DETERMINATION OF PROXIMATE AND MINERAL CONTENTS OF CHOCOLATE CUPCAKES PREPARED WITH *PERSEA AMERICANA* FRUIT AS FAT REPLACER

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In the name of Allah, the most Merciful and Compassionate

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ABSTRAK

Gantian lemak dalam produk bakeri dengan bahan-bahan berasaskan buah-buahan membantu dalam pengurangan keseluruhan pengambilan lemak dan meningkatkan pengambilan buah-buahan. Alpukat (*Persea americana*) mengandungi lemak tidak tepu tunggal yang tinggi dan mempunyai pelbagai bahan aktif seperti karotenoid dan fenolik. Penggunaan kek cawan telah semakin meningkat dan menjadi trend sejak beberapa tahun kebelakangan ini. Oleh itu, terdapat peluang yang lebih baik untuk meningkatkan kualiti pemakanan kek cawan untuk meningkatkan status pemakanan masyarakat yang lebih baik. Oleh itu, satu kajian telah dijalankan untuk menentukan makronutrien dan kandungan mineral kek cawan coklat disediakan dengan menggantikan mentega dengan puri alpukat. Kek cawan coklat telah disediakan dengan menggunakan puri alpukat (0%, 25%, 50%, dan 75%) sebagai ganti mentega. Analisis proksimat telah ditentukan dengan menggunakan kaedah AOAC standard.Kandungan mineral telah ditentukan dengan menggunakan penyerapan spektrofotometri atom. Keputusan yang diperolehi dianalisis dengan menggunakan (versi 21.0) perisian SPSS. Hasil kajian menunjukkan bahawa nilai minimun kelembapan, protein dan lemak kandungan berbeza secara ketara ($P < 0.05$) antara empat sampel. Kelembapan meningkat dengan ketara ($P < 0.05$) dengan peningkatan dalam peratusan puri alpukat. Kandungan protein paling tinggi didapati dalam 75% sampel lemak diganti (10.87g /100g) manakala sampel kawalan (9.19g /100g) mengandungi protein yang paling rendah. Sebagai peratusan alpukat meningkat, kandungan lemak telah menurun dengan ketara ($P < 0.05$) dalam semua sampel lemak diganti. 75% sampel lemak diganti (8.33g /100g) yang terkandung 63% kurang lemak daripada sampel kawalan (22.74g /100g).Tidak ada perbezaan yang signifikan dalam nilai abu dan karbohidrat. Kandungan mineral menunjukkan bahawa natrium, kalium, magnesium dan zink adalah paling tinggi dalam 25% sampel lemak menggantikan. Kesimpulannya, pengeluaran kek cawan coklat disediakan dengan puri

alpukat sebagai peganti lemak meningkat komposisi nutrisi dengan peningkatan kandungan protein dan mineral dan pengurangan kandungan lemak.

ABSTRACT

Replacing fat in baked products with fruit based ingredients can aid in the overall reduction of fat intake and increase the consumption of fruits. Avocado (*Persea americana*) fruits contain high monounsaturated fat and various phytochemicals such as carotenoids and phenolics. Consumption of cupcakes has been has been increasing and becoming a trend since the past few years. Thus, there is an opportunity to better increase the nutritional quality of cupcake to better improve the nutritional status of community. Thus, a study was conducted to determine the macronutrients and mineral contents of chocolate cupcake prepared by with avocado puree as butter replacer. Chocolate cupcakes were prepared by using pureed avocado (0%, 25 %, 50%, and 75%) in place of butter. Proximate analysis was determined by using standard AOAC method. Mineral content was determined by using atomic absorption spectrophotometry. The results were analyzed by using SPSS (version 21.0) software. The results show that the mean values of moisture, protein and fat contents were significantly different ($P < 0.05$) among the four samples. The moisture increased significantly ($P < 0.05$) with the increase in percentage of avocado puree. The highest protein content was found in 75% fat-replaced sample (10.87 g/100g) while the control sample (9.19 g/100g) contained the lowest protein. As the percentage of avocado increased, the fat content was significantly decreased ($P < 0.05$) in all fat-replaced samples. The 75% fat-replaced sample (8.33 g/100g) contained 63% less fat than the control sample (22.74 g/100g). There was no significance different in the ash and carbohydrate values. The mineral contents show that sodium, potassium, magnesium and zinc were highest in the 25% fat-replaced sample. As a conclusion, the production of chocolate cupcakes prepared with avocado puree as fat replacer enhanced its nutritional composition with the increase in protein and minerals and decrease in fat content.

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BC	Before Christ
CHD	Coronary Heart Diseasa
CVD	Cardiovascular Disease
E	Energy
DRV	Daily Reference Value
HDL	High Density Lipoprotein
HDL-C	High Density Lipoprotein Cholesterol
LDL	Low Density Lipoprotein
LDLC	Low Density Lipoprotein Cholesterol
MUFA	Monounsaturated Fatty Acid
mg	milligram
NHANES	National Health and Nutrition Examination Survey
PUFA	Polyunsaturated Fatty Acid
SFA	Saturated Fatty Acid
UK	United Kingdom
kg	kilogram
g	gram
µg	microgram
ml	milliter
%	percentage
° C	Celsius

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

The avocado is valuable in human nutrition as a source of various nutrients, especially as source of energy and monounsaturated fatty acids. The avocado tree is a fruit plant originated in the Americas, mainly found in the Mexico and Central America, belongs to the *Lauraceae family* and *Perseal genus* .Avocados contains approximately 70% of total fruit weight represent to the their pulp with an average of 6.94 g of carbohydrates, 17.34 g of fat, 2.08 g of proteins, 2.72 g of fibers, in 100 g of fresh pulp (Mooz et al., 2012) . There are also varieties of vitamins, minerals and phytochemicals such as lutein, phenolic antioxidants, and phytosterols contain in avocados that associated with numerous potential health benefits (McCormack et al., 2010; U.S. Department of Agriculture (USDA), 2011; Wu et al, 2004).

