.0 ± 0.2^{c1}
Water, mL	1765 ± 633	1713 ± 543	1756 ± 553	1733 ± 563

Significant difference from week 0 $^{a1}p<0.0001$, $^{a2}p<0.0005$, $^{a3}p<0.001$, $^{a4}p<0.005$, $^{a5}p<0.01$, $^{a6}p<0.05$

Significant difference from week 4 $^{b1}p<0.0001$

Significant difference from week 8 $^{c1}p<0.0001$

Table 4.8 Daily nutrients intake compare with % Thai RDI throughout the study

Nutrients	Week 0		Week 4		Week 8		Week 12	
	Intake/day	% RDI	Intake/day	% RDI	Intake/day	% RDI	Intake/day	% RDI
Cholesterol, mg	287.5 ± 114.5	95.8 ± 38.2	267.1 ± 68.1	89.0 ± 22.7	159.3 ± 56.0	53.1 ± 18.7	258.8 ± 59.4	86.3 ± 19.3
Fiber, g	9.1 ± 4.7	36.4 ± 18.7	7.3 ± 2.8	29.2 ± 11.3	8.6 ± 2.5	34.3 ± 10.1	7.2 ± 2.5	28.9 ± 10.0
Vitamin A, RE	486.5 ± 540.3	60.8 ± 67.5	338.2±127.7	42.3 ± 16.0	186.4 ± 152.5	23.3 ± 19.1	343.9 ± 124.9	43.0 ± 15.6
Iron, mg	11.0 ± 3.3	73.4 ± 21.8	10.6 ± 3.4	70.4 ± 22.6	6.8 ± 3.7	45.4 ± 24.5	10.3 ± 2.2	68.7 ± 15.0
Sodium, mg	3153.4 ±1221.6	131.3 ± 50.9	2837.8 ± 560.7	118.2 ± 23.4	1905.4 ± 568.8	79.4 ± 553.0	2735.0±675.7	113.9 ± 28.2
Vitamin C, mg	85.1 ± 92.3	141.8 ± 153.8	66.8 ± 58.7	111.3 ± 97.8	46.1 ± 43.1	76.9 ±71.8	73.7 ± 59.9	122.8 ± 99.9
Calcium, mg	389.5 ± 125.7	48.7 ± 48.7	372.3 ± 109.9	46.5 ± 13.7	213.7 ± 70.4	26.7 ± 8.8	354.7± 92.7	44.3 ± 11.6
Phosphorus, mg	718.3 ± 178.7	89.8 ± 22.3	655.7 ± 121.8	82.0 ±15.2	390.6 ± 97.5	48.8 ± 12.2	643.3 ± 107.5	80.4 ± 13.4
Thiamin, mg	1.1 ± 0.3	73.1 ± 21.1	1.0 ± 0.2	63.8 ± 11.4	0.6 ± 0.2	37.5 ± 10.8	1.0 ± 0.2	64.4 ± 16.3

Subjects consumed MJ and GB during at weeks 5 - 8. Subjects rated the acceptability of MJ consumption as taste, texture, flavor, and satiety scale in good score. Their acceptability of GB consumption as taste, flavor, and satiety scale were in good score, however the texture of GB was in average score because this biscuit had hard texture. No adverse effects were reported during this study **(Table 4.9)**.

Table 4.9 Acceptability assessments from MJ and GB consumptions in 42 obese female subjects during weeks 5-8

Acceptability	**rating**
Taste	
MJ	Good
GB	Good
Texture	
MJ	Good
GB	Average
Flavor	
MJ	Good
GB	Good
Satiety scale	
Lunch (MJ+GB)	Good
Dinner (MJ)	Good

Rating: Excellence = 5 Good = 4 Average = 3 less = 2 No = 0

MJ: mangosteen juice concentrate mixed with garcinia, GB: garcinia biscuit barbecue flavor

No adverse effects

4.3 Efficacy of MJ consumption on nutritional status

Table 4.10 shows mean of BP throughout the study. After consuming MJ at week 8, their SBP and DBP were significantly decreased from week 4.

Table 4.11 shows mean ± SD of body composition throughout the study. The study found after subjects received dietary advice at week 4, their body weight and %body fat had significant decrease from baseline, whereas there was significantly increased of %TBW. At week 8 after consuming MJ, their body weight, %body fat, FFM, and muscle mass were significantly lower than those at baseline and week 4. Percentage of TBW was significantly higher than that at week 0. At the end of study no significant differences of all body composition parameter from week 8 were observed. However, their body weight and body fat were significantly decreased from week 0 and week 4.

Table 4.12 shows weight, body fat, and muscle mass reduction during the study. After first 4 weeks of dietary advice (week 4 - 0), their weight, %body fat, and body fat reduced from week 0, -0.9 kg, -0.7%bw, and -0.8 kg respectively. Next 4 weeks of MJ consumption (week 8 - 4), their weight, %body fat, and body fat were greater than the reduction during first 4 weeks of dietary advice, -1.9 kg, - 0.8 %bw, and -1.3 kg, respectively. There also was some loss of muscle mass 0.5 kg (week 8 - 4). There was the minor reduction of the aforesaid body composition parameters at the last 4 weeks of dietary advice (week 12 - 8).

We found 15 subjects who had continuous body weight and body fat reductions throughout the study. After receiving dietary advice (week 4 - 0), their weight, %body fat, and body fat decreased from baseline, -1.5 kg, -0.9 %bw, and -1.4 kg respectively. At week 8 - 4 after consuming MJ for weight loss, their body weight, %body fat, and body fat were greater than the reduction during first 4 weeks of dietary advice, -2.3 kg, -1.3 %bw, and -1.9 kg respectively. At week 12 – 8 subjects also received the same advice as week 4 - 0, our subjects had continuous weight, %body fat, and body fats were lesser than the reduction from week 8. The end of study, their net of weight, % body fat, and body fat reduced from baseline , -5.1 kg, -2.9 %bw, and -4.3 kg respectively as shown in **Table 4.13**.

We found only 10 subjects (23.8 % of total subjects) were not control diet for weight loss after first 4 weeks of dietary advice (week 4 - 0). Next 4 weeks after

consuming MJ (week 8 - 4), their body weight, %body fat, and body fat decreased from week 4, - 2.1 kg, -0.4 %bw, and -1.2 kg respectively. Last 4 weeks after stopping MJ consumption, subjects received dietary advice for weight loss, their body weight, % body fat were not change whereas body weight and body fat increased from week 8 (week 12 - 8) **(Table 4.14)**.

Table 4.15 shows mean ± SD of segmental body composition: arm, leg and trunk throughout the study. At week 4 the study found each segmental % fat of both arms, both legs, and trunk were significant reduced from baseline. After 4 weeks of MJ consumption and the last 4 weeks of diet control their all segmental fats were significantly decreased from baseline and week 4. However, there were no significant differences between week 8 and week 12.

Table 4.16 shows segmental fat reduction during the study. After first 4 weeks of dietary advice (week 4 - 0), the highest of segmental fat reduction was trunk fat. Next 4 weeks of MJ consumption (week 8 - 4), there was the highest reduction of all segmental fats when compared with the other periods of study. At the end of study (week 12 - 0), the highest of segmental fat reduction was right arm fat, -4.9% of baseline.

Table 4.17 shows 3 WC sites throughout the study. The study found that only UWC at week 4 was significantly lower than that at baseline. At week 8 after consuming MJ, the 3 WC sites were statistically significant decreased from baseline and week 4 as AUWC, UWC, and BUWC. Last 4 weeks after stopping MJ, our subjects also received the same advice as week 4, the 3 WC sites were significantly lower than those at the other periods of study. At the end of study, we found the greatest reduction of WC was at UWC (-4.9 cm).

Table 4.10 Mean (± SD) of BP parameters in 42 obese female subjects throughout the study

BP	Week 0	Week 4	Week 8	Week 12
SBP, mmHg	120 ± 15	122 ± 14	117 ± 11[b6]	117 ± 13[b6]
	(88 - 150)	(97 - 165)	(90 - 151)	(80 - 148)
DBP, mmHg	78 ± 11	79 ± 12	75 ± 10[b6]	76 ± 10
	(57 - 101)	(56 - 79)	(55 - 75)	(51 - 107)
PR, times/min	76 ± 2	76 ± 1	79 ± 2	75 ± 1
	(57 - 101)	(60 - 101)	(58 - 109)	(51 - 100)

Significant difference from week 4 [b6]$p<0.05$

Table 4.11 Mean (±SD) of body composition parameters in 42 obese female subjects throughout the study

Parameters	Week 0	Week 4	Week 8	Week 12
Body weight, kg	71.1 ± 10.7	70.2 ± 10.3^{a1}	68.3 ± 10.1^{a1b1}	68.2±10.0^{a1b1}
	(50.4-102.4)	(49.4 - 101.4)	(48.0 - 100.5)	(47.8 - 101.1)
BMI, kg/m^2	28.6 ± 4.3	28.3 ± 4.2^{a1}	27.5 ± 4.1^{a1b1}	27.5 ± 4.1^{a1b1}
	(23.0 - 41.8)	(22.9 - 40.9)	(22.2 – 39.0)	(22.1 – 38.8)
Body fat, %bw	41.2 ± 5.5	40.6 ± 5.5^{a1}	39.8 ± 5.4^{a1b1}	39.6 ±5.4^{a1b1}
	(32.8 – 55.8)	(32.5 – 56.0)	(32.7 – 54.1)	(32.5 – 53.9)
Body fat, kg	29.8 ± 8.6	28.9 ± 8.3^{a1}	27.6 ± 7.9^{a1b1}	27.4 ± 7.8^{a1b1}
	(17.7 - 54.6)	(17.0 – 53.4)	(17.0 – 52.6)	(16.1 – 52.6)
FFM, kg	41.3 ± 3.5	41.3 ± 3.5	40.7 ± 3.6^{a1b1}	40.8 ± 3.5^{a1b2}
	(32.7 – 48.0)	(32.4 – 48.6)	(31.9 – 47.9)	(31.9 – 48.2)
Muscle mass, kg	38.9 ± 3.2	38.9 ± 3.2	38.4 ± 3.3^{a1b1}	38.4 ± 3.2^{a1b2}
	(31.0 – 45.0)	(30.8 – 45.6)	(30.3 – 44.9)	(30.4 – 45.2)
TBW, kg	30.7 ± 3.2	30.7 ± 3.2	29.9 ± 3.3^{a1b2}	30.1 ± 3.2^{a1b3}
	(23.5 - 38.4)	(23.3 – 38.4)	(22.8 – 38.4)	(22.9 – 38.3)
TBW,%bw	43.5 ± 3.2	44.0 ± 3.2^{a5}	44.1 ± 3.0^{a6}	44.3 ± 2.9^{a3}
	(35.4 – 48.8)	(35.2 – 49.8)	(36.7 – 50.2)	(36.9 – 50.1)
Bone mass, kg	2.42 ± 0.3	2.42 ± 0.3	2.37 ± 0.3^{a6}	2.38 ± 0.3
	(1.7 – 3.0)	(1.6 – 3.0)	(1.6 – 3.0)	(1.5 – 3.0)

Significant difference from week 0 $^{a1}p<0.0001$, $^{a3}p<0.001$, $^{a5}p<0.01$, $^{a6}p<0.05$

Significant difference from week 4 $^{b1}p<0.0001$, $^{b2}p<0.0005$, $^{b3}p<0.001$

Table 4.12 Weight, body fat, and muscle mass reduction during the study

Parameter	Week 4 - 0	Week 8 - 4	Week 12 - 8
Weight , kg			
weight loss, kg	-0.9 ± 1.4	-1.9 ± 1.3^{k4}	-0.1 ± 1.2^{k4l1}
Body fat, %bw			
body fat loss, %bw	-0.7 ± 0.7	-0.8 ± 0.9	-0.2 ± 0.6^{k2l2}
Body fat, kg			
body fat loss, kg	-0.8 ± 1.1	-1.3 ± 1.1^{k5}	-0.2 ± 0.9^{k2l5}
Muscle mass, kg			
muscle loss, kg	0.0 ± 0.5	-0.5 ± 0.6^{k3}	0.0 ± 0.5^{l2}

Significant difference from week 4 - 0 $^{k2}p<0.0005$, $^{k3}p<0.001$, $^{k4}p<0.005$, $^{k5}p<0.01$

Significant difference from week 8 - 4 $^{l1}p<0.0001$, $^{l2}p<0.0005$, $^{l5}p<0.01$

Table 4.13 Continuous body weight and body fat reductions in 15 obese female subjects during the study

Reduction	Mean + SD (range)			
	Week 4 - 0	**Week 8 - 4**	**Week 12 - 8**	**Week 12 - 0**
Weight, kg	-1.5 ± 1.6	-2.3 ± 1.3	-1.3 ± 0.9	-5.1 ± 2.9
Body fat, %bw	-0.9 ± 0.7	-1.3 ± 0.8	-0.7 ± 0.6	-2.9 ± 1.6
Body fat, kg	-1.4 ± 1.4	-1.9 ± 1.1	-1.0 ± 0.7	-4.3 ± 2.7

Week 4, Week 12: Diet control Week 8: Diet control + MJ consumption

Table 4.14 Uncontinuous of weight and body fat reduction in 10 obese female subjects during the study

Reduction	Mean + SD (range)			
	Week 4 - 0	**Week 8 - 4**	**Week 12 - 8**	**Week 12 - 0**
Weight, kg	+0.5 ± 0.5	-2.1 ± 1.0	+0.5 ± 1.1	-1.1 ± 1.7
Body fat, %bw	-0.2 ± 0.9	-0.4 ± 0.9	0.0 ± 0.6	-0.6 ± 1.0
Body fat , kg	+0.1 ± 0.6	-1.2 ± 1.2	+0.2 ± 0.7	-0.9 ± 1.4

Week 4, Week 12: Diet control Week 8: Diet control + MJ consumption

Table 4.15 Mean (± SD) of segmental composition parameters in 42 obese female subjects throughout the study

