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THE “ACTIVE INGREDIENTS” OF YIN, YANG AND NEUTRAL FOOD AND THE EFFECT OF THESE NUTRIENTS ON IMPROVING AND MAINTAINING HEALTH

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THE “ACTIVE INGREDIENTS” OF YIN, YANG AND NEUTRAL FOOD AND THE EFFECT OF THESE NUTRIENTS ON IMPROVING AND MAINTAINING HEALTH

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Abstract

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Chinese dietary therapy has been documented to date back at least 4000 years (Zhang, 2012). The aim of traditional Chinese dietary therapy was to maintain health by achieving the balance of Yin, cold or cool, and Yang, hot or warm, components in human bodies through having a Yin-Yang-balanced diet. Yin foods were to expel heat syndromes, such as constipation, caused by excessive Yang (heat), while Yang foods were to treat cold syndromes, such as fatigue, caused by excessive Yin (coldness). However, evidence of this food therapy phenomenon was not clear yet. The purpose of this study was to explore the features of Yin, Yang and neutral food for specific nutrient commonalities and to determine their effect on improving specific diseases or symptoms. The ESHA Food Processor software program was used to analyze nutrient compositions of foods in the Yin, Yang and neutral food list from traditional Chinese medicine. Parametric and non-parametric tests were used to determine the different amount in each variable between Yin, Yang and neutral groups. Based on the statistical analytic results, calories, dietary fiber, fat, retinol, and vitamin C were found to possibly determine the effect of Yin-Yang properties of foods on human health. The influence of these nutrients

on the human body was partially consistent with the function of Yin, Yang and neutral foods recorded in traditional Chinese medicine.

Chapter 1

Introduction and General Information

Four properties and five flavors

The theory of "Four Properties and Five Flavors" was first stated in Huangdi Neijing (Zhang, 2012) about 2000 years ago, which was considered the Bible of traditional Chinese medicine. The four properties refer to "coldness", "heat", "warm" and "coolness", while the five flavors refer to "sour", "sweet", "bitter", "chili" and "salty". The four properties were identified by ancient Chinese herbalists based on the different reactions the human body experienced to intake of various foods and the positive or negative health effects of these foods. First applied to herbs, this theory dictated that the health effect of herbs was determined by their properties and flavors. Simiao Sun, (Sun, 1999), famous as "The Master of Herbs" in the history of China, first proposed there was no rigorous method to divide food and herbs and that disease should be treated through manipulation of food intake. In one of his greatest masterpieces, Qianjin Yaofang in 654 AD (Sun, 1999), he explained that medications could be used as food and food could be combined with medications. In this way, medicine would function by means of food and food would reinforce the effects of medicine. Therefore, medications combined with the appropriate food, would bring out the best in this deliciously symbiotic relationship.

Arguments on the actual clinical effect of Yin-Yang food therapy continue as traditional Chinese food therapy meets Western medicine. Based on the theory of homology of herbs and food, food also has four properties. Foods with "warm" and "heat" properties, are considered to have similar effects on the body and are in the category called “Yang”, while foods with “coldness” or “coolness” properties, and similar functions, are in the category called “Yin” (Zhang, 2012). Other foods were considered to have Yin-Yang-balanced properties so that they are categorized into the group called “Neutral”. The balance in Yin and Yang properties of food and herbs is the fundamental principle of medication prescription and food therapy in traditional Chinese medicine. For example, it was stated in Huangdi Neijing Su Wen (Plain Questions: Yellow Emperor's Internal Canon of Medicine) (Zhang, 2012) that “Cold disease should be treated by hot food, while febrile disease should be treated by cold food” and “Use cold food to nourish Yin and to lower fire and use hot food to strengthen Yang and to disperse coldness”. These concepts were crucial in the holistic management of a patient.

Traditional Chinese medicine uses two types of intervention combining food and herbs to maintain health, prevent disease, remove illness and slow aging. One is called “Food therapy(食疗)” and the other is called “Medical Diet Therapy(药膳)” (Sun, 1999). In general, food therapy is aimed at maintaining a balanced intake of nutrients through a well-balanced diet, while medical diet therapy focuses on the balance of Yin and Yang properties through the combination of specific food and herbs. Using traditional culinary techniques and modern processing methods, medical diet therapy combines food with herbs to produce a health-promoting condition, increase the body’s resistance to disease, and facilitate healing as well as promoting longevity.

Basis of classification in traditional Chinese medicine

Food classifications in ancient Chinese medical literature were commonly summarized with long-term observations based on the color and flavor of foods, the environment, and weather conditions.

Color Green herbaceous plants were usually considered to be in the Yin category because most of these plants grow low to the ground. It is thought they would absorb more moisture. Several plants with red color also grow short stems but their fruit tends to have warm or hot properties because it is thought that they absorb more energy from sun.