The commercially known avocado is Hass avocado (*Persea americana*), a medium-size fruit with a pleasant, creamy, smooth texture .Approximately 90% of the avocados consumed in the US and a majority of avocados worldwide are Hass avocados (McCormack et al., 2010). The avocado is a medium energy dense (1.7 kcal/g) fruit because it contains about 80% water and dietary fiber (Fulgoni et al., 2013).Most of the fat found in this fruit is monounsaturated, and its consumption helps reduce total cholesterol, LDL cholesterol, and triglycerides while increasing HDL cholesterol levels (Salgado, 2005). Pieterse et al., found that MUFAs contribute 62.8% to 63.6% of the total fatty acids in avocados (2005). The avocado (*Persea americana*) is also known its pleasing taste and contain high proportion of monounsaturated fatty acids (Duester 2000).

The most prevalent MUFA in the diet, is *oleic acid* (C18:1) where it is contribute to the 58.6% of the total fatty acids content found in avocados. Study by Colquhoun et al.

(1992) suggest that a diet rich in avocado that contain high concentration of MUFA (*oleic acid*) may have beneficial effects on blood lipids, and provided a significant role in protecting against the development of CHD. There are variety use of avocados in food consumption including used as a fruit, mashed as a sandwich spread, and cubed as a topping for baked potatoes and soups, but its feasibility as a fat replacer has not yet been studied (Pieterse et al., 2003).

Based on the National Center for Biotechnology Information, obesity poses a major public health challenge and each year, obesity contributes to an estimated 112,000 preventable deaths (NCBI, 2010). The United States has experienced a significant increase in obesity and overweight between 1980 and 2011 (CDC, 2011; Shields et al., 2011). These increases in obesity and overweight were associated with many chronic diseases including type 2 diabetes, coronary heart disease, stroke, and high blood pressure (CDC, 2011).Obesity is generally defined as abnormal or excessive fat accumulation that presents a risk to health. The measurement of obesity by a crude population is the body mass index (BMI) which calculated via a person's weight (in kilograms) divided by the square of his or her height (in metres) (WHO, 2013).

Meanwhile, cardiovascular disease includes all the diseases of the heart and circulation, including coronary heart disease, heart failure, congenital heart disease and stroke (BHF 2012). This diseases cause by a multifactorial disease that arises from interactive effects of a combination of different risk factors. The common known the 'classical' risk factors for cardiovascular disease are smoking, raised blood cholesterol, raised blood pressure, physical inactivity, obesity and diabetes. Traditionally, cardioprotective has advised a lower total fat intake. This is due to fat contains higher energy density compared to protein and carbohydrate, as well as the perceived impact of dietary fat on cardiovascular risk.

However, advances in nutrition science and research methods suggest that the types of fatty acids consumed could be far more important for heart health than the total amount of fat in the diet (Mente et al. 2009).The major highlighting of current dietary guidelines involves replacing SFAs with complex carbohydrates to achieve a total fat intake of $\leq$ 30% of calories. On the other hand, there is also evidence suggesting that the substitution of MUFA instead of carbohydrate for SFA calories may favorably affect CVD risk (Lichtenstein et al., 1997). In UK, current guidance on dietary fat consumption for the primary and secondary prevention of heart disease specifies that saturated fatty acid intake should be below 11% of food energy intake.

The recommendation also highlighting on saturated fatty acids should be replaced by a combination of monounsaturated and polyunsaturated fatty acids with DRVs of 13% and 6.5% of food energy intake, respectively (COMA,1994). Hence, researchers have been focused on reducing the fat content in food products by replacing the fat with fruits or vegetables based ingredients to improve the weight status and overall health .Tropical fruits constitute a major nutritional and economic resource for developing countries such as banana, papaya, pineapple, mango and avocado which generally the most important in economic and trading terms in developing countries (Hayek& Ibrahim, 2013).

In addition, these fresh fruits also contain vitamins, essential minerals, phenolic antioxidants, glucosinolates and other bioactive nutrients help to prevent micronutrient deficiencies (Ansari et al., 2014). The fat in the food products may be replaced by traditional techniques such as substituting water or air for fat, using lean meats in frozen entrées, skim milk as a replacement for of whole milk in frozen desserts, and baking instead of frying for manufacturing or preparing snack foods (CCC, 1992).

Besides that, fat may also be substituted in foods by reformulating the foods with lipid-, protein-, or carbohydrate-based ingredients, individually or in combination.

Meanwhile, fat replacers represent a variety of chemical types with diverse functional and sensory properties and physiological effects. Generally, fat replacers are responsible for the low calories products with similar related to functional properties of fat.

1.2 Problem Statement

Diseases are seen more and more as consequences of consumer's own behavior instead of the result of environment.The individual diet intake and preferences may strongly influence an individual's risk of obesity; cardiovascular diseases, cancer, and other life style related diseases. On other hand, the nutritional factors such as fat, fiber, salt, and vitamin contents of food also associated healthfulness of an individual (Shiby & Mishra, 2013) .Reduced-fat food made with fat replacers can play an important role in helping people reach and maintain their goal of reducing consumption of dietary fat. Hence the replacement of the butter using the avocado is an alternative choice for the healthier fat diet.