Parameter	Week 0		Week 4		Week 8		Week 12	
Left arm								
fat, %	39.8 ± 6.0	(29.4 – 55.9)	39.2 ± 6.0^{a1}	(29.7 – 55.2)	38.1 ± 6.0^{a1b1}	(29.4 – 53.4)	38.0 ± 6.0^{a1b1}	(29.8-53.4)
fat mass, kg	1.36 ± 0.6	(0.7 – 3.2)	1.34 ± 0.5	(0.6 – 3.1)	1.24 ± 0.5^{a1b1}	(0.6 – 3.2)	1.23 ± 0.5^{a1b1}	(0.6 – 3.2)
fat free mass, kg	1.96 ± 0.3	(1.4 – 2.7)	1.98 ± 0.3	(1.4 – 2.7)	1.91 ± 0.3^{b1}	(1.3 – 2.8)	1.92 ± 0.3^{a6b2}	(1.3 – 2.8)
predicted muscle mass, kg	1.84 ± 0.2	(1.3 –2.6)	1.84 ± 0.3	(1.3 – 2.6)	1.80 ± 0.3^{a6b6}	(1.3 – 2.6))	1.79 ± 0.3^{a1b5}	(1.3 – 2.6)
Right arm								
fat, %	38.7 ± 6.2	(27.9 – 55.4)	38.0 ± 6.2^{a1}	(28.1 – 54.6)	37.0 ± 6.1^{a1b1}	(27.6 – 52.5)	36.8 ± 6.2^{a1b1}	(28.0 – 52.3)
fat mass, kg	1.37 ± 0.6	(0.7 – 3.2)	1.34 ± 0.6	(0.6 – 3.2)	1.24 ± 0.5^{a1b1}	(0.6 – 3.2)	1.25 ± 0.5^{a1b1}	(0.6 – 3.1)
fat free mass, kg	2.07 ± 0.3	(1.4 – 2.6)	2.07 ± 0.3	(1.5 – 2.8)	2.02 ± 0.3^{a6b1}	(1.5 – 2.9)	2.03 ± 0.2^{a5b4}	(1.5 – 2.8)
predicted muscle mass, kg	1.94 ± 0.2	(1.4 – 2.6)	1.96 ± 0.2	(1.4 – 2.7)	1.88 ± 0.2^{a5b1}	(1.4 – 2.7)	1.89 ± 0.2^{a5b1}	(1.4 – 2.6)
Left leg								
fat, %	40.2 ± 4.0	(34.9 -51.4)	39.9 ± 4.0^{a1}	(34.7 – 50.9)	39.2 ± 3.9^{a1b1}	(33.9 – 48.9)	39.1 ± 3.9^{a1b1}	(33.9 – 48.9)
fat mass, kg	5.00 ± 1.4	(3.1 – 8.9)	4.96 ± 1.4	(3.0 – 8.8)	4.71 ± 1.4^{a1b1}	(2.9 – 8.7)	4.69 ± 1.3^{a1b1}	(2.9 -8.9)
fat free mass, kg	7.26 ± 0.9	(5.5 – 9.2)	7.30 ± 0.9	(5.4 – 9.2)	7.15 ± 1.0	(5.4 – 9.8)	7.13 ± 0.9 ^{b6}	(5.6 – 9.3)
predicted muscle mass, kg	6.84 ± 0.8	(5.2 – 8.7)	6.87 ± 0.8	(5.2 -8.7)	6.72 ± 0.9	(5.1 – 9.2)	6.72 ± 0.8^{b6}	(5.3 – 8.7)
Right leg								
fat, %	40.4 ± 4.1	(34.6 – 52.1)	40.0 ± 4.1^{a1}	(34.4 – 51.3)	39.3 ± 4.0^{a1b1}	(33.9 – 49.5)	39.2 ± 4.0^{a1b1}	(33.9 – 49.2)
fat mass, kg	5.13 ± 1.5	(3.2 – 9.6)	5.04 ± 1.4^{a5}	(3.1 – 9.0)	4.76 ± 1.3^{a1b1}	(2.9 – 9.1)	4.75 ± 1.3^{a1b1}	(2.9 – 9.1)
fat free mass, kg	7.39 ± 0.8	(5.5 – 9.6)	7.40 ± 0.9	(5.4 – 9.3)	7.19 ± 0.9^{a2b3}	(5.4 – 9.4)	7.19 ± 0.8^{a3b2}	(5.5 – 9.3)
predicted muscle mass, kg	6.95 ± 0.8	(5.2 – 9.0)	6.96 ± 0.8	(5.1 – 8.7)	6.77 ± 0.8^{a3b2}	(5.1 – 8.8)	6.78 ± 0.8^{a4b5}	(5.2 – 8.8)
Trunk								
fat, %	42.1 ± 6.4	(32.1 – 59.1)	41.3 ± 6.5^{a1}	(31.8 – 59.6)	40.5 ± 6.3^{a1b2}	(31.2 – 57.3)	40.2 ± 6.3^{a1b1}	(31.1 – 57.0)
fat mass, kg	16.9 ± 4.8	(10.1 – 30.3)	16.3 ± 4.6^{a1}	(9.7 – 29.6)	15.7 ± 4.4^{a1b2}	(9.1 – 28.8)	15.6 ± 4.4^{a1b1}	(9.0 – 29.1)
fat free mass, kg	22.7 ± 1.9	(18.1 – 27.7)	22.6 ± 2.0	(18.1 – 27.3)	22.5 ± 1.9	(17.8 – 27.2)	22.5 ± 1.9	(17.8 – 27.2)
predicted muscle mass, kg	21.3 ± 1.8	(17.3 – 25.9)	21.2 ± 1.8	(17.3 – 25.6)	21.2 ± 1.7	(16.9 – 25.4)	21.2 ± 1.7	(17.0 – 24.9)

Significant difference from week 0 $^{a1}p<0.0001$, $^{a2}p<0.0005$, $^{a3}p<0.001$, $^{a4}p<0.005$, $^{a5}p<0.01$, $^{a6}p<0.05$

Significant difference from week 4 $^{b1}p<0.0001$, $^{b2}p<0.0005$, $^{b3}p<0.001$, $^{b4}p<0.005$, $^{b5}p<0.01$, $^{b6}p<0.05$

Table 4.16 Segmental fats reduction during the study

Parameter	Week 4 - 0	Week 8 - 4	Week 12 - 8
Left arm fat loss , %	-0.6 ± 0.7	-1.0 ± 0.8[k5]	-0.1 ± 0.7[k3l1]
Right arm fat loss , %	-0.6 ± 0.7	-1.1 ± 0.9[k6]	-0.1 ± 0.8[k3l1]
Left leg fat loss , %	-0.4 ± 0.4	-0.7 ± 0.6[k5]	-0.1 ± 0.4[k3l1]
Right leg fat loss , %	-0.4 ± 0.5	-0.6 ± 0.6	-0.1 ± 0.4[k3l1]
Trunk fat loss , %	-0.8 ± 1.0	-0.8 ± 1.2	-0.2 ± 0.8[k6l5]

Significant difference from week 4 - 0 [k3]$p<0.001$, [k5]$p<0.01$, [k6]$p<0.05$

Significant difference from week 8 - 4 [l1]$p<0.0001$, [l5]$p<0.01$

Table 4.17 Mean (± SD) of WC in 42 obese female subjects throughout the study

WC, cm	Week 0	Week 4	Week 8	Week 12
AUWC	88.7 ± 9.7	88.2 ± 9.2	85.9 ± 9.0^{a1b1}	84.7 ± 8.9^{a1b1c2}
	(69.5 –116.0)	(69.0 - 115.5)	(67.0 – 112.0)	(66.5 – 112.0)
UWC	94.2 ± 9.8	93.4 ± 9.1^{a6}	90.2 ± 8.9^{a1b1}	89.3 ± 8.6^{a1b1c6}
	(72.0 –119.0)	(73.0 – 119.0)	(71.1 – 115.0)	(71.0 – 114.5)
BUWC	97.6 ± 8.5	97.7 ± 8.2	95.0 ± 7.9^{a1b1}	93.3 ± 7.9^{a1b1c1}
	(50.4 –102.4)	(49.4 – 101.4)	(48.0 – 100.5)	(47.8 – 101.1)

Significant difference from week 0 $^{a1}p<0.0001$, $^{a6}p<0.05$

Significant difference from week 4 $^{b1}p<0.0001$

Significant difference from week 8 $^{c1}p<0.0001$, $^{c2}p<0.0005$, $^{c6}p<0.05$

We followed the nutritional status improvement in nutritional disorder subjects. The study divided pre-hypertension and hypertension by SBP and DBP as shown in **Table 4.18 – 4.19**.

The study found 33.3% of total subject were pre-hypertension at baseline. At week 4, only 7.1% can reduce BP level improve to normal BP. Next 4 weeks of MJ consumption, 35.7% of them improved BP to normal level. Half of subjects with pre-hypertension had normal BP at the end of study. At baseline we found 11.9% of subjects with hypertension, 60% of hypertensive improved BP after control diet at first 4 weeks: 20% of them had normal BP and 40% of them had pre-hypertension. At week 8 after MJ consumption, 60% of hypertensive subjects had pre-hypertension. Only 1 subject had hypertension at the end of study **(Table 4.18)**.

Table 4.19 we found 23.8% of total subjects with pre-hypertension at baseline. The end of study, only 20 % of pre-hypertensive subjects had normal BP. At week 0, their 14.3% of total subjects were within hypertension. At week 12, half of hypertensive subjects can decrease BP to normal levels.

Table 4.18 SBP status of 19 subjects throughout the study

SBP status*	**Week 0**	**Week 4**	**Week 8**	**Week 12**
	n (%[a])	**n (%[b])**	**n (%[b])**	**n (%[b])**
Pre-hypertension				
Normal (SBP < 120 mmHg)	-	1 (7.1)	5 (35.7)	7 (50.0)
Pre-hypertension (SBP 121-139 mmHg)	**14 (33.3)**	12 (85.8)	9 (64.3)	7 (50.0)
Hypertension (SBP > 140 mmHg)	-	1 (7.1)	-	-
Hypertension				
Normal (SBP < 120 mmHg)	-	1 (20.0)	1 (20.0)	1 (20.0)
Pre-hypertension (SBP 121-139 mmHg)	-	2 (40.0)	3 (60.0)	3 (60.0)
Hypertension (SBP > 140 mmHg)	**5 (11.9)**	2 (40.0)	1 (20.0)	1 (20.0)

[a]% of total subject, [b]% of SBP status at week 0

* Base on Thai Guidelines on the Treatment of Hypertension 2012

Table 4.19 DBP status of 16 subjects throughout the study

DBP status*	Week 0	Week 4	Week 8	Week 12
	n (%[a])	n (%[b])	n (%[b])	n (%[b])
Pre-hypertension				
Normal (DBP < 80 mmHg)	-	4 (40.0)	6 (60.0)	2 (20.0)
Pre-hypertension (DBP 81 - 90 mmHg)	**10 (23.8)**	4 (40.0)	2 (20.0)	7 (70.0)
Hypertension (DBP > 90 mmHg)	-	2 (20.0)	2 (20.0)	1 (10.0)
Hypertension				
Normal (DBP < 80 mmHg)	-	-	-	3 (50.0)
Pre-hypertension (DBP 81 - 90 mmHg)	-	2 (33.3)	6 (100)	2 (33.3)
Hypertension (DBP > 90 mmHg)	**6 (14.3)**	4 (66.7)	-	1 (16.7)

[a]% of total subject, [b]% of DBP status at week 0

* Base on Thai Guidelines on the Treatment of Hypertension 2012

This study classified over body fat at 3 levels as to describe severity of subjects. All subjects had over body fat status throughout the study.

Mean of over body fat 3 levels were reduced continuously until the end of study. Especially at week 8, impact of MJ consumption for body fat 3 levels were significantly reduced than those at week 4 and week 12. The greatest reduction in body fat was found in subjects who had over body III as shown in **Table 4.20**.

Table 4.20 Progression of over body fat of 42 subjects classified by body fat during the study

Total body fat, %bw*	Mean ± SD of body fat, %bw			
	Week 0	**Week 4**	**Week 8**	**Week 12**
Over body fat I (n= 20)				
30.1 - 40.0	**36.9 ± 1.9**	36.4 ± 1.9^{a1}	35.7 ± 2.0^{a2b5}	35.5 ± 2.0^{a2b5}
Over body fat II (n=18)				
40.1 - 50.0	**43.2 ± 2.2**	42.5 ± 2.6^{a5}	41.7 ± 2.8^{a2b4}	41.6 ± 3.1^{a4b6}
Over body fat III (n= 4)				
50.1 - 60.0	**53.7 ± 2.6**	53.1 ± 2.5	51.6 ± 2.6	51.1 ± 2.9

Significant difference from week 0 $^{a1}p<0.0001$, $^{a2}p<0.0005$, $^{a4}p<0.005$, $^{a5}p<0.01$

Significant difference from week 4 $^{b4}p<0.005$, $^{b5}p<0.01$, $^{b6}p<0.05$

*Body fat status was classified by Gallagher et al., 2000

Table 4.21 shows weight status classified by BMI throughout the study. We found 6 subjects (14.3 % of total subjects) had normal weight throughout the study. At baseline the study found 36 subjects were overweight. Next 4 weeks after control diet, only 1 subject can achieved normal weight. After consuming MJ, their 7 subjects can achieved normal weight. At the end of study, we found 8 subjects can reduce body weight to normal weight.

Table 4.21 Body weight status of 42 subjects classified by BMI throughout the study

Body weight status*	Week 0	Week 4	Week 8	Week 12
	n (%[a])	n (%[b])	n (%[b])	n (%[b])
Normal weight				
	6 (14.3)	6 (100)	6 (100)	6 (100)
Overweight				
Normal weight	-	1 (2.8)	7 (19.4)	8 (22.2)
Overweight	**36 (85.7)**	35 (97.2)	29 (80.6)	28 (77.8)

[a]% of total subject, [b]% of body weight status at week 0

**BM I>24.9 kg/m^2: overweight*

The subjects with normal weight status had continuous reductions of their body weight but did not reach significance throughout the study. The same evidences were also observed in 36 overweight subjects, their mean body mass index at week 4, 8, and12 were significantly lower than that at baseline and at week 8 and 12 were significantly lower than that at week 4 as shown in **Table 4.22**.

Moreover, we follow body composition changed in each of adulthood. At the end of study, 15 subjects with early adulthood, their weight and body fat reduced from baseline -5.2 kg (-5.2% of wk 0) and -2.1 %bw (5.2 % of wk 0) respectively. 26 subjects with middle adulthood, their weight and body fat reduced from baseline -2.4 kg (-3.4% of wk0) and -1.4 %bw (3.4 % of wk0) respectively. Only 1 subject with lately adulthoods, we found her weight and body fat reduced from baseline -2.4 kg (-3.1% of wk0) and -1.6 %bw (3.6 % of wk0) respectively.

Table 4.22 Progression of body weight status in 42 subjects classified by BMI during the study

Body weight status*	Mean ± SD of BMI, kg/m^2			
	Week 0	**Week 4**	**Week 8**	**Week 12**
Normal weight (n=6)	**24.0 ± 0.8**	23.7 ± 0.8	23.2 ± 0.8	23.1 ± 0.8
Overweight (n=36)	**29.4 ± 4.2**	29.1 ± 4.1^{a4}	28.2 ± 3.9^{a1b1}	28.2 ± 3.9^{a1b1}

Significant difference from week 0 at $^{a1}p<0.0001$, $^{a4}p<0.005$

Significant difference from week 4 at $^{b1}p<0.0001$

**BMI>24.9 kg/m^2: overweight*

We found 3 subjects (7.1% of total subjects) had low bone mass status throughout the study.

Overview of the subjects, their biochemical parameters were within normal range at baseline. At baseline we found, their total cholesterol was higher than normal levels however, LDL-C was within normal levels. At week 4 after receiving dietary advice, their biochemical parameters were not statistically significant differences from baseline. Next 4 weeks after consuming MJ, the study found HDL-C had significant increased from baseline and week 4, moreover, serum uric acid was also significantly decreased from week 4. The end of study at week 12, their influential parameter as FBG and LDL-C were significant decreased from week 8 and that parameters were the lowest.