Flavor Foods with sweet or spicy flavors are considered to have warm or hot properties while food with bitter or sour flavors would be put in the Yin or neutral categories.

Environment Plants which grow in water would be considered to have Yin properties while plants grown in a drier environment of soil would be described as having Yang properties.

Sunshine Plants which grow in the shade or with low levels of sunshine are often classified as Yin. Plants which grow facing southeast, where they have more exposure to sunshine are considered to have hot or warm, yang properties.

Season Plants which grow in winter are considered cold and contain Yin properties while plants which flourish in summer would have Yang properties.

Recommended diet directions based on the classifications of Yin-Yang Some recommended diet directions in traditional Chinese medicine use these basic classifications. For example, people who work or stay mostly in cold and wet environments should increase the proportion of Yang food in their diets. People working or staying in a hot and dry environment should eat more Yin food. Individual preference in flavors could cause imbalance of yin and yang in daily food routines. People who live close to rivers or seas are considered to have more Yin food than Yang food in their diets. These people need to intentionally add some Yang food to their diets. In this way, people who live deeply in the middle of a continent away from an ocean or river should eat more Yin food to clean away heat and reduce fire. People should adjust the proportions of Yin and Yang food in the food routines based on the changing of seasons, which means more Yang food in cold winter and more Yin food in hot summer.

Current findings about Yin-Yang food therapy

Several studies have found the relations between Yin-Yang properties and bio-active nutrients. Yang food has been found to have more carbohydrate, protein, and fat than Yin food. It is thought that the Yang foods could increase the excitability of central nervous system and raise metabolic rate to produce more heat and energy (Yue, Zhao, & Yao, 2010; Cao et al., 2011; Zhou, Li, & Li, 2009; Feng et al., 2010). Vitamin C, Vitamin E, copper, iron, and magnesium were found to be related to the properties of food which determine the effects of Yin and Yang food on human bodies (Ni et al., 2015; Zhang & Zhao, 2008). However, all the studies about the Yin and Yang properties of food and herbs were done in China. Most of the studies merely picked a few foods or herbs and determined the differences in compositions between Yin and Yang food by analyzing the chemical composition of those food or observing the biochemical reactions of experimental animals to them (Hu et al., 2012; Zhao & Pan, 2007; Wang et al., 2005;

Yue, Cao, & Yao, 2010; Zhou, Li, & Li, 2009). The few studies which included most evidence-based foods in each category used the China version of a nutrient database (Zhang & Zhao, 2008). While Yin-Yang properties of food appear to be associated with the nutrient compositions, the objective and quantitative distinction between Yin and Yang food with multiple nutrients has yet to be determined. General evaluation methods and indicators on the Yin-Yang properties need to be evaluated and disseminated to further explore the understanding of the benefits of balancing Yin and Yang. The biological mechanisms in the human body and the material basis for the effect Yin and Yang food have on human health needs to be elucidated. The purpose of this study is to explore the features of Yin, Yang, and neutral foods for specific nutrient commonalities; to define and determine the "active ingredients", which are nutrients that determine the property of foods with influences on human health, in each food category; to describe the effect of Yin and Yang properties for convalescence from specific diseases or maintaining health through these "active ingredients". New traditional Chinese medicine is faced with more and more challenges in modern society because information and knowledge were collected in a more-than-two-thousand-year-old practice rather than based on well-designed and highly controlled studies. As evidence-based practice has become dominant, more people are questioning the clinical effects of "old" practices. In other words, doing research on traditional Chinese medical theories and interventions using western scientific research methods is a necessary and significant way to provide evidence demonstrating the relationship with improving and maintaining health, and to narrow the gap in available scientific knowledge between traditional Chinese medicine and western medicine. Food and herbs are definitely a very important component of alternative medicine. This study will provide recommendations on engaging in evidence-based Yin-Yang-balanced-diets and management of such diets to address specific diseases or symptoms.

Chapter 2

Literature Review

Yin and Yang properties can be interpreted by nutrients and other active compositions in food