Basically, all fats have the same number of calories, but they all function differently in the body. Knowledge and awareness about adverse affects of excessive dietary fat intake is virtually universal. As a result, health conscious motivate the individuals modifying their dietary habits and eating less fat (Miller & Groziak, 1996). Although consumers want foods with minimal to no fat or calories, they also want the foods to taste good. Thus, due to several foods formulated with fat replacers do not compare favorably with the flavor of full-fat counterparts, it is difficult for some people to maintain a reduced fat dietary routine. Meanwhile, the food manufacturers are continuing searching for the elusive "ideal fat replacer" that tastes and functions like conventional fat without the potential adverse health impact.

Low fat or low calorie market has gained more popularity due to the public awareness of nutrition and health (Clark, 1994). A number of chronic degenerative diseases also related

to the dietary factor dietary factors. People continue to look for ways to improve their nutritional habits without changing psychological satisfaction. High fat intake result increased risk for some types of cancer and high blood cholesterol and heart problems are associated with saturated fat intake. Also, high fat intake results in excess energy intake, positive energy balance, and the development of obesity. (Wylie- Rosett, 2002).Therefore, during the last decade, there have been increased substantially on the consumers' demands in the United States and other western countries for low fat, reduced fat, and fat-free (Hayek & Ibrahim, 2013) .

The term of the high-fat diets usually mean increased intakes of saturated fat. Epidemiologic data suggest that saturated fats raise the concentration of LDL cholesterol in the bloodstream of some persons and that elevated cholesterol concentrations heighten the risk of heart disease (Hu & Willett, 2001). Besides, there is abundant literature describing high consumption of fruits and vegetables is recommended as a key component of a healthy diet. In addition, the importance of increased consumption of fruits and vegetables has been widely acknowledged, both for cancer (Steinmetz & Potter, 1991; Block et al., 1992; Margetts et al., 1992) and CVD (Ness & Powles 1997) in the public health.

In the western countries, current concern for fat intake has raised the question of the individual fatty acid (FA) impact on health. (Dubois et al., 2007) This important issue has strengthened the awareness of nutritionists and food manufacturers for the control of the FA profile of food products. Furthermore, over the last decade commercial production of high *oleic acid* modified dietary oils with improved stability for the use in food processing has been significantly increased in order to replace dietary oils rich in SFA and *trans* fatty acids (Tarrago-Trani et al., 2006).According Hunter et al, 2011 describe that not all saturated fats have same effects on serum LDL cholesterol fractions or lipid fractions (Hunter et al, 2010). Butter and other dairy fats (high in 14 : 0, myristic acid) most strongly increase LDL, beef fat

(containing palmitic acid, 16 : 0; stearic acid, 18 : 00) raised LDL to a lesser degree and cocoa butter (containing largely stearic acid) raises LDL only slightly (Mensink & Katan,1987 ;Denke & Grundy, 1991).

Basically, fat has different purpose in cooking such as the heat transfer to the food in order to speedy heating and increase the temperature during cooking. The fat also affects the functional properties that are melting point, viscosity and texture, crystallinity, and spreadability of foods (Sandrou & Arvanitoyannis, 2000). Baked food products are very much known to contain high fat and calorie (Saeed & Salam,2013) .In baked products , the fat enhance the gluten strength, provide tenderness, softening of the crumb and it also reduce the staling in bread (Penfield & Campbell, 1990) . Butter is an important ingredient in baked products and contributes to the flavor, taste, texture, and final product acceptability. In addition, the saturated fatty acids of the butter are more stable and are solid in room temperature.

Baking industry has its importance among food industry all over the world. Cakes and biscuits occupy primary position, both for production and consumption, as compared to other bakery products. Cakes are commonly consumed as snacks between meals, as supplementary foods for toddlers and school going children and as refreshment item in variety occasions and other social gatherings (Akhtar et al., 2006). Cakes are also eaten in breakfast and are liked by all age groups. Cakes are generally low in protein and fiber but very high in carbohydrates and fats (Ahmad et al., 2010). Cake is emulsion of fat and water having flour, sugar, fat, eggs, and baking powder (Lin & Lee, 2005). Fat interferes with gluten development by inhibiting contact between water and flour proteins.

1.3 Objective of the study

1.3.1 General objective:

To determine the nutritional quality of chocolate cupcake prepared with local avocado as replacement for butter

1.3.2 Specific objectives:

1) To determine the proximate composition (moisture, ash, fat, protein, and carbohydrate) of the chocolate cupcake prepared local avocado as fat replacer
2) To determine the mineral content of chocolate cupcake prepared with local avocado as the fat replacer.

1.4 Research questions

1. Is there any difference in the proximate composition (moisture, ash, fat, protein, and carbohydrate) between chocolate cupcake prepared with local avocado and butter?
2. Is there any difference in the mineral contents between chocolate cupcake prepared with local avocado and butter?

1.5 Hypothesis

Null hypothesis, Ho:

There are no significant differences in proximate compositions between chocolate cupcake prepared with avocado and butter.

Alternative hypothesis, H_A:

There are significant differences in proximate compositions between chocolate cupcake prepared with avocado and butter.

Null hypothesis, Ho:

There are no significant differences in mineral contents between chocolate cupcake prepared with avocado and butter.

Alternative hypothesis, H_A:

There are significant differences in mineral contents between chocolate cupcake prepared with avocado and butter.