In order to assess safety, we studied the efficacy of MJ on various biochemical parameters with metabolic, liver, and kidney functions. Throughout the study liver function and kidney function were within normal levels as shown in **Table 4.23**.

Table 4.23 Mean (± SD) of biochemical parameters in 42 obese female subjects throughout the study

Parameters	Week 0	Week 4	Week 8	Week 12
Hemoglobin, g/dL	12.6 ± 1.0	13.0 ± 1.0	12.9 ± 1.0	13.1 ± 0.7^{a6}
FBG, mg/dL	95 ± 14	96 ± 10	95 ± 10	91 ± 9^{a3b1c1}
Total cholesterol, mg/dL	201.4 ± 31.5	208.1 ± 34.9	217.1±43.5^{a2b4}	201.4±38.5^{b6c2}
HDL-C, mg/dL	53.5 ± 10.1	54.5 ± 6.7	59.5 ± 8.7^{a2b2}	59.0 ± 8.8^{a2b3}
LDL-C, mg/dL	124.8 ± 22.8	132.2 ± 32.1	133.6 ± 33.6	120.9±30.6^{b6c2}
Triglyceride, mg/dL	115.9 ± 53.7	107.1 ± 38.2	116.2 ± 51.3	107.1 ± 38.4
Serum uric acid, mg/dL	5.3 ± 0.2	5.4 ± 0.2	5.0 ± 0.2^{b2}	5.0 ± 0.2^{a6b2}
SGOT, U/L	24.0 ± 7.9	23.2 ± 6.8	21.9 ± 6.9	23.6 ± 12.4
SGPT, U/L	23.5 ± 8.5	23.2 ± 8.5	20.0 ± 7.0^{a5b5}	23.5 ± 20.1^{a6}
Alkaline phosphatase, U/L	56.1 ± 13.3	61.5±10.5^{a4b2}	72.5 ±14.1^{a1}	73.4 ±18.7^{a2b4}
BUN, mg/dL	15.2 ± 3.3	14.6 ± 2.5	14.6 ± 2.8	14.9 ± 2.7
Creatinine, mg/dL	1.0 ± 0.1	0.9 ± 0.1	1.0 ± 0.2^{b5}	1.0 ± 0.2^{b5}

Significant difference from wk 0 $^{a1}p<0.0001$, $^{a2}p<0.0005$, $^{a3}p<0.001$, $^{a4}p<0.005$, $^{a5}p<0.01$, $^{a6}p<0.05$

Significant difference from wk 4 $^{b1}p<0.0001$, $^{b2}p<0.0005$, $^{b3}p<0.001$, $^{b4}p<0.005$, $^{b5}p<0.01$, $^{b6}p<0.05$

Significant difference from wk 8 $^{c1}p<0.0001$, $^{c2}p<0.0005$

The study found 9 subjects (21.4% of total subjects) were anemia at baseline. The end of study, only 6 of 9 subjects with anemia had normal level of hemoglobin. We observed 4 of our subjects had hyperuricemia and 3 of them had normal serum uric acid at the end of study **(Table 4.24)**.

At baseline and week 8 after consuming MJ, we found 6 subjects were IFG. At the end of study 2 of them had normal level of FBG. We found 2 subjects with DM at baseline. All subjects with DM can reduce FBG from baseline **(Table 4.25)**. Throughout the study FBG of diabetic subjects reduced continuously until the end of study, mean of FBG at week 0, week 4, week 8, and week 12 were 144.0 mg/dL, 117.0 mg/dL, 109.0 mg/dL, and 108.5 mg/dL respectively**.**

Table 4.26 shows 5 subjects with borderline high triglyceride at baseline. At the end of study 4 of them had normal level of serum triglyceride, and one subject was in borderline high triglyceride. **Table 4.26** shows 3 subjects with high triglyceride. After consuming MJ 4 weeks, one of them had normal triglyceride level, one of them had borderline triglyceride, and the rest was in high triglyceride. At the end of study no subjects had high triglyceride level.

Table 4.27 shows 12 subjects with borderline high LDL-C at baseline. After consuming MJ for 4 weeks, 5 of them had normal serum LDL-C and at the end of study, 9 of them had normal serum LDL-C. Four subjects had high LDL-C at baseline. After consuming MJ for 4 weeks, 2 of them had improved their serum LDL-C, one subject was in normal LDL-C level and one subject was in borderline high LDL-C. At the end of study, 2 of high LDL-C subjects had normal level of LDL-C.

All subjects had HDL-C status were within normal level (>40 mg/dL) throughout the study.

Tables 4.28 – 4.31 shows pearson's correlation coefficient among various nutritional parameters.

Tables 4.32 – 4.33 shows body composition, BP status, and biochemical parameters of 42 subjects during the study. We found after our subjects entered in study, their body composition, BP status, and biochemical parameters can improve from baseline.

Table 4.24 Anemia and hyperuricemia subjects throughout the study

Anemia and hyperuricemia	Week 0	Week 4	Week 8	Week 12
	n (%[a])	n (%[b])	n (%[b])	n (%[b])
Anemia (hemoglobin <12 g/dL)	**9 (21.4)**	2 (22.2)	4 (44.4)	3 (33.3)
Hyperuricemia (Serum uric acid >7 mg/dL)	**4 (9.5)**	1 (25)	1 (25)	1 (25)

[a]% of total subject, [b]% of anemia or hyperuricemia at week 0

* Base on World Health Organization 2011

* Base on Thai Rheumatism Association 2009

Table 4.25 FBG status of 8 subjects throughout the study

FBG, mg/dL*	Week 0	Week 4	Week 8	Week 12
	n (%[a])	n (%[b])	n (%[b])	n (%[b])
IFG				
Normal (FBG < 100 mg/dL)	-	1 (16.6)	-	2 (33.3)
IFG (FBG 101-125 mg/dL)	**6 (14.3)**	5 (83.4)	6 (100)	4 (66.7)
DM (FBG>126 mg/dL)	-	-	-	-
DM				
Normal (FBG < 100 mg/dL)	-	-	-	-
IFG (FBG 101-125 mg/dL)	-	2 (100)	2 (100)	2 (100)
DM (FBG >126 mg/dL)	**2 (4.8)**	-	-	-

[a]% of total subject, [b]% of FBG at week 0

* Base on Thai Clinical Practice Guideline for Diabetes 2014

Table 4.26 Triglyceride status of 8 subjects throughout the study

Triglyceride, mg/dL*	Week 0	Week 4	Week 8	Week 12
	n (%[a])	n (%[b])	n (%[b])	n (%[b])
Borderline high triglyceride				
Normal (Triglyceride < 150 mg/dL)	-	4 (80)	3(60)	4 (80)
Borderline high triglyceride (Triglyceride 150 - 199 mg/dL)	**5 (11.9)**	1 (20)	-	1 (20)
High triglyceride (Triglyceride 200 - 499 mg/dL)	-	-	2(40)	-
High triglyceride				
Normal (Triglyceride < 150 mg/dL)	-	1 (33.3)	1 (33.3)	1 (33.3)
Borderline high triglyceride (Triglyceride 150 - 199 mg/dL)	-	1 (33.3)	1 (33.3)	2 (66.7)
High triglyceride (Triglyceride 200 - 499 mg/dL)	**3 (7.1)**	1 (33.3)	1 (33.3)	-

[a]% of total subject, [b]% of triglyceride status at week 0

* Base on NCEP III 2002

Table 4.27 LDL-C status of 16 subjects throughout the study

LDL-C, mg/dL*	Week 0	Week 4	Week 8	Week 12
	n (%[a])	n (%[b])	n (%[b])	n (%[b])
Borderline high LDL-C				
Normal (LDL-C < 130 mg/dL)	-	7 (58.3)	5 (41.7)	9 (75.0)
Borderline high LDL-C (LDL-C 130 - 159 mg/dL)	**12 (28.6)**	2 (16.7)	3 (25.0)	1 (8.3)
High LDL-C (LDL-C > 160 mg/dL)	-	3 (25.0)	4 (33.3)	2 (16.7)
High LDL-C				
Normal (LDL-C < 130 mg/dL)	-	1 (25.0)	1 (25.0)	2 (50.0)
Borderline high LDL-C (LDL-C 130 - 159 mg/dL)	-	-	1 (25.0)	-
High LDL-C (LDL-C > 160 mg/dL)	**4 (9.5)**	3 (75.0)	2 (50.0)	2 (50.0)

[a]% of total subject, [b]% of LDL-C status at week 0

* Base on NCEP III 2002

Table 4.28 Pearson's correlation coefficient %body fat and body weight between nutritional parameter in 42 obese female subjects

Nutritional parameter	Body fat, %bw		Body weight, kg	
	r	**p-value**	***r***	**p-value**
Weight, kg	0.817	< 0.001	-	-
Body fat, %bw	-	-	0.817	< 0.001
Body fat, kg	0.945	< 0.001	0.954	< 0.001
Trunk, %	0.997	< 0.001	0.789	< 0.001
AUWC, cm	0.904	< 0.001	0.835	< 0.001
UWC, cm	0.816	< 0.001	0.804	< 0.001
BUWC, cm	0.844	< 0.001	0.808	< 0.001
Hemoglobin, g/dL	-0.079	NS	-0.105	NS
FBG, mg/dL	0.041	NS	0.006	NS
HDL- C, mg/dL	-0.118	<0.05	-0.209	<0.01
LDL- C, mg/dL	0.159	<0.05	0.110	NS
Triglyceride, mg/dL	0.196	<0.05	0.048	NS
Uric acid, mg/dL	0.215	<0.005	0.082	NS
SBP (mmHg)	0.127	NS	0.158	<0.05
DBP (mmHg)	0.042	NS	0.090	NS

NS: no significant

Table 4.29 Pearson's correlation coefficient between %trunk fat and nutritional parameters in 42 obese female subjects

Nutritional parameter	*r*	p-value
Weight, kg	0.789	< 0.001
Body fat, %bw	0.997	< 0.001
Body fat, kg	0.929	< 0.001
AUWC, cm	0.896	< 0.001
UWC, cm	0.809	< 0.001
BUWC, cm	0.839	< 0.001
Hemoglobin, g/dL	0.048	NS
FBG, mg/dL	-0.081	NS
HDL- C, mg/dL	-0.110	NS
LDL- C, mg/dL	0.157	<0.05
Triglyceride, mg/dL	0.212	< 0.01
Uric acid, mg/dL	0.288	< 0.005
SBP (mmHg)	0.129	NS
DBP (mmHg)	0.049	NS

NS: no significant

Table 4.30 Pearson's correlation coefficient between saturated fat intake and biochemical parameters in 42 obese female

Biochemical parameters	***r***	**p-value**
FBG, mg/dL	0.172	<0.05
HDL-C, mg/dL	-0.252	<0.05
LDL - C, mg/dL	-0.081	NS
Triglyceride, mg/dL	0.010	NS
Serum uric acid, mg/dL	0.059	NS

NS: no significant

Table 4.31 Pearson's correlation coefficient between age and body composition parameters in 42 obese female

Body composition	***r***	**p-value**
Body weight, kg	0.207	NS
Body fat, %bw	0.208	NS
Body fat, kg	0.196	NS
Trunk fat, %	0.190	NS

NS: no significant

Table 4.32 Body composition and blood pressure status of 42 subjects during the study

Parameters	Week 0	Week 12
	n (%[a])	n (%[a])
Over body fat status		
Over body fat I (30.1 - 40.0,%bw)	20 (47.6)	25 (59.6)
Over body fat II (40.1 - 50.0,%bw)	18 (42.9)	14 (33.3)
Over body fat III (50.1 - 60.0,%bw)	4 (9.5)	3 (7.1)
Weight status		
Normal weight (BMI < 24.9 kg/m^2)	6 (14.3)	14 (33.3)
Overweight (BMI > 24.9 kg/m^2)	36 (85.7)	28 (66.7)
SBP status		
Normal (SBP < 120 mmHg)	23 (54.8)	27 (64.3)
Pre-hypertension (SBP 121-139 mmHg)	14 (33.3)	14 (33.3)
Hypertension (SBP > 140 mmHg)	5 (11.9)	1 (2.4)
DBP status		
Normal (DBP < 80 mmHg)	26 (61.9)	28 (66.7)
Pre-hypertension (DBP 81 - 90 mmHg)	10 (23.8)	12 (28.5)
Hypertension (DBP > 90 mmHg)	6 (14.3)	2 (4.8)
Bone mass status		
Low bone mass	3 (7.1)	3 (7.1)
Normal bone mass	39 (92.9)	39 (92.9)

[a]% of total subject

Table 4.33 Biochemical parameters status of 42 subjects during the study

Parameters	Week 0	Week 12
	n (%[a])	n (%[a])
Hemoglobin, g/dL		
Normal (Hemoglobin > 12 g/dL)	33 (78.6)	39 (92.9)
Anemia (Hemoglobin < 12 g/dL)	9 (21.4)	3 (7.1)
FBG, mg/dL		
Normal (FBG < 100 mg/dL)	34 (80.9)	35 (83.3)
IFG (FBG 101-125 mg/dL)	6 (14.3)	7 (16.7)
DM (FBG > 126 mg/dL)	2 (4.8)	-
LDL-C, mg/dL		
Normal (LDL-C < 130 mg/dL)	26 (61.9)	33 (78.6)
Borderline high LDL-C (LDL-C 130 - 159 mg/dL)	12 (28.5)	3 (7.1)
High LDL-C (LDL-C > 160 mg/dL)	4 (9.5)	6 (14.3)
Triglyceride, mg/dL		
Normal (Triglyceride < 150 mg/dL)	34 (80.9)	35 (83.3)
Borderline high triglyceride (Triglyceride 150 - 199 mg/dL)	5 (11.9)	7 (16.7)
High triglyceride (Triglyceride 200 - 499 mg/dL)	3 (7.1)	-
Serum uric acid, mg/dL		
Normal	38 (90.5)	41 (97.6)
Hyperuricemia (Serum uric acid >7 mg/dL)	4 (9.5)	1 (2.4)

[a]% of total subject

CHAPTER V
DISCUSSION

Obesity is generally caused by energy intake over energy expenditure. The excess energy intake is stored by the body fat. Overweight and obesity are major risk factors for NCD including diabetes, hypertension, dyslipidemia, cardiovascular diseases, and cancer. Major problem of obese people are incapable of losing weight because dietary behavior and lifestyle changes are difficult, their obese people find out alternative choice as health foods or natural supplement promoted for weight loss in the expect that these products will help them more easily achieve their weight reduction. Several studies showed the benefits of *Garcinia mangostana* or *Garcinia cambogia* for weight management and reducing body fat accumulation (4, 5). Thus we are interested to study the synergy effects of combined *Garcinia mangostana* and *Garcinia cambogia* on weight loss and body fat accumulation.

This study aimed to evaluate efficacy of MJ for weight loss and body fat reduction in obese females for 12 weeks. The study was divided in to 4 parts for discussion, health and dietary behavior information, dietary intakes, efficacy of MJ on nutritional status, and after stopping MJ consumption on nutritional status respectively.