While major scientific evidence of Yin and Yang properties has not yet been found, Zhang and Zhao (2006) did build a multinomial logistic regression equation with ten nutrients significantly predicting Yin-Yang property of foods. Water (*OR*: 2.245E+28, 95% *CI*: 4.874E+26~1.034E+30), the macronutrients protein (*OR*: 2.545E+27, 95% *CI*: 2.412E+25~2.686E+29), fat (*OR*: 4.292E+33, 95% *CI*: 1.253E+28~1.470E+39), carbohydrates (*OR*: 2.503E+28, 95% *CI*: 5.299E+26~1.183E+30) along with dietary fiber (*OR*=0.327, 95% *CI*: 95%CI:0.115~0.923), and the minerals iron (*OR*=2.404, 95% *CI*: 1.068~5.411), selenium (*OR*=7.456, 95% *CI*: 1.084~51.297), magnesium (*OR*=0.933, 95% *CI*: 0.865~1.007), zinc (*OR*=38.245, 95% *CI*: 0.634~2308.413), and copper (*OR*=0.002, 95% *CI*: 4.327E-06~1.381) were used to develop a logistic regression model (a=0.10) as follows:

$$\text{Logit } P_j = a_j + 65.281x_1 + 63.104x_2 + 77.44x_3 + 65.390x_4 - 1.117x_5 - 0.069x_{18} + 0.877x_{19} + 3.644x_{20} + 2.009x_{21} - 6.014x_{22}$$

$$j = 1,\ 2 \qquad a_1 = 6531.378 \qquad a_2 = 6532.819$$

As the dietary fiber, magnesium, and copper in foods increased by one unit, the possibility of increasing the property of foods by one or more levels (Yin < Neutral < Yang) reduced 67%, 7%, and 99% on average respectively (OR<1), which indicated that these three nutrients contributed to the Yin property. However, the possibility of promoting the property of foods to a higher level rose with increasing the amount of water, protein, fat, carbohydrates, iron, selenium and zinc by one unit (OR>1), which represented the Yang property. The researchers also did principle component analysis on the 23 nutrient variables to make predictive models and found that the top four principal components accounted for 85.296% variability of the data. The first principal component, which accounted for the largest variance (58.443%), were related to protein (*r*=0.959), dietary fiber (*r*=0.971), ash (*r*=0.904), vitamin B2 (*r*=0.906), and phosphorus (*r*=0.938), which indicated that the first principal component was a reflection of comprehensive nutrient composition of foods. The remaining three principal components revealed the energy content (fat, *r*=0.908; vitamin B2, *r* =0.908), fat-soluble vitamin content (vitamin A, *r*=0.758; carotene, *r*=0.758) and soluble vitamin content (vitamin C, *r*=0.661) separately.

Hu and Mei (1997) reported that the "conflicts of food" referred to types of food, nutrients, and other active components that were constrained by each other, including any toxic reactions happening between two different foods. In other words, the digestion and metabolic process for a type of food (ie. Yin) would be affected by the composition of the other category of food (ie. Yang) in a transformative, synergistic, or antagonistic way, which potentially caused a reduction of the bioavailability of some nutrients in the human body.

However, there was a possibility that defining food by Yin-Yang properties would make no sense, and the hot or cold feelings people had after eating those foods might be associated with the chemical reactions happening in human body, rather than the Yin or Yang of the food. For example, mint-flavored items tended to taste cold. Montell (2006) stated that there were receptors in the mouth that responded to menthol, a chemical in most mint-flavored foods. The receptor was a protein called transient receptor potential cation channel, subfamily M, member 8(TRPM8). Menthol caused the TRPM8 channel to open. When open, it allowed sodium and calcium ions to enter, causing an action potential, the same action potential that responded to low temperatures. So, the signal that was produced when the receptor sensed menthol was indistinguishable from the signal that would be produced if the receptor sensed cold. Therefore, when it detected menthol, the receptor signals 'cold', creating the perception that mint felt cold. Another example was chili pepper. Mahmmoud (2008) stated that consumption of capsaicin (CPS) contained in chili pepper was linked with increased energy expenditure and fat oxidation by stimulating ATP hydrolysis through sarcoplasmic reticulum Ca^{2+} -ATPase (SERCA), in regard to which CPS intake rapidly increased core body temperature and subsequently increased heat loss. These would be perceived as a hot feeling when eating chili pepper. It was not because the chili pepper itself had more energy or created heat.