1.6 Significance of the Study

Improve the nutritional contents of the baked product

Produce the baked product with less saturated fatty acid with unsaturated fatty acid

Produced an alternative healthier dessert (cupcakes) of the low saturated fat

CHAPTER 2

LITERATURE REVIEW

2.1 Cakes

Recent years has seen much growth in the bakery industry in Malaysia (Sudha, et al. 2007). Bakery product derived from variety of types (e.g bread, cake, cookies) and form depending on their ingredients and techniques of baking. Cake is the semi-dry foam foods consist air pockets enclosed in a protein and starch network. In general, the cake ingredients of cake made up of soft wheat of cake flour and variable levels of fat, sugar, eggs, milk, baking powders, emulsifiers and other commonly used ingredients such as cocoa powder, nuts, fruits, icings, and certain flavorings are used for specialty cakes (Cauvain & Cyster, 1996; Cauvain &Young, 2006).

Sugar and fat are responsible tenderizing the cake, softening, giving the soft structure, and enhancing the flavour. Meanwhile, eggs are drying, leavening agents and emulsifying agents of the batter ingredients .The role of baking powder is to enlarge the bubbles causing the cake to rise to its potential. A basic cake preparation process involves mixing, depositing, baking, cooling and packaging. The airy structure of cakes comes from emulsion and foam from egg proteins during mixing. Formation of foam occurs during mixing where air cells are introduced into batter. The higher the number of air pockets the higher the volume. In addition, gelatinization of starch and denaturation of protein together with carbon dioxide formation gives cake its porous and soft structure. The high volumes with a fine homogeneous moist crumb give a good quality of cake (Cauvain &Young, 2000; Sahi & Alava, 2003).

2.2 Fat Replacers in Baking Products

Fat is a major food component and contribute in sensory and physiological benefits. The fat also can develop flavor, mouth feel, taste, and aroma (Mistry, 2001; Sampaio et al., 2004). It's also contributed to the creaminess, appearance, palatability, texture, and lubricity of foods and during meal enhance the satiety. In fact, due to lipophilic flavor it act as originator of flavor development (e.g, by lipolysis or frying), and stabilize flavor (Romeih et al., 2002). Fat-soluble vitamins and essential fatty acids are derived from fat which also carrier for lipophilic drugs. In diet, fat provides more energy as compared to other nutrients and supplying 9 kcal/g of energy as compared to the 4 kcal/g for proteins and carbohydrates. The fat in adipose tissue aids absorbed fat soluble vitamins and other phytochemicals that helps the body to maintain its temperature and functional for energy reserve (Stretch, 2006).

Reducing dietary fat is the primary dietary goal for many consumers. Not so long ago the terms 'low-fat', 'fat-free', 'cholesterol-free' or 'reduced-calorie' would not have applied to sweet bakery products. Nowadays these products are becoming recognized to the consumer as more and more baking establishments are offering 'healthier' alternatives. The present day consumer is struggling with the conflict between health and satisfaction. This conflict is related in the baked goods since these products are typically made from whole milk, sugar, eggs and butter, major sources of fat, calories or cholesterol (Barndt & Antenucci, 1993).

Fat replacers are used to provide some or all of the functional properties of fat, while providing fewer calories than the fat being replaced, and are known used in a variety of products, from baked goods to frozen desserts. Fat replacers may be used for numerous purposes, one of which is to facilitate a reduction in total and saturated fat consumption. The main primary goal of many scientists is to reduce the incidence of obesity and certain chronic

diseases through the development and promotion of low-fat products. Secondly purpose is to decrease total energy consumption to improve health, and a third is to increase the palatability of foods without increasing fat intake (Sampaio et al., 2004).

Fat replacers can be effective only if they lower the total caloric content of the food and if the consumer uses these foods as part of a balanced meal plan. It is important consumers should not be led to believe that fat and calorie-reduced products can be consumed in unlimited amounts (ADA , 2005) .There are some study with some degree of success were showed natural fat replacers like okra gum (Romanchik-Cerpovicz et al. 2002), apple sauce, prune paste (Swanson & Munsayac, 1999), pureed white beans (Rankin & Bingham, 2000), mung bean paste (Adair & Knight 2001) and pawpaw puree (Wiese & Duffrin, 2003) have all been used in baked products.

One of the studied on the natural fat replacer had been done by Tiffany & Duffrin (2003) on *Effects of Substituting Pawpaw Fruit Puree on the Sensory Properties of a Plain Shortened Cake*. The cake was prepared with the 25%, 50% and 75% of the fat with the pawpaw fruit and was evaluated by untrained panelist using a hedonic scale to measure the sensory characteristic. The pawpaw fruit (*Asimina triloba*) is an excellent fat reducing agent in baked and give the advantages to consumer to lower their dietary fat intake. Eventually, the data presented show that a 25 % of fat replacement with pawpaw fruit is acceptable for formulation recipe of the plain shortened cake. However, the high percentage of fat replacement is plain shortened cake is less preferable due loss functional properties of fat based on their effect reduction of the texture, less tenderness and unfavorable color in cake.

Meanwhile on 2008, Wekwete & Navder had conducted a study to *Effects of avocado fruit puree and oat rim as fat replacers on the physical, textural and sensory properties of oatmeal cookies*, which looked to the properties in regard to avocado puree. They found that partial replacement of butter fat by avocado puree, compared with the control cookie, had

greater height and reduced spread ratio. Water activity was significantly higher in avocado cookies compared to control which make the avocado cookie had a softer texture. As the conclusion, this substitution improved the nutritional content which showed both avocado and Oat rim cookies were found at the 50% level of fat replacement, the total fat content for the avocado and Oat rim cookies decreased by 35 and 39%, respectively.