5.1 Health information and dietary behavior

Over half of our obese subjects were office workers (59.5 %). Only 78.6% of them did not exercise and inactive physical activity, thus occupational physical inactivity had been associated with obesity. Choi et al. (57) reported cross-sectional of sedentary work, low physical job demand, and obesity in US workers aged 32 - 69 years. The sedentary work was workers needing to spend long periods in a seated position. Physical job was physical effort during work. This study was carried out by questionnaire. They found low physical activity was risk for total and central obesity

in male workers and the sedentary works marginally increased the risk for total and central obesity in female workers, and similar to Hu et al. (58) reported prospective cohort study of relation among risk of obesity and T2DM with sedentary behavior in women aged 30 – 55 years in the nurses' health study of US. That study found each 2-hr/d increment in sitting at work was associated with a 5% increase in obesity and a 7% increase in DM.

Our study found most of subjects had over body fat 30.1 – 50.0 %bw. NHANES reported obese women aged ≥ 20 years had average of body fat 40 %bw (59). According to Ho-Pham et al. (60) studied relationship between %body fat and BMI in the Vietnamese population. Vietnamese people aged ≥ 20 years, women had average of body fat 34.7%bw.

Subject health information showed that only 23.8% of total subjects knew that they had underlying diseases including 6 subjects with hypertension and 4 hypercholesterolemia subjects. At baseline the study found 3 subjects with hypertension, 2 subjects with hyperglycemia, 13 subjects with hypercholesterolemia, and 8 subjects with hypertriglyceridemia, however all of these subjects did not know that they had those abnormal nutritional status. Obesity associate with many medical complications that can reduce a quality of life and in some cases shorten life. Many of the complications described here or eliminated with weight loss. It is important that people realize that obesity is a serious risk to long-term health. Early educating in obese people can reduce risk consequence of obesity and NCD prevention.

Most of our subjects (78.6%) did not exercise, we found 2 major causes of lack of exercise were busy working, and they did not like to exercise. Grave et al. (61) reviewed behavioral strategies to increase adherence to exercise in obese. They found several reasons in obese subjects did not exercise including low motivational status, self-esteem, negative learning history with exercising, high costs of training programs, and low social or cultural supports. Grave et al. suggested that behavioral strategies to increasing the level of exercise were education about the benefit of exercising and the need to increase the level of physical activity for long-term weight control, turning everyday activities into exercise (using stairs, walking to work, etc.), planning enjoyable activities or amusing exercising (e.g., group dancing or walking), increasing

goals very slowly, and focus is to modify the external environment to make it more conducive to making choices that support exercising.

Our subjects skipped their breakfast 44.4%, and dinner 44.4%. This behavior lead to obesity according to Ma et al. (62) studied to evaluate the association between eating patterns and obesity. Three days dietary record and body weight status were classified by BMI were collected 1 year period. They reported subjects skip breakfast had significant higher risk of obesity 4.5 times as subjects consumed breakfast.

Our 69% of subjects consumed buffet 1-3 times/month. Buffets are restaurants that allow unlimited amounts of various foods to be eaten at a fixed price. In particular, as customers are free to help themselves to extra portions, the price factor is not acting as a brake on excessive intake as it often does at à la carte style restaurants. Duerksen et al. (63) found family restaurant choices are associated with child and adult overweight status in Mexican-American families. They reported parent overweight was associated with eating at American restaurants, primarily buffets (odds ratio: 2.8; 95% confidence interval: 1.3 to 6.2). Rodrigues et al. (64) studied relationship between food portion size with overweight or obesity among consumers at a restaurant serving buffet-by-weight in Brazil. Food portion size was collected by customer record. They found overweight or obese people were positively associated with large portion size (PR = 1.16 for a portion size of 463 g or more).

The present study found our subjects had dietary behavior relate to obesity including sugar drink intake, animal fat or animal skin consumption, and > 50% of total subjects added sugar or fish sauce in dishes. According to Thailand health report (11) surveyed dietary behavior in Thai population. Thai people aged > 35 years had the following favorite diets or dietary behaviors: deep fried foods, food composed of coconut milk, high energy dense food and high fat foods, added sugar, and added fish sauce in plate were 96.2%, 91.8%, 85.1%, 86.1%, and 82.5% respectively. Moreover, they reported Thai females ate high dense fat food, fast food, animal fats, and deep fried foods 4 times/week.

Interestingly, most of subjects had snack meals during a day and also had snacks before bed. Their favorite snacks were sweetened beverage and sweeten fruits. Only 17 subjects had snack meal before bed, their mean body fat was 40.6%bw (32.8

– 53.1%bw). Mean body fat in subjects had not snack meal before bed was 41.6%bw (35.1 – 55.8 %bw). %Body fat was not difference in both groups, thus snack meals consumption did not affect to % body fat in our obese subjects. This evidence is supported by their total energy intakes at baseline period which is not different.

Department of health (65) reported sugar contains per serving of sugar-sweetened carbonated soft drink typically, drinking yoghurt, and vegetable or fruit juice were 30g (6 tsp.), 19g (4 tsp.), and 20g (4 tsp.). WHO (66) mention evidence of nutrition action in reducing consumption of sugar sweetened beverages to reduce the risk of unhealthy weight gain topic, excess calories contribute to overweight and obesity as they can be readily converted to body fat and stored within various tissues.

Schulze et al. (67) studied the association between consumption of sugar sweetened beverages and weight change and risk of T2DM in women. Prospective cohort analyses conducted from 1991 to 1999, they found weight gain over a 4-year period was highest among women who increased their sugar sweetened soft drink consumption from <1 drinks/week to >1 drinks/day (multivariate-adjusted means, 4.69 kg for 1991 to 1995 and 4.20 kg for 1995 to 1999). In our study we found subjects had soft drink consumption 600 mL (320 kcal)/week.

A systematic reviewed by Malik et al. (68), shows sugar sweetened beverages associated with weight gain. Several review of sugar sweetened beverages intakes promoted overweight and obesity in adolescent and adults.

5.2 Dietary intake

The averages of compliance in subjects were 98%. Subjects rated the acceptability of MJ with GB consumption in good score. MJ with GB is no adverse effects during this study including various safety parameters related to liver, kidney functions, serum uric acid, and hemoglobin levels were in normal limits throughout the study.

Subjects had completely recorded their daily dietary intake and our subjects had regular physical activity throughout the study. At baseline before study energy intake was 99.5% of energy requirement (energy intake: 1533 kcal, energy

requirement: 1540 kcal). Energy intake were 85.9%, 68.9%, and 85.5% of requirement at first 4 weeks after receiving dietary advice, week 8 of MJ consumption, and last 4 weeks of dietary advice the same as week 4 respectively. At first 4 weeks subjects able to reduce energy intake 14.1% from energy requirement for weight loss. At week 8 after consuming MJ with GB replace meals (263 kcal/day), subjects had energy intake decreased from energy requirement 31.1%, 2 times of first 4 weeks reduction. Their energy intake reduced from baseline 496 kcal result to weight reduction. After stopping MJ consumption at week 12, subjects still can control their energy intake which was similar to mean energy intake at week 4.

At week 4 after receiving dietary advice, their energy intake reduced 14.1 % from baseline. Next 4 week of MJ consumption, the MJ would be a good replacement for a ready-to-eat to keep subjects full for a prolonged period, energy intake was lower than those at week 0 and week 4. Energy intake reduced 21.3 % from first 4 weeks, consistent with the study of Westerterp-Plantenga et al. found after consuming tomato juice mixed with HCA, these 24-hour energy intake reduction of 15 –30% compared with placebo (39). It may be the α-mangostin mechanism according to Taher et al. studies (28), these reported the α-mangostin could increase gene expression of leptin hormone in vitro study. Leptin hormone related to satiety index, hence reducing appetite and improving energy expenditure influence for weight loss. At week 12 energy intakes increased from week 8, however energy intake was significantly lower than that at baseline. Thus our subjects received learning process of control diet for weight management. Energy intake at week 4, week 8, and week 12 reduced from baseline 14.1%, 32.4%, and 16.0% of energy intake at baseline respectively.

Due to MJ consumption, their energy intake was the lowest (1037 kcal), 26.2 % of total energy was derived from MJ and GB. Their energy distributions of carbohydrate, protein, and fat were 58.0%, 15.7%, and 26.5% of energy respectively. During week 5 – 8, subjects consuming MJ was similar to low calorie diet plan or hypo-caloric for weight loss. These diets plan composed protein (10–20% energy), carbohydrate (50–65% energy), and fat (25–35% energy) in energy intake of 500–1000 kcal/d (69).

According to Hall et al. (70) found the trends in high carbohydrate with low fat consumption group decreased energy intake and body fat higher than those low carbohydrate with high fat consumption group (-765 ± 36.6 kcal/day and -0.588 ± 0.14 kg) respectively. In our study, at week 4 of diet control their dietary pattern was normal carbohydrate with high fat consumption had energy intake and body fat reduction from week 0, -216 ± 212 kcal/day and -0.8 ± 1.1 kg. Next 4 week of MJ consumption was high carbohydrate with low fat diet pattern had energy intake and %body fat reduction from week 4, -280 ± 176 kcal/day and -1.3 ± 1.1 kg.

After MJ consumption , the study found distribution of protein was the lowest, however energy distribution of protein was not less than Thai RDI (≥ 10% total energy) (71). Their fat intake and saturated fat intake were lower than those at baseline and week 4. At the end of study, fat and saturated fat intakes had higher than that at week 8, however their fat and saturated fat consumption were not higher than that at baseline. Subjects performed dietary advice to restrict fat and saturated fat intakes. Their high fat and saturated fat intake as dense fried foods, animal skin, and organ meat intakes reduced from baseline.

At baseline before study, we found subjects had daily sugar intake 60.7 g. During the study, their sugar intakes had 46.4 g, 71.8 g, and 45.0 g at week 4, 8, and 12 respectively. It was noticed that at week 8 sugar intake was highest of study, 44.1g of sugar intake derived from MJ and GB. Our study did not find the effect of high sugar intake to weight gain during MJ consumption. This evidence agrees with the study of Hall et al (70). Throughout the study their sugar intakes were higher than 25 g / day of WHO recommendation (6 tsp.) (72). If our obese subjects had high sugar intake for long-term, it may increase the risk of many health problems such as DM, heart disease, or kidney disease. Thus nutritional education of sugar intake in obese people is important for prevention of diet-related chronic diseases. High sugar intake is also observed in general Thai population. Between 2001 and 2011, Thai health promotion foundation (the sustainability of well-being for Thai people) showed that sugar consumption increased 2.3 times in Thai population, and they found Thai people consumed sugar 100 g / day (25 tsp.) (73).

At baseline before study, our obese subjects had sodium intake higher than Thai RDI because of their high sodium intake, including added fish sauce in dishes

and processed foods. After receiving dietary advice at first 4 weeks, their sodium intake reduced from baseline. Next 4 weeks of MJ consumption replace 2 meals their mean sodium intake was the lowest level, 1905 mg/day (79.4 %Thai RDI), during the study. However, at the last period of study subjects turned to had regular diets alone for weight reduction their mean sodium intake was significantly higher than that at week 8 but not higher than that at baseline. During only diet control periods at week 4 and 12, due to subjects reduced foods consumption result in decrease sodium intake but their mean sodium intake higher than Thai RDI because of obese subjects did not have the knowledge about high sodium foods such as processed foods and some fruits. Thus nutrition education of sodium intake in obese people is important because of high sodium intake is a serious risk to hypertension and cardiovascular diseases.

We found subject had fiber intake 9.1 g/day at baseline which was lower than Thai RDI (< 25 g/day) (71). Hay Alfieri et al. found the lack of dietary fiber may be a contributing factor in obesity. In obese female group had fiber intake 12.9 g/day lower than 18.4 g/day of normal weight female group and their fiber intakes were lower than the expert committee on dietary fiber recommends that the adult Canadian population at least double its current intake of dietary fiber to reach a level of between 25 to 35 g/day.

In our study, their fiber intake remained lower than Thai RDI as especially only diet control periods, fiber intake was reduced from restrict foods consumption for weight loss. At week 8 after consuming MJ, mean fiber intake had significant higher than those at week 4 and week 12 of dietary advice for weight loss, 3.7g of fiber intake derived from MJ and GB increasing volume of total fiber intake during study. We suggested understanding of high dense energy restriction in obese people had not decreased fiber intake for weight loss. Obese subjects should increase fiber intake from vegetable growing above ground. Dietary fiber intakes have effect on satiety as slow gastric emptying reach weight reduction.

Throughout the study our subjects had water intake ranged 1,713 – 1,765 mL/day. Their water intake was less than water intake recommendation in woman 2,700 mL/day (74). Dennis et al. (75) studied hypocaloric diet with increasing water intake 500 mL comparison with hypocaloric diet alone for weight loss in adults. Weight loss and energy intake reduction were greater in the water group than in the

non-water group. Drinking water before meals could reduce appetite. Muckelbauer et al. (76) reviewed evidence on the association between water consumption and body weight outcomes. In participants dieting for weight loss or maintenance, various study design showed that increased water consumption, in addition to a program for weight loss or maintenance, reduced body weight after 3–12 mo compared with such a program alone. Thus we should recommend obese people had fresh water intake not less than 2,000 mL/day.

5.3 Efficacy of MJ consumption on nutritional status

5.3.1 Body composition

After first 4 week of dietary advice, mean energy intake decreased 216 kcal/day from baseline resulted in body weight reduction 0.9 kg, %body fat reduction 0.7 %bw, and body fat reduction 0.8 kg. After consuming MJ, mean energy intake decreased 280 kcal/day from week 4 resulted in continuous body weight reduction 1.9 kg, %body fat reduction 0.8%bw, and body fat reduction 1.3 kg.

According to Wishnofsky's rule, was reasoned that low calorie dieting the main body weight loss derives from adipose tissue. The restriction of 500 kcal a day rule will be made up chiefly by the catabolism of body fat rounded to 3500 kcal/lb or 7700 kcal/kg (77).

In our study at first 4 week, their energy intake decreased 216 kcal/day (216 kcal x 28 days = 6104 kcal) resulted in body weight reduction 0.9 kg and body fat reduction 0.8 kg close to weight and body fat reduction 0.8 kg predicted by the 7700 kcal/kg rule. Next 4 week of MJ consumption, their energy intake decreased 280 kcal/day (280 kcal x 28 days = 7840 kcal) resulted in body weight reduction 1.9 kg and body fat reduction 1.3 kg greater than weight and body fat reduction 1 kg predicted by the 7700 kcal/kg rule. Interestingly, during MJ consumption weight and body fat reduction were greater than Wishnofsky's rule. We assumed impact of MJ effect on weight and body fat reduction. Quan et al. (30) studied in vitro found that α-mangostin could inhibit fatty acid synthesis in 3T-3L1 preadipocyte cell and suppression decreases fat accumulation and stimulates lipolysis in mature adipocytes.

Effects of Garcinia via regulation of serotonin level and glucose uptake. Besides, it also helps to enhance fat oxidation while reducing de novo lipogenesis (5).

During MJ, their % body fat and fat mass were greater than the reduction during first 4 weeks of dietary advice. There was the highest reduction of all segmental fats when compared with the other periods of study. The 3 WC sites were statistically significant decreased from baseline and week 4 as AUWC (-2.3 cm), UWC (-3.2 cm), and BUWC (-2.7 cm). Researchers of operation BIM of the Thai mangosteen research and development centre studied effect of mangosteen concentrate, 80% in obese subjects for reducing excess body fat. Obese subjects drank mangosteen juice concentrate 1 bottle (300 mL) before meal per day for 4 weeks, both mean body weight and mean UWC decreased from baseline as 1.41 kg and 5.55 cm, respectively (34). Stern et al. (31) studied the efficacy of 7-hydroxyfrullanolide, the phytochemical in *Sphaeranthus indicus* and α-mangostin, the phytochemical in *Garcinia mangostana* on weight loss. Obese subjects received 2 capsules of herbal extract per day, each capsule is 400 mg consisting of 300 mg from the flower of *Sphaeranthus indicus* and 100 mg from the pericarp of mangosteen. After 4 weeks of the experiment the herbal blend group had significant weight loss of 3.1 kg and WC reduction of 7.7 cm in comparison with the placebo group. Kudiganti et al. (32), found statistically significant reductions in body weight 1.53 ± 0.20 kg and WC 3.38 ± 0.37 cm were observed in the Meratrim™ (*Sphaeranthus indicus* and α-mangostin) versus the placebo group. Roongpisuthipong et al. (41) studied effects of water soluble calcium hydroxycitrate in *Garcinia atroviridis* for reducing body weight and body fat in obese subjects. After supplement in garcinia group significantly reduced body weight 2.3 ± 0.1 kg and 2.8 ± 0.1 kg at weeks 4 and 8, respectively. At week 8 garcinia group was significantly decreased body fat from baseline 4.9 % of body weight and had significant increased lean mass 1.3 kg.

Our subjects had most of fat mass in the trunk (abdominal). Although the highest of segmental fat reduction was trunk fat at week 4, but that only UWC was significantly lowers than that at baseline. However, our study found positive correlation between trunk fat and 3 WC sites (AUWC, UWC, and BUWC: r= 896, r=809, and r=839 $p<0.001$). Thus trunk fat reduction associated WC reduction.

According to Wang et al. (19) confirmed UWC associated with visceral fat and BUWC related with total body fat.

At week 8 there also was some loss of muscle mass 0.5 kg (26.3 % of weight loss). Muscle mass reduction was responded by hypo-caloric diet for weight loss. Heymsfield et al. (77) summarized a widely cited rule guiding expected weight loss of lean tissue that approximately 25% of weight loss will be lean mass. Mark et al. (78) explained FFM influences several physiological functions, it may be that a minimal loss of FFM from the obese state is not only unavoidable, but actually desirable if the loss is in the form of less essential FFM as muscle mass. They suggested that FFM loss should compose no more than 30% of total weight loss. Dixon et al. (79) estimated FFM loss that may be expected during weight loss. They summarized 25% of FFM loss rule is inappropriate and guiding, 35–40% and 30–35% are the expected FFM to total weight loss ratios for men and women obese. Thus, our study was acceptability to 26.3 % of **Δ** muscle mass/**Δ** weight after consuming MJ.

Only 15 subjects who had continuous weight, %body fat, and body fat mass reductions throughout the study. We found 12 of 15 subjects had over 95% compliance. Subject had good intention and discipline for participant throughout the study. After MJ consumption, their body weight, %body fat and body fat mass were greater than the reduction during first 4 week of dietary advice, and the impact of MJ on body weight reductions were greater 1.5 times of week 4. Their reductions of energy intake below energy requirement were 486 kcal/day and water intake approximately 2000 mL/day. There was the minor reduction of the aforesaid body composition parameters at the last 4 week of dietary advice.

We found only 10 subjects (23.8 % of total subjects) did not control diet for weight loss after first 4 weeks. Before study we found behavior of them, no exercise and snacks consumption during a day as sugar sweetened drinks. Their BMI and %body fat in 10 subjects were 28.5 kg/m^2 and 40.8%bw respectively. Subjects had excess body fat. At week 4, their sugar and saturated fat intake also were higher than Thai RDI. Next 4 week after consuming MJ, their weight, %body fat, and body fat reduced from first 4 weeks. After quitting from MJ consumption, there was no more reduction of the aforesaid body composition parameters at the last 4 week of dietary

advice. Thus, this study confirmed efficacy of MJ on weight and body fat reductions in uncontrolled diet persons.

Although the study found weight and body fat reduction depend on age. Young age group had high potential difference change on body composition more than elder age. Thomas et al. (80) found effect of age on fat oxidation was significant lower 22% than younger. However our 1 subject of lately adulthood can reduce her body weight and body fat like the younger age group. Our study did not find relationship between age and body composition parameters.

Only 3 subjects had low bone mass, their aged in 50 – 60 years. Calcium intake and phosphorus intake were lower than Thai RDI. The physiology of bone loss in aging women and men is largely explained by the effects sex hormone deficiency. As especially in women, estrogen hormone reduction is the main cause of early rapid postmenopausal bone loss, whereas hyperparathyroidism and vitamin D deficiency are thought to explain age-related bone loss in older adults (81).

5.3.2 Blood pressure status

After receiving MJ, mean BP was significantly lower than baseline and first 4 weeks of dietary control. This evidence was supported by their sodium intake reduce 1,248 mg/day and 933 mg/day from baseline and week 4 respectively. Law et al. (82) reviewed trials of salt reduction on BP, they summarized in people aged 50-59 years a reduction in daily sodium intake of 1150 mg after 5 week or longer weeks was lower 5 mmHg in SBP, and 7 mmHg in DBP.

Our study found relationship between weight and SBP (r = 0.158, $p < 0.05$). Influence of weight reduction affect to low BP refer to Judith et al. (83) reviewed meta-analysis several RCT, these reveal BP decreased 1 mmHg for each kilogram of weight loss. Wang et al. (84) found xanthones was antihypertensive reagent to low high BP in rat. Xanthones were an inhibitory effect on angiotensin-I-converting-enzyme, calcium channel and an independent of parasympathetic blocking effects with vasodilating properties.

5.3.3 Biochemical parameters

Overview of the subjects, their all blood biochemistry were within normal range. We followed the nutritional status improvement in nutritional disorder subjects.

MJ did not increase blood sugar in diabetic subjects, and can improve blood sugar level in 2 IFG subjects changed to normal blood sugar level. However, there are several factors affecting the blood glucose level.

Interestingly, we found mean saturated fat intake was significantly reduced from week 4 and saturated fat intake was positive association with FBG level (r = 0.172, $p < 0.05$). Consistent, Uusitupa et al. (85) reported comparison of the effect of low and high saturated fat diets on glucose metabolism in normal female subjects. After consumption of the high saturated fat diets, in response to a standard glucose tolerance test, blood glucose reducing was slower than after the subjects consumed the low saturated fat diet and Lichtenstein et al. (86) reviewed high-fat diets, independent of fatty acid profile had been insulin insensitivity.

At baseline the study found 8 subjects with hypertriglyceridemia including borderline high triglyceride and high triglyceride, their mean body fat 41.1%bw were excess body fat in these subjects. We found % body fat and trunk fat had significant positive correlation with triglyceride (r= 0.196, $p < 0.05$ and r= 0.212, $p < 0.01$).

Most of them had high fat intake, dessert and sweeten fruit. After weight reduction of receiving dietary advice at week 4, 8 subjects with hypertriglyceridemia can reduce triglyceride levels, their improved quality of foods consumption as avoid 3 in 1 coffee and sweeten fruits as durian and ripe mango consumptions. Next 4 week of MJ consumption at week 8, 2 subjects with hypertriglyceridemia can reduce triglyceride levels. But their mean triglyceride levels in 42 subjects were not difference from baseline and week 4. Triglyceride levels decreased at over 8 weeks after consuming magosteen or garcinia supplement this evidence was supported by pervious study of Stern et al. (31) studied the efficacy of herbal extract (*Sphaeranthus indicus* and mangosteen) for weight loss. After 8 weeks of the experiment the herbal blend group had significant decreased triglyceride 41.6% of baseline. Roongpisuthipong et al. (41) studied effects of water soluble calcium hydroxycitrate in *Garcinia atroviridis* for reducing body weight and body fat in obese subjects. After 8 weeks the result showed serum triglyceride reduced from baseline 5.5 mg/dL.

At baseline the study found 16 subjects had hypercholesterolemia including borderline high LDL-C and high LDL-C. After first 4 weeks of receiving dietary advice, 8 subjects with hypercholesterolemia can reduce LDL-C from baseline. We found their organ meat consumption was lower than baseline. Next 4 week after consuming MJ, 9 subjects with hypercholesterolemia can reduce LDL-C from week 4, their mean fat and saturated fat intake decreased 33.8% and 28.9% of week 4.

At week 8 after consuming MJ, their HDL-C had significant increased from week 4 9.2%. In experimental study extract of mangosteen increased HDL-C levels in rats (87).

5.4 After stopping of MJ consumption on nutritional parameters

5.4.1 Body composition

At week 12 after stopping of MJ consumption, all body composition parameters were not statistically significant differences from week 8 although energy intake increased 251 kcal/day from week 8. However, their body weight and body fat were significantly decreased from week 0 and week 4. Subjects can control diet for weight reduction and no weight cycling after stopping MJ consumption (YO YO-effect). The end of study, our subjects received learning process of control diet for weight management. Their mean sugar intake and saturated fat intake were lower than those at baseline and week 4.

5.4.2 Biochemical parameters

At week 12 subjects turned to receive dietary advice, 2 subjects with IFG can reduce FBG to normal levels and 4 subjects of them also reduce FBG although it did not improve to normal levels. Only 2 subjects with DM remained the same levels as week 8. Finally our study found all subjects with hyperglycemia can control dietary for weight loss and it result in FBG improvement.

At the end of study after receiving dietary advice for weight loss, 5 of 8 subjects with hypertriglyceridemia improved triglyceride levels to normal level, although fat and saturated fat intake had higher than week 8 of consuming MJ but it

did not effect to increase triglyceride level. Only 3 of 8 subjects with hypertriglyceridemia can not reduce triglyceride levels because their fat intake increased 50% of week 8.

The last 4 weeks, 11 of 16 subjects with hypercholesterolemia improved LDL-C levels to normal level, 3 subjects of them can reduced LDL-C levels from week 8 although it did not improve to normal levels. Only 2 subjects of them increased LDL-C from week 8 because their saturated fat intake increased 44% of week 8.

Wing et al. (88) studied longitudinal study 1 year of weight loss in improving cardiovascular risk factors. Subjects who lost 5 - 10% of their body weight had increased odds of achieving a 0.5%point reduction in HbA1c (odds ratio 3.52 [95%CI 2.81–4.40]), a 5-mmHg decrease in DBP (1.48 [1.20–1.82]), a 5-mmHg decrease in SBP (1.56 [1.27–1.91]), a 5mg/dL increase in HDL-C (1.69 [1.37–2.07]), and a 40mg/dL decrease in triglyceride (2.20 [1.71–2.83]).

CHAPTER VI
CONCLUSION

Major problem of obese people are incapable of losing weight because dietary behavior and lifestyle changes are difficult, their obese people find out alternative choice as health foods or natural supplement promoted for weight loss with the expectation to see these products will help them more easily achieve their weight reduction. Several studies showed the benefits of *Garcinia mangostana* or *Garcinia cambogia* for weight management and reducing body fat accumulation (4, 5). Thus we are interested to study the synergy effects of combined *Garcinia mangostana* and *Garcinia cambogia* on weight loss and body fat accumulation.

This study aimed to evaluate efficacy of MJ for weight loss and body fat reduction in 42 obese females.

6.1 Efficacy of MJ consumption on nutritional status

MJ has the better effects on weight loss and body fat reduction than only diet control period and it has the efficacy to reduced segmental fat, and 3 waist circumference sites without any adverse effect. In our study at first 4 week of dietary advice, our obese subjects reduced body weight and body fat 0.9 kg and 0.8 kg close to weight and body fat reduction predicted by the 7700 kcal/kg rule (Wishnofsky's rule). Next 4 weeks of MJ consumption, their continuous body weight and body fat reduction were 1.9 kg, and 1.3 kg from week 4 of diet control alone. Interestingly, during MJ consumption weight and body fat reduction were greater than Wishnofsky's rule, it may be due to the synergy effects of combined *Garcinia mangostana* and *Garcinia cambogia* can reduce weight and body fat accumulation in obese people.

The end of study, body weight and body fat were not statistically significant decreased from week 8 however, there were the minor reduction of weight,

%body fat, and body fat from week 8. Although stopping MJ consumption, subjects can control diet for weight reduction and no weight cycling (YO YO-effect).

This study found 10 subjects (23.8 % of total subjects) did not control diet for weight loss after first 4 weeks. After consuming MJ, weight, %body fat, and body fat of them reduced from first 4 weeks. We confirmed efficacy of MJ on weight and body fat reductions in uncontrolled-diet persons. Moreover subjects who had continuous weight, %body fat, and body fat mass reductions throughout the study, we found during week 5 – 8 after consuming MJ, their body weight, %body fat and body fat mass were greater than the reduction when compared with the other periods of dietary advice.

Influence of weight reduction affected biochemical parameters improvement. At the end of study, we found FBG status, LDL-C status, and triglyceride status were within normal level as 83.3%, 78.6%, and 83.3%, of total subjects respectively. Moreover the study found significant increased in HDL-C at week 8.

Our findings indicate that MJ has the effects on weight and fat reduction especially trunk fat and 3 WC sites in obese.

6.2 Recommendation

This study found dietary behavior in our subjects had high sugar sweetened drink and high fat consumption including, saturated fat intake, sodium intake were higher than Thai RDI. Sweet flavor, sugar drinks and high fat foods consumption induced overweight and obesity. We suggested that subject should replace low sugar drinks by drinking water, decrease deep fried foods, organ meat, a animal skin, and animal fat consumptions. Reduction of sugar and fish sauce added in dishes.

Our subject had fiber and water intakes lower than recommendation. We suggest increasing fiber intake from fresh vegetable growing above ground and low glycemic foods consumption such as brown rice, whole wheat bread, multigrain, guava, apple, dragon fruit etc., and water intake was not less than 2000 mL/day.

Due to most of obese people did not exercise, we suggest increasing low-impact cardio exercises including walking, cycling, swimming and water aerobics 30 – 60 minute/day appropriate for obese people activity.

We recommend high dense energy restriction in obese people but obese people should be consumed high quality of protein intake such as chicken breast, fish, egg, tofu, skim milk, and legume etc.

Because of changes in dietary behavior and exercise are good way for weight loss, but MJ consumption is appropriate for uncontrolled-diet people to help them to lose weight and try to change dietary behaviors and lifestyle for achieving normal weight.

Further research is required on isolating the active ingredients of MJ and the mechanisms mediating its effects. Well-designed large randomized clinical trials should be conducted to reveal the entire spectrum of its favorable effects on human health.