Another study on the fat replacement was conducted by the Hayek & Ibrahim (2012) based on the consumer acceptability of chocolate chip cookies using applesauce as a fat (butter) substitute. Three recipes were included the control made according to NestléToll House recipe, half replacement made by replacing 50% of butter with applesauce, full replacement made by replacing 100% of butter with applesauce. Nestlé Toll House recipe was used in this study and Mott's applesauce was used for fat replacement. The 9 point hedonic rating scale system was evaluated by 35 food science students and employees at North Carolina Agricultural and Technical State University. The sensory evaluations were based on the appearance, texture, color, chewiness, sweetness, moistness, flavor, after taste and overall acceptability of the cookies.

The results showed no significant ($P>0.05$) differences were reported in the acceptability of control and half replacement, but full replacement showed significantly ($P<0.05$) lower acceptability. Meanwhile, moistness of control was the least acceptable where it is significantly ($P<0.05$) among all control characteristics. The present of applesauce, as high moisture ingredient (58% water) (Mott's, 2011), raised the moisture content of the cookies and that was more acceptable. As conclusion, applesauce can be a successful substitute of fat in baked goods, thus adding health benefits and nutritional value to baked products and help reduction of obesity (Hayek & Ibrahim, 2012)

2.3 Butter

Butter is the other types of fat animals that popularity today is higher for its attractive yellow color and pleasing flavor. The butter is useful as table spread as well as a fat for cooking. The United States government defines butter as 80 percent milk fat and no more than 16 percent water and 4 percent milk solids. Salt and coloring additives such as extract of annato seed or carotene may or may not be added the butter is made whereby dramatic changes occur when the cream of milk is converted to butter. The milk is oil-in –water emulsion that reverse butter to a water-in-oil emulsion (Brown, 2008).

For this to occur, the membranes (phospholipids) around the fat globules have to be mechanically broken down. The methods of doing this include stirring cooled cream or, in commercial operations, centrifuging the cram to expel the water. The fatty portion of the cream separates out as a soft, yellowish solid; these are granules of the butter size of the corn kernels. Liquid drained from the process is collected and called buttermilk, a tangy tasting, opaque, reduced texture, flavor, color and salt content (Brown, 2008).

Butter contain high-energy concentrated natural dairy product mainly made of milk fat (≥80%), water (≤16%) and nonfat solids (proteins 0.6–0.7%, lactose 0.7–0.8%, minerals ≈0.2%, plus traces of vitamins, particularly A and D). The unique delicate flavor is the combination of its characteristic and pleasant mouth feel is an unparalleled selling point. Butter has been labeled as 'saturated' and of high cholesterol content as means both of these properties have been associated with vascular and heart disease (Frede , 2002).

2.4 High fat diary food in Butter (Saturated fat) related its health issues

High fat intake is associated with increased risk for some types of cancer, and saturated fat intake is associated with high blood cholesterol and coronary heart disease. Also, consumption of a diet rich in fat has been identified as a risk factor for excess energy

intake, positive energy balance, and the development of obesity (Ognean, et al., 2006). Public dietary recommendations for recommended intakes of macronutrients have targeted lowering total fat. The targeted total fat is specifically are cholesterol, saturated fat and trans- fat intake significantly to improve the overall health of the population. The rationale for the association between dairy fat consumption and CVD is that saturated fats increase plasma cholesterol, which in turn is associated with increased CVD (German et al., 2009).

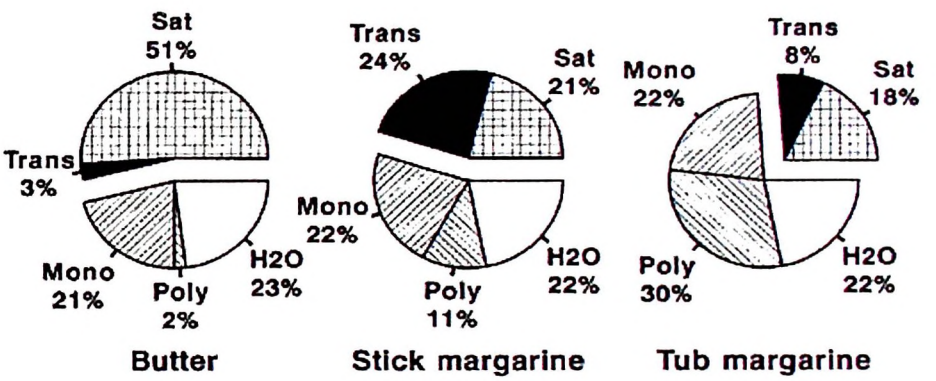
Butter fat could consistently raise plasma cholesterol concentrations, especially in hypercholesterolaemic subjects. Due to its saturated fat contents and traditional process, the butter is consistency maintaining its structure. Besides that, the risk of myocardial infarction scales significantly with chronic dietary content of butter and margarine primarily due to saturated and/or *trans* fat in the high fat dairy products. There also showed the advanced epidemiological association present between national consumption of butter fat and cardiovascular mortality as a key reason and promote reducing intake of full-cream dairy fat (Nestel et al., 2005).

The studied were conducted Zock & Katan (1996), they calculated the differences change in average blood lipid levels between study diets (49 comparisons) as a function of the percentage of calories as margarine substituted for butter. They found that 10% of calorie of butter which is replaced by hard high-trans stick margarines lowered total serum cholesterol by 0.19, LDL by 0.11, and HDL by 0.02 mmol:l, but did not affect the total: HDL cholesterol ratio. Then, the substation of butter with soft low-trans tub margarines decreased total cholesterol by 0.25 and LDL by 0.20 mmol:l, meanwhile did not affect HDL, and decreased the total:HDL cholesterol ratio by 0.20.