REFERENCES

1. Obesity and overweight [Internet]. 2016 [cited 2016 Aug 2]. Available from:http://www.who.int/mediacentre/factsheets/fs311/en/.
2. Dietary Supplements for Weight Loss [Internet]. 2015 [cited 2016 Aug 2]. Available from: https://ods.od.nih.gov/factsheets/WeightLoss-Health Professional/.
3. Obolskiy D, Pischel I, Siriwatanametanon N, Heinrich M. Garcinia mangosta-na L.: a phytochemical and pharmacological review PTR. 2009; 23(8): 1047-65.
4. Liu QY, Wang YT, Lin LG. New insights into the anti-obesity activity of xan-thones from Garcinia mangostana. Food & function 2015; 6(2):383–93.
5. Chuah LO, Ho WY, Beh BK, Yeap SK. Updates on Antiobesity Effect of Gar-cinia Origin (-)-HCA eCAM 2013;2013:751658.
6. Rosenbeaum M., Hirsch J.Obesity. N Engl J Med. 1997; 337(6):397-407.
7. How body fat stored or used [Internet].2016[cited 2016 Oct 2]. Available from: http://www.weightlossforall.com/fat-storage-body.htm
8. NIH. What Causes Overweight and Obesity? [Internet]. 2012 [cited 2015 AUG 2]. Available from: http://www.nhlbi.nih.gov/health/health-topics/topics/obe/causes.
9. Fatima SS, RR, Chaudhry B. Body mass index or body fat! which is a betterobesity scale for Pakistani population?. J Pak Med Assoc. 2014; 64 (11).
10. Gallagher D, Heymsfield SB, Heo M, Jebb SA, Murgatroyd PR, Sakamoto aY.Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index[1–3]Am J Clin Nutr. 2000; 72:694-701.

11. วิชัย เอกพลากร, เยาวรัตน์ ปรปักษ์ขาม, สุรศักดิ์ ฐานีพานิชสกุล, หทัยชนก พรรคเจริญ, วราภรณ์ เสถียรนพเก้า, กนิษฐา ไทยกล้า. การสำรวจสุขภาพประชาชนไทยโดยการตรวจร่างกายครั้งที่ 4 พ.ศ. 2551-2.นนทบุรี:บริษัท เดอะ กราฟิโก ซิสเต็มส์ จำกัด;2552.
12. Fuentes E., Fuentes F., Vilahur G., Badimon L. and Palomo I. Mediators Inflammation. Mediators Inflamm. 2013; 2013.
13. 20 Common Reasons Why You're Not Losing Weight [Internet]. 2016 [cited 2015 AUG 2]. Available from: https://authoritynutrition.com/20-reasons-you-are-not-losing-weight/
14. Wells J C K, Fewtrell M S. Measuring body composition. Arch Dis Child.2006 ;91:612–617.
15. Knox TA. Assessment of Nutritional Status, Body Composition, and Human Immunodeficiency Virus– Associated Morphologic Changes. Clin Infect Dis. 2003; 36 (Suppl 2): S63–8
16. ต่อศักดิ์ อินทรไพโรจน์, ปัทมวรรณ เผือกผ่อง. ฮอร์โมนจากเนื้อเยื่อไขมัน: เลปทิน อดิโพเนคทิน และ รีซิสทิน.วารสารไทยไภษัชยนิพนธ์. 2554; (6):1-18
17. Tanita. Understanding your Measurements [Internet]. 2016[cited 2015 AUG 2]Available from: http://tanita.eu/tanita-academy/understanding-your-measurements
18. Tanita. Bioelectrical Impedance Analysis [Internet]. 2016 [cited 2015 AUG 2]. Available from: http://tanita.eu/tanita-academy/bioelectrical-impedance-analysis
19. Wang J, Thornton JC, Bari S, Williamson B et al. Comparisons of waist circumferences measured at 4 sites[1–3] Am J Clin Nutr 2003;77:379–84.
20. Wikipedia. Purple mangosteen [Internet]. 2009 [cited 2015 Mar 23]. Available from: https://en.wikipedia.org/wiki/Purple_mangosteen
21. อภิชัย อารยะเจริญชัย. มังคุด วิกิวิทยาศาสตร์ [Internet]. [cited 2015 Mar 23].Available from: http://www.sc.mahidol.ac.th/wiki/doku.php?id=มังคุด
22. สำนักงานเศรษฐกิจการเกษตร กระทรวงเกษตรและสหกรณ์. มังคุด [Internet]. 2015[cited 2015 Mar 23]. Available from: http://www.oae.go.th/ fruits/ ind-ex.php/2013-01-25-03-34-09?id=155

23. Mangosteen fruit (*Garcinia mangostana* L.) [Internet]. 2015 [cited 2015 Mar 23]. Available from: http://www.pktradingthailand.com/6397/fresh-mangosteen-from-thailand.jpg
24. USDA National Nutrient Database for Standard Reference Release 27. Basic Report 09177, Mangosteen, canned, syrup pack [Internet]. [cited 2015 Mar23]. Available from: http://ndb.nal.usda.gov/ndb/ foods/ show/2319 ?format=mangosteen.
25. Ibrahim MY, Hashim NM, Mariod AA , Mohan S, Abdulla MA, Abdelwahab-SI, et al. α-Mangostin from Garcinia mangostana Linn:An updated review of its pharmacological properties. ARAB J CHEM 2014:1-13.
26. The structure of α–mangostin and γ-mangostin [Internet]. 2015 [cited 2015 Mar 23]. Available from: https://www.researchgate.net/profile/Zhari-Ismail/publication/229434291/figure/fig1/AS:214248727814144@1428092285940/Chemical-structure-of-a-mangostin-and-g-mangostin-the-mainconstituents-of-theG.png
27. Chitchumroonchokchai C, Riedl KM, Suksumrarn S, Clinton SK, Kinghorn-AD, Failla ML. Xanthones in mangosteen juice are absorbed and partially conjugated by healthy adults. JN 2012;142:675-80.
28. Taher M, Amiroudine MZAM, Zakaria TMFST, Ichwan DSJA, Kaderi MA, Ahmed QU, et al. alpha-Mangostin Improves Glucose Uptake and Inhibits Adipocytes Differentiation in 3T3-L1 Cells via PPARgamma, GLUT4, and Leptin Expressions. eCAM 2015; 2015: 740238.
29. Udani JK, Singh BB, Barrett ML, Singh VJ. Evaluation of Mangosteen juice blend on biomarkers of inflammation in obese subjects: a pilot, dose finding study. NJ. 2009;8:48.
30. Quan X, Wang Y, Ma X, Liang Y, Tian W, Ma Q, et al. alpha-Mangostin induces apoptosis and suppresses differentiation of 3T3-L1 cells via inhibiting fatty acid synthase. PloS one. 2012;7:1-10.
31. Stern JS, Peerson J, Mishra AT, Mathukumalli VS, Konda PR. Efficacy and tolerability of an herbal formulation for weight management. J Med Food. 2013;16:529-37.

32. Kudiganti V, Kodur RR, Kodur SR, Halemane M, Deep DK. Efficacy and tolerability of Meratrim for weight management: a randomized, double-blind, placebo-controlled study in healthy overweight human subjects. Lipids Health Dis 2016;15:136.
33. Saiyed ZM, Sengupta K, Krishnaraju AV, Trimurtulu G, Lau FC, Lugo JP. Safety and toxicological evaluation of Meratrim(R): an herbal formulation for weight management. Food Chem Toxicol 2015;78:122-9.
34. คณะนักวิจัยจากศูนย์วิจัยและพัฒนามังคุดไทย. การพัฒนาผลิตภัณฑ์อาหารเพื่อสุขภาพและความงามจากผลมังคุด. Available from: http://www.operationbim.com/news_th_10.html.
35. อภิชัย อารยะเจริญชัย. ส้มแขก วิกิวิทยาศาสตร์ [Internet]. 2009 [cited 2015 Mar 23]. Available from: http://www.sc.mahidol.ac.th/wiki/doku.php?id=ส้มแขก.
36. Garcinia fruit (*Garcinia cambogia* Desr.) [Internet]. 2015 [cited 2015 Mar 23]. Available from: http://www.ideadigezt.com/wp-content/uploads/2015/10/garcinia-cambogia.jpg
37. The structure of hydroxy citric acid (HCA) [Internet]. 2015 [cited 2015 Mar 23]. Available from: https://www.uspuregarciniacambogia.com-/sites/default/files/imagepicker/1/Hydroxycitric-Acid.png
38. Kovacs EM, Westerterp-Plantenga MS. Effects of (-)-hydroxycitrate on net fat synthesis as de novo lipogenesis. Physiol. Behav 2006;88:371-81.
39. Westerterp-Plantenga MS, Kovacs EM. The effect of (-)-hydroxycitrate on energy intake and satiety in overweight humans. Int J Obes 2002; 26:870-2.
40. Hayamizu K, Ishii Y, Kaneko I, Shen M, Okuhara Y, Shigematsu N, et al. Effects of garcinia cambogia (Hydroxycitric Acid) on visceral fat accumulation: a double-blind, randomized, placebo-controlled trial. Curr Ther Res Clin Exp 2003;64:551-67.
41. Roongpisuthipong C, Kantawan R, Roongpisuthipong W. Reduction of adipose tissue and body weight: effect of water soluble calcium hydroxycitrate in Garcinia atroviridis on the short term treatment of obese women in Thailand. Asia Pac J Clin Nutr 2007;16:25-9.

42. Márquez F, Babio N, Salas-Salvadó MBJ. Evaluation of the Safety and Effica- cy of Hydroxycitric Acid or Garcinia cambogia Extracts in Humans. Crit Rev Food Sci Nutr 2012;52:585–594.
43. Shuttleworth M. Repeated Measures Design [Internet]. [cited 2015 Mar 23]; Available from: https://explorable.com/printpdf/repeated-measures-design
44. จรณิต แก้วกังวาล, ประตาป สิงหศิวานนท์. ขนาดกลุ่มตัวอย่างในการวิจัยทางคลินิก [Inter-net]. 2011 [cited 2015 Mar 30]; Available from: http://www.tm.mahidol.ac.th/th/tropical-medicine-knowledge/ book-clinic/Textbook-of-Clinical-Researh/107-144.pdf.
45. Leelahagul P, Klawisait K , Kongpun P , Udomlap J, Janthranant G , Hoiyeephoo K. Segmental bioelectrical impedance analysis in northern Thai secondary school-age students (PCCCR). Ann Nutr Metab. 2013; 63(suppl 1):1426.
46. BS-400 Chemistry Analyzer [Internet]. Shenzhen: Mindray Bio-Medical Electronics Co., Ltd. Shenzhen, China [cited 2015 mar 14]; Available from: http://www.mindray.com/en/products/34.html.
47. สถาบันโภชนาการ มหาวิทยาลัยมหิดล. (2556) โปรแกรมคอมพิวเตอร์สำเร็จรูปคำนวณสารอาหาร INMUCAL-Nutrients V3 ฐานข้อมูลชุด NB1. นครปฐม.
48. WHO. BMI classification [Internet].2004[cited 2015 mar 14]; Available from: http://apps.who.int/bmi/index.jsp?introPage=intro_3.html
49. NCEP. Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). National Cholesterol Education Program.2002:27-32.
50. สมาคมความดันโลหิตสูงแห่งประเทศไทย. Thai Guidelines on The Treatment of Hypertension. 2015:14.
51. สมาคมโรคเบาหวานแห่งประเทศไทย. Clinical Practice Guideline for Diabetes.1. กรุงเทพมหานคร: หจก. อรุณการพิมพ์;2014
52. สมาคมรูมาติสซั่มแห่งประเทศไทย.แนวทางเวชปฏิบัติภาวะกรดยูริกในเลือดสูง และโรคเกาต์;. 2012
53. WHO Iron deficiency anemia assessment, prevention, and control. World Health Organization. 2001:114.

54. Liver Foundation of Thailand. Bangkok. [cited 2016 Jun 14]; Available from:http://www.thailiverfoundation.org/th/cms/detail.php?id=27
55. Hotern AO. BUN and Creatinine. Clinical Methods: The History, Physical, and Laboratory Examinations. 3rd edition. Butterworth Publishers. Oxford;1990
56. Levesque R. SPSS Programming and Data Management: A Guide for SPSS and SAS Users.Fourth Edition. Chicago: SPSS Inc; 2007.
57. Choi B, all PLS, Yang H, Dobson M, Landsbergis P, Israel L, et al. Sedentary Work, Low Physical Job Demand, and Obesity in US Workers. Am J-Ind Med. 2010; 53:1088–1101.
58. Hu FB, Li TY, Coldiz GA, Manson JF. Television Watching and Other Sedentary Behaviors in Relation to Risk of Obesity and Type 2 Diabetes Mellitus in Women. JAMA. 2003;289(14):1785-1791.
59. St-Onge MP. Are Normal-Weight Americans Over-Fat?. Obesity (Silver-Spring). 2010 November ; 18(11).
60. Ho-Pham LT, Lai TQ, Nguyen MT, Nguyen TV. Relationship between Body Mass Index and Percent Body Fat in Vietnamese: Implications for the Diagnosis of Obesity. PLoS One. 2015;10(5):e0127198.
61. Grave RD, Calugi S, Ghoch ME, Marchesini G. Cognitive-Behavioral Strategi- es to Increase the Adherence to Exercise in the Management of Obesity. J Obes.2011.
62. Ma Y, Bertone ER, Stanek EJ, Reed GW, Hebert JR, Cohen NL, et al. Association between Eating Patterns and Obesity in a Free-living US Adult Population. Am J Epidemiol. 2003;158:85–92.
63. Duerksen SC, Elder JP, Arredondo EM, Ayala GX, Slymen DJ, Campbell NR, et al. Family restaurant choices are associated with child and adult overweight status in Mexican-American families. J Am Diet Assoc. 2007;107(5):849-53.
64. Rodrigues AG, Proença RPC, Aclvo MCM, Fiat GMR. Overweight / obesity is associated with food choices related to rice and beans, colors of salads, and portion size among consumers at a restaurant serving buffet-by-weight in Brazil. Appetite 59 (2012) 305–311.

65. ปริมาณน้ำตาลในเครื่องดื่ม. [Internet]. กระทรวงสาธารณสุข. [cited 2016 Aug 10]; Available from:food.fda.moph.go.th/data/document/2558/CS_sugar.pdf
66. WHO [Internet]. Reducing consumption of sugar-sweetened beverages to reduce the risk of unhealthy weight gain in adults [cited 2016 Oct 10]; Available from: https://www.hfocus.org/content/2014/01/6153
67. Schulze MB, Manson JE, Ludwig DS, Colditz GA, Stampfer MJ, Willett WC, et al. Sugar-Sweetened Beverages, Weight Gain, and Incidence of Type 2 Diabetes in Young and Middle-Aged Women. JAMA. 2004; 292(8):927-34.
68. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. Am J Clin Nutr 2006; 84: 274–88.
69. Godey A, Bellido4 D, Sajoux I, Crujeiras AB, Burguera B, García-Luna PP, Oleaga A, Moreno B, Casanueva FF. Short-term safety, tolerability and efficacy of a very lowcalorie-ketogenic diet interventional weight loss program versus hypocaloric diet in patients with type 2 diabetes mellitus. Nutrition & Diabetes.2016;(6):1 – 7.
70. Hall KD, Bemis T, Robert, Brychta, Mary Walter PJW, Yannai L. Calorie for Calorie, Dietary Fat Restriction Results in More Body Fat Loss than Carbohydrate Restriction in People with Obesity. Cell Metabolism.2015;(22), 427–436.
71. กระทรวงสาธารณสุข. [Internet]. สารอาหารที่แนะนำให้บริโภคประจำวันสำหรับคนไทยอายุตั้งแต่ 6 ปีขึ้นไป [cited 2016 Feb 10]; Available from: http://food.fda.moph.go.th/Rules/dataRules/4-4-2ThaiRDI.pdf
72. WHO [Internet] WHO calls on countries to reduce sugars intake among adults and children [cited 2016 AUG 10]; Available from: http://www.who.int/mediacentre/news/releases/2015/sugar-guideline/en/
73. สำนักงานกองทุนสนับสนุนการสร้างเสริมสุขภาพ (สสส.). [Internet] ดันมาตรการเก็บ' ภาษีกินหวาน'พบคนไทยบริโภคน้ำตาล 25 ช้อนชา / วัน [cited 2016 AUG 10] ; Available from: http://www.thaihealth.or.th/.html
74. WHO. Rolling Revision of the WHO Guidelines for Drinking-Water. World Health Organization. 2004:9.

75. Dennis EA, Dengo AL, Comber DL, Flack KD, Savla J, Davy KP, et al. Water Consumption Increases Weight Loss During a Hypocaloric Diet Intervention in Middle-aged and Older adults. Obesity (Silver Spring). 2010 February ; 18(2): 300–307.

76. Muckelbauer R, Sarganas G, Gru¨neis A, Mu¨ller-Nordhorn J. Association between water consumption and body weight outcomes: a systematic review[1–3]. Am J Clin Nutr.2013; 1-18.

77. Heymsfield SB, Gonzalez C, Shen W, Redmen L, Thomas D. Weight Loss Composition is One-Fourth Fat-Free Mass: A Critical Review and Critique of This Widely Cited Rule. Obes Rev. 2014 April ; 15(4): 310–321.

78. Mark BL, Rippe JM. The Importance of Fat Free Mass Maintenance in Weight Loss Programmes. Sports Me d. 1996 Nov; 22 (5): 273-28 1.

79. Dixon J. B., Lambert E. A., Grima M., Rice T., Lambert G.W., Straznicky N. E. Fat-free mass loss generated with weight loss in overweight and obese adults: what may we expect?. Diabetes, Obesity and Metabolism.2015, 17: 91-93.

80. Thomas P. J. Solomon, Christine M. Marchetti, Raj K. Krishnan, Frank Gonzalez, John P. Kirwan. Effects of Aging on Basal Fat Oxidation in Obese Humans. Metabolism. 2008 August ; 57(8): 1141–1147.

81. Bart L. Clarke, Sundeep Khosla. Physiology of Bone Loss. Radiol Clin North Am. 2010 May ; 48(3): 483–495.

82. M R Law, C D trost, NJ ald. Analysis of data from trials of salt reduction. BMJ7.1991;302:819-24

83. Judith E. Neter, Bianca E. Stam, Frans J. Kok, Diederick E. Grobbee, Johanna M. Geleijnse. Influence of Weight Reduction on Blood Pressure A Meta-Analysis of Randomized Controlled Trials. Hypertension.2003; 42:878-884.

84. Wang LW, Kang JJ, Chen IJ, Teng CM, Lin CN. Antihypertensive and vasorelaxing activities of synthetic xanthone derivatives. Bioorg Med Chem. 2002 Mar; 10 (3):567-72.

85. Uusitupa M, Schwab U, Ma¨kimattila, Karhapa¨a¨ P, Sarkkinen E, Maliranta H, Agren J, Penttila¨ I. Effects of two high-fat diets with different fatty acid

compositions on glucose and lipid metabolism in healthy young women. Am J Clin Nutr 1994;59:1310–1316.

86. Lichtenstein AH, Schwab US. Relationship of dietary fat to glucose metabolism. Atherosclerosis. 150 (2000) 227–243

87. Adiputro DL, Widodo MA, Romdoni R, Sargowo D. Extract of mangosteen increases high density lipoprotein levels in rats fed high lipid. Univ Med. 2013;32(1):38-43.

88. Wing RR, Lang W, Wadden TA, Saffrod M, Knower WC, BertoniI AG, et al. Benefits of Modest Weight Loss in Improving Cardiovascular Risk Factors in Overweight and Obese Individuals With Type 2 Diabetes. Diabetes Care. 2011(34):1481-6.

APPENDICES

APPENDIX A
MANGOSTEEN JUICE CONCENTRATE MIXED WITH GARCINIA
GARCINIA BISCUIT BARBECUE FLAVOR

APPENDIX B

ขั้นตอนการรับประทานน้ำมังคุด และ บิสกิต
ตั้งแต่วันที่ 23 ก.ค. –19 ส.ค. 2558

โดย รศ.ดร. ปรียา ลีพหกุล โทร 081-8699839 และคุณ จุฑาวรรณ นวลจันทร์คง

1. **ตลอดตั้งแต่วันที่ 23 ก.ค –19 ส.ค. 2558 ควบคุมอาหารเพื่อการลด น้ำหนักเหมือนเดิมทุกประการ**
2. **ผู้ใดเคยมีกิจกรรมอย่างไรขอให้คงเดิมตลอดไป**
3. **อาหารเช้าทุกมื้อ ทานตามปกติที่เคยรับประทาน**
4. **อาหารกลางวัน เป็น น้ำมังคุดสกัดเข้มข้น 1 กระป๋อง ดื่มสลับไปกับการทานบิสกิต ทีละแผ่นจนครบ 10 แผ่น/มื้อ ให้ค่อยๆกินไปเรื่อยๆ ช้าๆ แล้วจะค่อยๆรู้สึกอิ่มได้ดีขึ้น**
5. **หลังจากนั้นควรดื่มเฉพาะน้ำเปล่าตลอด**
6. **อาหารมื้อเย็น ค่อยๆจิบน้ำมังคุดสกัดเข้มข้น 1 กระป๋อง จนหมด ไม่ต้องกินบิสกิตนะคะ ทิ้งช่วงไปประมาณ 1 ชม. ถ้าไม่รู้สึกหิวจะไม่ทานอาหารอื่นเลยก็ได้ ถ้ารู้สึกหิวทานอะไรเล็กน้อยได้ เช่น เกาเหลาลูกชิ้น 1 ถ้วยเล็ก หรือ ลูกชิ้นปิ้ง 2 ไม้ หรือ โจ๊ก 1 ถ้วยเล็ก หรือ แอปเปิ้ล 1 ผลเล็ก**
7. **วันพฤหัสบดี ที่ 23ก.ค. , 30ก.ค. ,6ส.ค. ,13ส.ค. แต่ละครั้งจะได้รับน้ำมังคุด 14 กระป๋อง สำหรับ 7 วัน**
   ดื่มกลางวัน 1 กระป๋อง และ เย็น 1 กระป๋อง (น้ำมังคุดจะรสชาติดีขึ้นถ้าแช่เย็นก่อนดื่ม)
   และได้รับบิสกิต 2 ห่อใหญ่ 1 ห่อมี 60 แผ่น
   รับประทานเฉพาะมื้อกลางวัน มื้อละไม่เกิน 10 แผ่น ที่เหลือปิดให้สนิท ไว้กินวันถัดไป

****ดื่มน้ำเปล่าได้ตลอดทั้งวัน**

****บันทึกอาหารทุกอย่างที่รับประทานทุกวัน เหมือนเดิม**

ขอบคุณมากนะคะ

รศ.ดร. ปรียา ลีพหกุล

APPENDIX C
GENERAL INFORMATION QUESTIONNAIRE FORM

แบบสอบถามพฤติกรรมการบริโภคอาหารในช่วงระยะเวลา 3 เดือน ที่ผ่านมา

สำหรับผู้เข้าร่วมโครงการวิจัย เรื่อง ประสิทธิผลของน้ำมังคุดสกัดเข้มข้นผสมส้มแขกต่อการลดน้ำหนักในหญิงอ้วน

โดย รศ.ดร. ปรียา ลีพหกุล และคุณจุฑาวรรณ นวลจันทร์คง

อาคารวิจัยชั้น 2 คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี โทร. 02-201-2625

ชื่อ.....นามสกุล.....เบอร์โทรศัพท์.....

โรคประจำตัว..... ยาที่รับประทาน.....

คำชี้แจง โปรดเขียนเครื่องหมาย✓ ลงใน❑ หน้าข้อความและเติมคำในช่องว่างที่ตรงกับความเป็นจริงของท่านมากที่สุด

<u>ตอนที่ 1 แบบสอบถามเกี่ยวกับการบริโภคอาหารมื้อหลัก</u>

1.1 ท่านรับประทานอาหารในแต่ละวันครบทุกมื้อหรือไม่

❑ 1. รับประทานครบทุกมื้อ

❑ 2. รับประทานไม่ครบและ มักไม่ได้รับประทานมื้อ ❑ มื้อเช้า ❑ มื้อกลางวัน ❑ มื้อเย็น

1.2 การรับประทานอาหารในแต่ละมื้อท่านบริโภคมื้อใดปริมาณมากที่สุด

❑ มื้อเช้า ❑ มื้อกลางวัน ❑ มื้อเย็น

1.3 อาหารที่ท่านรับประทานประจำทุกวันส่วนใหญ่ได้มาจาก

มื้อเช้า	❑ 1.ปรุงเอง	❑ 2.ซื้อจากร้านอาหาร
มื้อกลางวัน	❑ 1.ปรุงเอง	❑ 2.ซื้อจากร้านอาหาร
มื้อเย็น	❑ 1.ปรุงเอง	❑ 2.ซื้อจากร้านอาหาร

1.4 ประเภทอาหารที่ท่านรับประทานบ่อยครั้ง

❑ อาหารปรุงสุกทั่วไป เช่น ข้าวราดแกง ก๋วยเตี๋ยว อาหารตามสั่ง

❑ อาหารสำเร็จรูป เช่น อาหารแช่แข็ง ปลากระป๋อง บะหมี่กึ่งสำเร็จรูป โจ๊กกึ่งสำเร็จรูป

1.5 ท่านรับประทานอาหารประเภทจานด่วน (Fast food) เช่น พิซซ่า แฮมเบอร์เกอร์ ฮอทดอกเป็นประจำหรือไม่

❑ 1.ไม่รับประทาน ❑ 2.รับประทานทุกวัน ❑ 3.รับประทาน 3 ครั้งต่อสัปดาห์

❑ 4. 1 ครั้งต่อเดือน ❑อื่นๆ.....

1.6 ท่านไปรับประทานอาหารแบบบุฟเฟต์โดยเฉลี่ย.....ครั้ง/เดือน

1.7 ประเภทของบุฟเฟต์ที่ท่านรับประทาน

❑ ปิ้ง/ย่าง/หมูกระทะ❑ ชาบู-สุกี้ ❑ บุฟเฟต์อาหารทั่วไป❑ บุฟเฟต์ของหวาน

1.8 อาหารที่ท่านรับประทานส่วนใหญ่ใช้วิธีการปรุงแบบใด

❑ ทอด ❑ ผัด ❑ นึ่ง/ตุ๋น/ต้ม ❑ ปิ้ง/ย่าง/อบ

1.9 น้ำมันที่ใช้ในการประกอบอาหารของท่านเป็นประจำที่บ้าน.....

1.10 เนื้อสัตว์ที่ท่านรับประทานบ่อยมากที่สุดเรียงตามลำดับ (มากที่สุด = 1 รองลงมา = 2……..)

…… หมู …… วัว …… ไก่ เป็ด …… ปลา …… อาหารทะเล เช่น กุ้ง ปู …… ไม่ทานเนื้อสัตว์

1.11 ท่านรับประทานเนื้อสัตว์ติดมัน

❑ 1.รับประทานหมด ❑ 2.รับประทานบางส่วน ❑ 3.ไม่รับประทานเลย

1.12 ท่านรับประทานหนังสัตว์

❑ 1.รับประทานหมด ❑ 2.รับประทานบางส่วน ❑ 3.ไม่รับประทานเลย

1.13 ท่านรับประทานเครื่องในสัตว์

❑ 1.รับประทานหมด ❑ 2.รับประทานบางส่วน ❑ 3.ไม่รับประทานเลย

1.14 ท่านรับประทานอาหารทะเล กุ้ง ปลาหมึก ปู.....ครั้ง/สัปดาห์

1.15 ท่านรับประทานอาหารเนื้อสัตว์แปรรูป หรือ อาหารแห้ง ได้แก่ ไส้กรอก ลูกชิ้น ปลาเค็ม เป็นประจำหรือไม่

❑ 1. ไม่รับประทาน ❑ 2. รับประทานทุกวัน ❑ 3. รับประทาน 3 ครั้งต่อสัปดาห์

1.16 ท่านรับประทานไข่อย่างไร (ตอบทุกข้อ)

1.ประเภทไข่ที่ท่านชอบรับประทานมากที่สุด ❑ ไข่ไก่ ❑ ไข่เป็ด ❑ ไข่นกกระทา

2.รับประทานไข่โดยเฉลี่ย.....ฟอง/วัน หรือ.....ฟอง/สัปดาห์

3.ท่านรับประทานเฉพาะ ❑ ไข่ขาว ❑ ไข่แดง ❑ ทั้งไข่ขาวและไข่แดง

1.17 ท่านรับประทานอาหารประเภทผัก ผลไม้ อย่างไรบ้าง

❑ 1.ผักสลัด.....ครั้ง/สัปดาห์ ปริมาณต่อครั้ง.....น้ำสลัดที่ท่านนิยมมากที่สุด.....

❑ 2.ผัดผัก.....ครั้ง/สัปดาห์ ปริมาณต่อครั้ง.....

❑ 3.ผักลวก/ผักต้ม.....ครั้ง/สัปดาห์ ปริมาณต่อครั้ง.....

❑ 4.ผลไม้สด.....ครั้งต่อสัปดาห์ ปริมาณต่อครั้ง.....

ผลไม้ที่ท่านชอบมากที่สุด 3 อันดับแรก.....