Based on replacement of 30 g of butter per day by soft tub margarines significantly reduced the total:HDL cholesterol ratio, would theoretically predict a reduction in coronary heart disease risk of 10%, while replacement of butter by hard, high-trans margarines would

have no effect. Butter contains on average 51 g saturated, 3 g *trans,* 21 g *cis*-monounsaturated, and 2 g of *cis*-polyunsaturated fatty acids per 100g. While the margarines on average contained 20 g saturated, 18 g *trans* (range 0–39 g), 22 g *cis*-monounsaturated, and 18 g of *cis*-polyunsaturated fatty acids per 100 g of product. The most abundant saturated fatty acid in butter and margarine is *palmitic acid* (C16:0), followed in butter by *myristic acid* (C14:0) and followed by *stearic acid* (C18:0) in margarines. (Zock & Katan, 1996)

FIGURE 2.4 Composition of fat in g per 100 of product, of butter and of the average stick margarines and tube margarines.



The figure shows the composition of fat in g per 100 of product, of butter and of the average stick margarines and tube margarines. Based on the figure showed the butter product has high saturated (51%) of compared with the stick margarine and tube margarine

Source from Zock P.L. & Katan M.B. (1997) .Review article: Butter, margarine and serum lipoproteins. *Atherosclerosis, 131;* 7–16

Insulin resistance is the pathogenetic link causal the different metabolic abnormalities clustering in the metabolic syndrome. The dietary habit is one of the factors due to the consumption of energy dense or high fat diets. The high fat diet is positively associated with overweight cause deteriorates insulin sensitivity. Lipoprotein metabolism is characterized

mainly by high triglyceride levels and low HDL cholesterol. . Epidemiological studies have found significant associations between fat intake and blood pressure levels. The studies signifying that the consumption of saturated fat is associated with higher blood pressure levels, as contrast the higher the intake of MUFA the lower is blood pressure (Riccardi .et al., 2004).

2.5 The nutrition of Avocado

The avocado (*Persea Americana*) originated in Mexico, Central or South America, and was first cultivated in Mexico as early as 500 BC. By the 1950s, there were over 25 avocado varieties commercially packed and shipped in California, with Fuerte accounting for about two-thirds of the production. When large-scale expansion of the avocado industry occurred in the 1970s, the Hass avocado cultivar replaced Fuerte as the leading California variety and subsequently became the primary global variety.

Hass avocados, the most common commercial avocado cultivars in the world, contain a variety of essential nutrients and important phytochemicals. The Hass avocado contains about 136 g of pleasant, creamy, smooth texture edible fruit covered by a thick dark green, purplish black, and bumpy skin. The avocado seed and skin comprise about 33% of the total whole fruit weight (Dreher & Davenport , 2013).

The official avocado serving is one-fifth of a fruit (30 g). Based on NHANES analysis as cited in Dreher and Davenport, 2013, the average consumption is one-half an avocado (68 g), which provides a nutrient and phytochemical dense food consisting of the following: dietary fiber (4.6 g), total sugar (0.2 g), potassium (345 mg), sodium (5.5 mg), magnesium (19.5 mg), vitamin A (43 μ g), vitamin C (6.0 mg), vitamin E (1.3 mg), vitamin K (14μg), folate (60 mg), vitamin B-6 (0.2 mg), niacin (1.3 mg), pantothenic acid (1.0 mg), riboflavin

(0.1 mg), choline (10 mg), lutein/zeaxanthin (185μg), phytosterols (57 mg),and high-monounsaturated fatty acids (6.7 g) and 114 kcals or 1.7 kcal/g.

Avacodos contain a very little sugar compared to other fruits which is one-half an avocado contains only about 0.2 g sugar (e.g., sucrose, glucose, and fructose (USDA, 2011). A unique seven-carbon sugar called D-mannoheptulose is primary sugar found in avocados and its reduced form, perseitol, contributes about 2.0 g per one-half fruit. However, this is not accounted for as sugar in compositional database as it does not behave nutritionally as conventional sugar and is more of a unique phytochemical to avocados (Meyer & Terry, 2008; Shaw et al., 1980).

While, the avocado oil consists of 71% monounsaturated fatty acids (MUFA), 13% polyunsaturated fatty acids (PUFA), and 16% saturated fatty acids (SFA), which helps to promote healthy blood lipid profiles and advance the bioavailability of fat soluble vitamins and phytochemicals from the avocado or other fruits and vegetables, naturally low in fat, which are consumed with avocados.

In addition, Compared with other sources of vegetable oils, avocado oil is characterized by showing high levels of monounsaturated fatty acids mainly in *oleic* (18:1 n-9) and *palmitoleic acids* (16:1 n-9), low contents of polyunsaturated *linoleic acid* (18:2 n-6), relatively high content of saturated *palmitic acid* (16:0), and low content of *stearic acid* (18:0) (Soares et al., 1992:Turatti; Canto 1985).