1.18 ท่านรับประทานผลไม้พร้อมกับการจิ้ม พริกเกลือ น้ำปลาหวาน กะปิหวาน ด้วยหรือไม่

❑ 1.ไม่จิ้มเลย ❑ 2. จิ้มบางครั้ง ❑ จิ้มทุกครั้ง

1.19 ท่านรับประทานผลไม้แปรรูปเป็นประจำหรือไม่ เช่น มะม่วงดอง ทุเรียนกวน ฝรั่งแช่บ๊วย บ๊วยเค็ม

❑ 1.ไม่รับประทาน ❑ 2.รับประทานทุกวัน ❑ 3.รับประทาน 3 ครั้งต่อสัปดาห์ ❑ 4. 1 ครั้งต่อเดือน

1.20 รสชาติอาหารที่ท่านชอบรับประทาน

❑ เปรี้ยว ❑ หวาน ❑ เผ็ด ❑ เค็ม

1.21 ท่านเติมเครื่องปรุงต่อไปนี้ในอาหารที่กำลังจะรับประทานอย่างไร

น้ำตาลทราย

❑ 1.ไม่เติม ❑ 2.เติม.....ช้อนชา/ก๋วยเตี๋ยว 1 ชาม

น้ำส้มสายชู

❑ 1.ไม่เติม ❑ 2.เติม.....ช้อนชา/ก๋วยเตี๋ยว 1 ชาม

พริกป่น

❑ 1.ไม่เติม ❑ 2.เติม.....ช้อนชา/ก๋วยเตี๋ยว 1 ชาม

น้ำปลา

❑ 1.ไม่เติม ❑ 2.เติม.....ช้อนชา/ก๋วยเตี๋ยว 1 ชาม

น้ำปลาพริก

❑ 1.ไม่เติม ❑ 2.เติม.....ช้อนชา/ข้าวราดแกง 1 จาน

ตอนที่ 2 แบบสอบถามเกี่ยวกับการบริโภคอาหารระหว่างมื้อและมื้อก่อนนอน

2.1 ท่านรับประทานอาหารระหว่างมื้อเป็นประจำหรือไม่

❑ 1.ไม่รับประทาน ❑ 2.รับประทานทุกวัน ❑ 3.รับประทานเป็นบางวัน

2.2 ส่วนใหญ่ของอาหารระหว่างมื้อของท่านเป็นประเภท

❑ 1.ขนมกรุบกรอบ เช่น มันฝรั่งทอด ข้าวเกรียบ ขนมปังกรอบต่างๆ

❑ 2.ขนมหวาน เช่น บัวลอย ลอดช่อง กล้วยบวชชี ไอศกรีม หวานเย็น

❑ 3.ขนมปังต่างๆ เช่น เค้ก ขนมปังไส้ต่างๆ คุ๊กกี้

❑ 4.เครื่องดื่มต่างๆ เช่น ชา กาแฟ ไมโล โอวัลติน น้ำผลไม้

❑ 5.ผลไม้สด

❑ 6.อื่นๆ ระบุ.....

2.3 ท่านรับประทานอาหารก่อนนอนเป็นประจำหรือไม่

❑ 1.ไม่รับประทาน ❑ 2.รับประทานทุกวัน ❑ 3.รับประทาน 3 ครั้งต่อสัปดาห์ ❑ 4. 1 ครั้งต่อเดือน

2.4 ประเภทอาหารที่ท่านรับประทานก่อนนอน.....

ตอนที่ 3 แบบสอบถามเกี่ยวกับการบริโภคอาหารประเภทเครื่องดื่ม

3.1 ท่านบริโภคน้ำเปล่า.....แก้ว/วัน

3.2 ท่านดื่มนมเป็นประจำหรือไม่

❑ 1.ไม่ดื่ม ❑ 2.ดื่ม ชนิด.....ปริมาณ.....ต่อวัน

3.3 ท่านดื่มเครื่องดื่มอื่นๆนอกเหนือจากน้ำเปล่าหรือไม่ (สามารถตอบได้มากกว่า 1 ข้อ)

❑ชา ❑ กาแฟ ❑ น้ำเต้าหู้ ❑น้ำหวาน น้ำอัดลม

❑น้ำผลไม้หรือน้ำปั่น ❑แอลกอฮอล์ ❑ อื่นๆ.....

3.4 จากข้อ 3.3 (1) ดื่มระบุชนิด.....ปริมาณ…….. ต่อสัปดาห์

(2) ดื่มระบุชนิด.....ปริมาณ…….. ต่อสัปดาห์

(3) ดื่มระบุชนิด.....ปริมาณ…….. ต่อสัปดาห์

(4) ดื่มระบุชนิด.....ปริมาณ…….. ต่อสัปดาห์

3.5 ท่านเติมครีมเทียมลงในเครื่องดื่มประเภท ชา กาแฟ ทุกครั้งหรือไม่

❑ 1.ไม่เติม ❑ 2.เติม.....ช้อนชา

3.6 ท่านเติมน้ำตาลลงในเครื่องดื่มประเภท ชา กาแฟ ทุกครั้งหรือไม่

❑ 1.ไม่เติม ❑ 2.เติม.....ช้อนชา

3.7 ท่านเติมนมข้นหวานลงในเครื่องดื่มประเภท ชา กาแฟ ทุกครั้งหรือไม่

❑ 1.ไม่เติม ❑ 2.เติม.....ช้อนชา

APPENDIX D
24 hr-DIETARY RECORD FORM

ใบบันทึกอาหารทุกวัน และนำมาส่งในวันที่มาประเมินสัดส่วนร่างกายทุกครั้ง

โดย รศ.ดร. ปรียา ลีพหกุล และคุณ จุฑาวรรณ นวลจันทร์คง

กลุ่มสาขาวิชาโภชนศาสตร์

ชื่อ.....นามสกุล.....โทร.....

วันที่	รายการอาหาร	ส่วนประกอบและปริมาณ

APPENDIX E
EVALUATING THE ACCEPTABILITY, SAFETY AND ADVERSE EFFECT

แบบประเมินการรับประทานน้ำมังคุดสกัดเข้มข้นและขนมอบกรอบรสบาร์บีคิว

โดย รศ.ดร. ปรียา ลีพหกุล และ คุณ จุฑาวรรณ นวลจันทร์คง

อาคารวิจัยชั้น 2 คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี โทร. 02-201-2625

ชื่อ.....นามสกุล.....สัปดาห์ที่……..

กรุณาให้คะแนนการรับประทานน้ำมังคุดและขนมอบกรอบรสบาร์บีคิว โดยใส่เครื่องหมาย ✔ ช่องคะแนนความคิดเห็นของท่าน

<u>ตอนที่ 1 รสชาติและลักษณะของน้ำมังคุดสกัดเข้มข้นและขนมอบกรอบรสบาร์บีคิว</u>

(ระดับคะแนน 5= ดีที่สุด 4=ดี 3=ปานกลาง 2=น้อย 1=น้อยที่สุด 0=ไม่มี)

รายการ	คะแนนความคิดเห็น					
	5	4	3	2	1	0
1.รสของน้ำมังคุดสกัดเข้มข้น						
2.ลักษณะของน้ำมังคุดสกัดเข้มข้น						
3.กลิ่นของน้ำมังคุดสกัดเข้มข้น						
4.รสของขนมอบกรอบรสบาร์บีคิว						
5.เนื้อของขนมอบกรอบรสบาร์บีคิว						
6.กลิ่นของขนมอบกรอบรสบาร์บีคิว						

<u>ตอนที่ 2 หลังจากรับประทานน้ำมังคุดสกัดเข้มข้นและขนมอบกรอบรสบาร์บีคิว(มื้อกลางวัน)</u>

(ระดับคะแนน 4=อิ่มนานจนถึงก่อนมื้อเย็น 3=อิ่มนาน1-2 ชม 2=อิ่มนาน 30-60 นาที 1=ไม่อิ่ม)

รายการ	**คะแนนความคิดเห็น**			
	4	**3**	**2**	**1**
7.หลังจากรับประทานน้ำมังคุด+ขนมอบกรอบ 10 แผ่น (มื้อกลางวัน) ระดับความอิ่ม				
	อื่นๆ **.....**			
8.หลังจากรับประทานน้ำมังคุด+ขนมอบกรอบ 10 แผ่น (มื้อกลางวัน) รู้สึกอย่างไรบ้าง	**ปกติเหมือนรับประทานอาหารทั่วไป [ ]** **มีอาการ** **.....**			
9.หลังจากรับประทานน้ำมังคุด+ขนมอบกรอบ 10 แผ่น (มื้อกลางวัน) มีอาการผิดปกติอย่างไรบ้าง	**ไม่มี [ ]** **มีอาการ** **.....**			

<u>ตอนที่ 3 หลังจากรับประทานน้ำมังคุดสกัดเข้มข้น 1 กระป๋องอย่างเดียว (มื้อเย็น)</u>

(ระดับคะแนน 4=อิ่มนานไม่ต้องรับประทานมื้อเย็น 3=อิ่มนาน 1-2 ชม 2=อิ่มนาน 30-60 นาที 1=ไม่อิ่ม)

รายการ	**คะแนนความคิดเห็น**			
	4	**3**	**2**	**1**
10.หลังจากรับประทานน้ำมังคุด1 กระป๋องอย่างเดียว(มื้อเย็น) ระดับความอิ่ม				
	อื่นๆ **.....**			
11.หลังจากรับประทานน้ำมังคุด 1 กระป๋องอย่างเดียว(มื้อเย็น) มีอาการผิดปกติอย่างไรบ้าง	**ไม่มี [ ]** **มีอาการ** **.....**			

ข้อคิดเห็นเพิ่มเติม

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APPENDIX F
PHYSICAL ACTIVITY AND EXERCISE FORM

บันทึกการออกกำลังกายหรือกิจกรรมทางกาย

โดย รศ.ดร. ปรียา ลีพหกุล และคุณ จุฑาวรรณ นวลจันทร์คง

อาคารวิจัยชั้น 2 คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี โทร. 02-201-2652

ชื่อ……หน่วยงาน……เบอร์โทรศัพท์……

ครั้งที่นัดพบ	ประเภทของการออกกำลังกายหรือกิจกรรมทางกาย	ระยะเวลา (นาที)	ความถี่(ครั้ง/สัปดาห์)

APPENDIX G

CRITERIA FOR NUTRITIONAL STATUS ASSESSMENT

Nutritional Parameter	Criteria
Weight status	
Normal weight	BMI < 24.9 kg/m^2
Overweight	BMI > 24.9 kg/m^2
Over body fat status	
Over body fat I	body fat 30.1 - 40.0,%bw
Over body fat II	body fat 40.1 - 50.0,%bw
Over body fat III	body fat 50.1 - 60.0,%bw
SBP status	
Normal BP	SBP < 120 mmHg
Pre-hypertension	SBP 121-139 mmHg
Hypertension	SBP > 140 mmHg
DBP status	
Normal	DBP < 80 mmHg
Pre-hypertension	DBP 81 - 90 mmHg
Hypertension	DBP > 90 mmHg
Hemoglobin, g/dL	
Normal	Hemoglobin > 12 g/dL
Anemia	Hemoglobin < 12 g/dL
FBG, mg/dL	
Normal	FBG < 100 mg/dL
IFG	FBG 101-125 mg/dL
DM	FBG > 126 mg/dL
LDL-C, mg/dL	
Normal	LDL-C < 130 mg/dL
Borderline high LDL-C	LDL-C 130 - 159 mg/dL
High LDL-C	LDL-C > 160 mg/dL
Triglyceride, mg/dL	
Normal	Triglyceride < 150 mg/dL
Borderline high triglyceride	Triglyceride 150 - 199 mg/dL
High triglyceride	Triglyceride 200 - 499 mg/dL
Serum uric acid, mg/dL	
Normal	Serum uric acid <7 mg/dL
Hyperuricemia	Serum uric acid >7 mg/dL

CRITERIA FOR NUTRITIONAL STATUS ASSESSMENT

Nutritional Parameter	Criteria
Liver function	
Normal	SGOT 10 – 35 U/L SGPT 9 – 40 U/L Alkaline phosphatase 30 –120U/L
Kidney function	
Normal	BUN 5 – 20 mg/dL Creatinine 0.6 – 1.2 mg/dL

APPENDIX H
INFORMED CONSENT FORM

หนังสือยินยอมโดยได้รับการบอกกล่าวและเต็มใจ

(Informed Consent Form)

ชื่อโครงการ ประสิทธิผลของน้ำมังคุดสกัดเข้มข้นผสมส้มแขกต่อการลดน้ำหนักในหญิงอ้วน

ผู้ทำการวิจัย รศ.ดร. ปรียา ลีฬหกุล

หลักสูตรโภชนศาสตร์ คณะแพทยศาสตร์ โรงพยาบาลรามาธิบดี มหาวิทยาลัยมหิดล

***ชื่อผู้เข้าร่วมการวิจัย** ---------- **อายุ** -----

คำยินยอมของผู้เข้าร่วมการวิจัย

ข้าพเจ้า นาย/นาง/นางสาว ---------- ได้ทราบรายละเอียดของโครงการวิจัยตลอดจนประโยชน์ และข้อเสี่ยงที่จะเกิดขึ้นต่อข้าพเจ้าจากผู้วิจัยแล้วอย่างชัดเจน ไม่มีสิ่งใดปิดบังซ่อนเร้นและยินยอมให้ทำการวิจัยในโครงการที่มีชื่อข้างต้น และข้าพเจ้ารู้ว่าถ้ามีปัญหาหรือข้อสงสัยเกิดขึ้น ข้าพเจ้าสามารถสอบถามผู้วิจัยได้ และข้าพเจ้าสามารถไม่เข้าร่วมโครงการวิจัยนี้เมื่อใดก็ได้ โดยไม่มีผลกระทบต่อการรักษาที่ข้าพเจ้าพึงได้รับ นอกจากนี้ผู้วิจัยจะเก็บข้อมูลเฉพาะเกี่ยวกับตัวข้าพเจ้าเป็นความลับและจะเปิดเผยได้เฉพาะในรูปที่เป็นสรุปผลการวิจัย การเปิดเผยข้อมูลเกี่ยวกับตัวข้าพเจ้าต่อหน่วยงานต่างๆที่เกี่ยวข้อง กระทำได้เฉพาะกรณีจำเป็นด้วยเหตุผลทางวิชาการเท่านั้น

ลงชื่อ.....(ผู้เข้าร่วมการวิจัย)

.....(พยาน)

.....(พยาน)

วันที่ .....

คำอธิบายของผู้วิจัย

ข้าพเจ้าได้อธิบายรายละเอียดของโครงการ ตลอดจนประโยชน์ของการวิจัย รวมทั้งข้อเสี่ยงที่อาจจะเกิดขึ้นแก่ผู้เข้าร่วมการวิจัยทราบแล้วอย่างชัดเจนโดยไม่มีสิ่งใดปิดบังซ่อนเร้น

ลงชื่อ.....(ผู้วิจัย)

วันที่.....

หมายเหตุ : กรณีผู้เข้าร่วมการวิจัยไม่สามารถอ่านหนังสือได้ ให้ผู้วิจัยอ่านข้อความในหนังสือยินยอมฯ นี้ให้แก่ผู้เข้าร่วมการวิจัยฟังจนเข้าใจดีแล้ว และให้ผู้เข้าร่วมการวิจัยลงนามหรือพิมพ์ลายนิ้วหัวแม่มือรับทราบในการให้ความยินยอมดังกล่าวข้างต้นไว้ด้วย

*ผู้เข้าร่วมการวิจัย หมายถึง ผู้ยินยอมตนให้ทำวิจัย

BIOGRAPHY

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