Table 2.5.1: Nutrient Profile of California Avocado and other "Bread Spread"

Bread Spread (1 oz.)	Calories (mg)	Total Fat (mg)	Saturated Fat(g)	Cholesterol (mg)	Sodium
Mashed Avocado	50	4.9	0.7	0	3
Peanut butter	168	14.5	2.9	0	132
Cream cheese	99	9.9	6.2	31	84
Mayonnaise	203	22.5	3.4	17	161
Butter	203	23.0	14.4	62	234

Table shows the comparison of the "bread spread with different other food spread," an ounce of mashed avocado offers a superior nutrient profile

Source: Duester, K.C. (2000).Avocados a look beyond basic nutrition for one of nature's whole foods. *Nutr. Today.* 35(4):151–157)

The avocado is a nutrient dense, cholesterol-free fruit, which is low in sodium and can be considered to be a source of fiber. New research from the University of California, Los Angeles, indicates that California avocados have nearly twice as much vitamin that may protect against disease, making avocados the highest fruit source of this powerful antioxidant. (Love & Sayed, 2001)

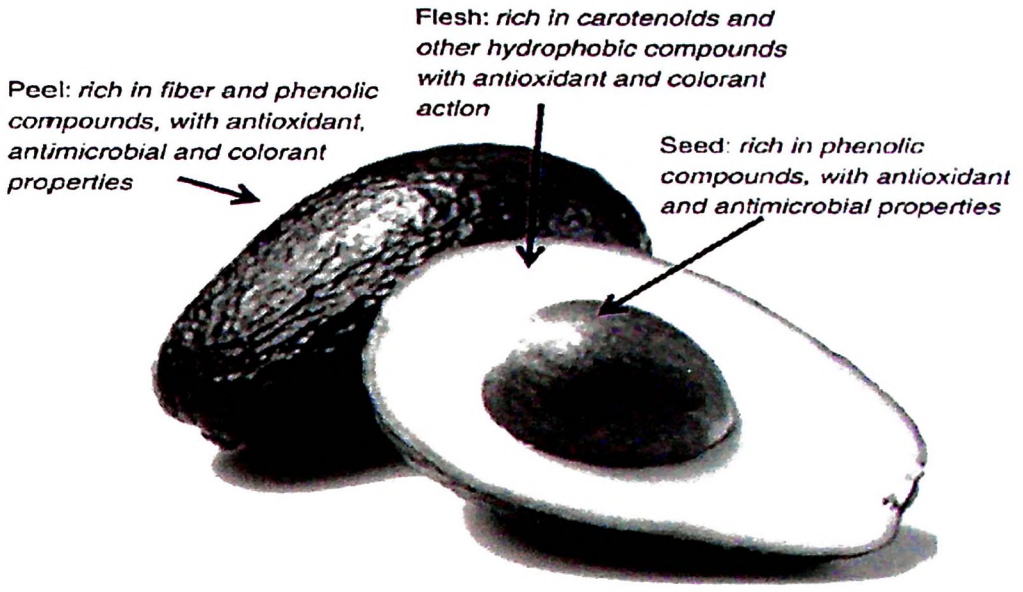


Figure 2.5 Main functional bioactive compounds in avocado and their general distribution in tissues.

Source: Ayala-Zavala, J. F., Vega-Vega, V., Rosas-Domínguez, C., Palafox-Carlos, H., Villa-Rodriguez, J. A., Siddiqui, M. W., Dávila-Aviña, J.E.& González-Aguilar, G. A. (2011). Agro-industrial potential of exotic fruit byproducts as a source of food additives. *Food Research International*, *44*(7), 1866-1874.

Table 2.5.2: Nutritional information of avocados (per 100 g edible portion)

Energy	South African	USDA
	1021	741
Protein (g)	1.7	2.11
Carbohydrate (g)	1.9	6.91
Fibre (g)	5.3	4.9
Fat (g)	23.5	17.33
Monounsaturated fatty acid(g)	15.63	11.21
Polyunsaturated fatty acids(g)	3.04	2.041
Saturated fatty acids (g)	4.82	2.59
Cholesterol (g)	0	0
Vitamin A (RE) (µg)	61	61
Vitamin C (mg)	14	7.9
Vitamin E (mg)	1	1.34
Thiamine (mg)	0.04	0.108
Riboflavin (mg)	0.03	0.122
Niacin (mg)	1.6	1.921
Folate (mg)	29	66
Magnesium (mg)	31	41
Iron (mg)	0.4	1.18
Potassium (mg)	583	634
Lutein (µg)	169	-
Beta-Sitosterol (mg)	76	

USDA: United States Department of Agriculture

Source: Pieterse Z, Jerling J ,Oosthuizen W (2003). Avocados (monounsaturated fatty acids),weight loss and serum lipids. South African Avocado Growers' Association Yearbook.26:65-71

Based on the Mooz et al. (2012), It shows that the avocado is a high energy food (95.27 to 130.21 kcal.100 g–1) when compared with other tropical fruits. Avocado significantly contains high nutritional value, since it is rich in proteins (1.11 to 1.75 g.100 g–1), lipids (4.8 to 10.15 g.100 g–1), and carbohydrates (7.3 to 11.54 g.100 g–1). It also has bioactive substances such as carotenoids (1.72 to 5.65 mg.mL–1), which are fat-soluble substances.

2.6 Avocados, MUFA and Health

The word dietary fat has become synonymous with obesity and heart disease in the public mind, whereas the words of low fat and fat-free have become synonymous with heart health. By the compelling evidence, indicates the greater importance of types of fat, instead of total amount of fat with respect to risk of CHD (Hu et al, 2001). Wolmarans & Oosthuizen (2001), suggest that a moderate-fat diet (30%E) with a low SFA (<10%E) and high MUFA has the most beneficial effect on lipid profiles and is also associated with a lower body mass.

Avocado is commercially valuable crop and its trees and fruits are cultivated in tropical climates around the globe, producing a green-skinned, pear-shaped fruit that ripens after harvesting. As the avocado fruit ripens, the saturated fat decreases and the monounsaturated oleic acid increases (Lu et al., 2009; Moreno et al., 1980; Slater et al., 1975). The use of avocado dips and spreads as an alternative to more traditional hard, SFA rich spreads or dips can assist in lowering dietary SFA intake (Avocado Central, 2012). Aside that, avocados have been also used in producing ice cream, pickle , and guacamole

powder, In addition, avocados have a good potential in the bakery since it is high in fibre vitamin A ,B and E (Varastegani & Yang , 2013).

In previous published diet studies related the effect of monounsaturated fatty acids on blood lipids, *olive oil* has been used most commonly as the food source. As mentioned earlier, all foods that rich in monounsaturated fatty acids, the predominant monounsaturated fatty acid was oleic acid (C18: 1 n9). On the studies of olive oil have shown that olive oil-enriched diets lower LDL cholesterol and preserve or increase HDL-cholesterol concentrations. The study is done by Mattson & Grundy (1985) showed similar results with a diet high in oleic safflower oil and *unhydrogenated* peanut butter. The positive result also is made by McDonald et al (1989) shown significant reductions of LDL with maintenance of HDL by using canola oil as a source of oleic acid.

On other hand, the first exploratory avocado clinical study demonstrated that the consumption of 0.5–1.5 avocados per day may help to maintain normal serum total cholesterol in men (Grant, 1960). Half the subjects were experienced a 9–43% reduction in serum total cholesterol and the other subjects (either diabetic or very hypercholesterolemic) experienced a neutral effect. Beside, none of the subjects showed increased total cholesterol. In addition, the subjects did not gain weight when the avocados were consumed to their habitual diet.

In the 1990, the clinical studies show hypercholesterolemic subjects, avocado enriched diets improved blood lipid profiles by lowering LDL-cholesterol and triglycerides and increasing HDL-cholesterol. This study was compared to high carbohydrate diets or other diets without avocado. Meanwhile, in normolipidemic subjects, avocado enriched diets improved lipid profiles by lowering LDL-cholesterol without raising triglycerides or lowering HDL-cholesterol. These studies suggest that avocado enriched diets have a positive effect on

blood lipids compared to low-fat, high carbohydrate diets or the typical American diet (Dreher ML & Davenport, 2013)

The studied design by Colquhoun et al. (1992) was compared a high-complex carbohydrate diet (AHA III) with a diet enriched in monounsaturated fatty acid from avocados. This study proves for further evidence that food rich in monounsaturated fatty acid are suitable as a substitute for dietary saturated fatty acid in cholesterol- reducing diet. However, intake diet enriched in *monounsaturated fatty acids* from avocados does not lower HDL lipoprotein or apolipoprotein A-I. Meanwhile, in a randomized crossover study of 12 women with type 2 diabetes, a monounsaturated fat diet rich in avocado was compared with a low-fat complex-carbohydrate-rich diet for effects on blood lipids (Lerman-Garber et al., 1994).

In this study, the avocado rich diet showed significantly in lowered plasma triglycerides and both diets maintained similar blood lipids and glycemic controls after 4 weeks. Furthermore, a preclinical study describe that avocados can modify the HDL-C structure by increasing paraoxonase 1 activity (PON-1), which can enhance lipophilic antioxidant capacity and help convert oxidized LDLC back to its nonoxidized form (Mendez & Hernandez, 2007). Avocados have both a medium energy density of 1.7 kcal/g and viscose water, dietary fiber and fruit oil matrix that appears to enhance satiety (Wien et al., 2011). This is reliable with research by Bes-Rastrollo et al. (2008), was suggested that avocados support weight control similar to other fruits.

There were several preliminary clinical studies suggest that avocados can help in weight control. The first trial was studied on the effect of including one and a half avocados (200g) in a weight loss diet plan. The subjects involves sixty-one healthy free-living, overweight and obese subjects were randomly assigned into either a group consuming 200

g/d of avocados (30.6 g fat) substituted for 30 g of mixed fats, such as margarine and oil, or a control group excluding avocados for 6 weeks (Pieterse et al., 2005).

The findings showed both groups lost similar levels of weight, body mass index (BMI), and percentage of body fat ($p < 0.001$) to confirm that avocados can fit into a weight loss diet plan. On other hand, a randomized single blinded, crossover postprandial study of 26 healthy overweight adults suggested that one-half an avocado consumed at lunch significantly reduced self-reported hunger and desire to eat, and increased satiation as compared to the control meal ($p < 0.002$) (Wien et al., 2011).

Phytochemicals had been recognized in cancer prevention by fruits and vegetables. Avocados contain a number of bioactive phytochemicals including carotenoids, terpenoids, D-mannoheptulose, persenone A and B, phenols, and glutathione that have been reported to have anti-carcinogenic properties (Ames, 1983: Ding et al., 2009; Jones et al., 1992).Studies have shown that phytochemicals extracted from the avocado fruit selectively induce cell cycle arrest, inhibit growth, and induce apoptosis in precancerous and cancer cell lines.

Recent studies by Ding et al., 2007 indicate that phytochemicals extracted with chloroform from avocado fruits target multiple signaling pathways and increase intracellular reactive oxygen leading to apoptosis. Apoptosis is an energy-requiring tightly regulated form of cell death involving multiple signaling pathways including cell surface death receptors and disruption of the mitochondria (Kim et al., 2003).