Yin-Yang properties and three main macronutrients

Food with hot or warm properties would enhance the excitability of the central nervous system, enhancing metabolism to produce heat and energy (Yue, Cao, & Yao, 2010). The material basis of the Yin-Yang properties of meat was found to include carbohydrate, protein and fat, the macronutrients, which contained energy commonly measured as calories in Western medicine (Cao, Yue, Wu, Li, & Ji, 2011). However, Zhang and Zhao (2008) found there were no significant differences among Yin, Yang, and neutral categories for fat, saturated fat, monounsaturated fat, or polyunsaturated fat using one-way ANOVA. Based on the formula used to determine the Yin-Yang property of meat, carbohydrates, iodine, and sodium determined the coldness, while fat, potassium and sulfur-containing amino acids determined the heat, and neutral property was determined by vitamin A, vitamin E and aromatic amino acids (Cao et al., 2011). Foods with hot or warm properties were found to have more carbohydrates than cold or cool food and would provide more energy. Studies done by Feng et al. (2010) on herbs found that Yang herbs contained more carbohydrate and amino acids than Yin herbs. Using non-parametric tests, Zhang and Zhao (2008) further analyzed the relativity between amino acids and Yin-Yang properties in 120 foods and found the significant relativity (p<0.05) between Yin-Yang properties and 16 amino acids (isoleucine, leucine, lysine, methionine, phenylalanine, tyrosine, threonine, valine, arginine, histidine, alanine, aspartic acid, glutamic acid, glycine, praline and serine). Based on the results of logistic regression analysis on 18 amino acids (reference: Yin), leucine (*OR*=0.997, 95% *CI*=0.995~0.999) and tyrosine (*OR*=0.988, 95% *CI*=0.977~1.000) increased the Yin components while methionine (*OR*=1.007, 95% *CI*=0.999~1.015), glycine (*OR*=1.004, 95% *CI*=1.002~1.010), isoleucine (*OR*=1.007, 95% *CI*=0.999~1.014), and lysine (*OR*=1.002, 95% *CI*=1.000~1.003) devoted to the Yang components of foods.

Yin-Yang properties and mineral

Ni et al. (2005) created the mathematical model and discerned the biochemical indicators to determine the Yin-Yang properties of fruit. The discriminant equation was $Y=-10.19173X_8-1.42593X_5+0.14975X_4$ (Y_{Yang}= -0.6423171~0.5275019, otherwise Yin). In the formula, X_8, X_5 and X_4 referred to the quantity of copper, iron, and magnesium contained in fruit respectively. By adjusting the amount of copper, iron, and magnesium in foods, its property could be changed. Yin foods were found to have more magnesium and copper while Yang food were found to have more iron and zinc. Zhao and Xu (2018) found that phosphorus was positively related to Yin-Yang properties (Yin<Neutral<Yang) while calcium was negatively related.

Yin-Yang properties and vitamin

Zhang and Zhao (2008) analyzed 7 vitamins using ordinal regression analysis and found a significant (a=0.10) positive correlation between the Yang properties and the quantity of vitamin C (P=0.047, OR=1.013, CI: 1.000~1.025) and E (P=0.057, OR=1.222, CI: 0.994~1.502).

Balance in Yin and Yang properties associated with disease

The concept of holism permeated the practice of traditional Chinese medicine, including physiology, pathology, diagnosis, syndrome differentiation and treatment. The Plain Questions, the Yellow Emperor's Internal Canon of Medicine (Zhang ed., 2012) associated five flavors with five Zang organs. Sour food was said to be absorbed by the liver, spicy by the lungs, bitter by the heart, salty by the kidney, and sweet by the spleen. A disordered diet or the excess intake of a flavor of food would do harm to five Zang organs. If the intake of food with sour flavors was high, the Qi of liver would increase, which was called “exuberance of liver fire”, and the Qi of spleen would decrease. Liver was stated to affect eyes in traditional Chinese medicine so increased Qi of liver was related to poor eyesight, dry eyes, tinnitus, excessive eye discharge, etc. Qi of spleen mainly affected gastrointestinal systems and the symptoms of decreased Qi of spleen included less intake of foods, bloating, fatigue after eating, diarrhea, weight loss, or edema. Bone damage, muscle weakness and depressed heart-Qi could be resulted from high-salt diets. If people ate excess sweet foods, heart-Qi would increase, causing asthma, darkened skin, and imbalance of the kidney-Qi. High-bitter diets might cause dryness of the spleen-Qi. Tendons and vessels would become flaccid and strength could be undermined by high intake of spicy foods. Pathological mechanism of the five Zang organs were tightly associated with the five flavors of food.

Yang food was thought to improve the deficiency of Yang with hyperactivity of Yin and cold constitution, the symptoms of which included cold limbs and waist, chills, thin sloppy stools and frequent nocturia. Yin food was thought to clear heat and purge fire, to detoxify and to expel dryness, which was beneficial to those with deficiency of Yin and with hyperactivity of Yang. A hot constitution had the symptoms of repeated sore mouth and tongue, dry mouth and tongue, dysphoria with a feverish sensation in chest, palms and soles, and dry stools. Traditional Chinese Medicine believed that health signified the balance of Yin-Yang, while a pathological condition implied imbalance of Yin-Yang. Predominance of Yang brought about heat syndrome and predominance of Yin brought about cold syndrome. Traditional Chinese Medical dietary therapy was developed based on the guidance of theory of Yin-Yang balance.

But how do we explain this theory using modern physiological and pathological mechanisms? Is the effect of Yang food on Yin symptoms associated with the nutrient features of Yang food? Is the effect of Yin food on Yang symptoms associated with the nutrient features of Yin food?

Current findings revealed the biochemical activities in the central nervous system related to Yang and Yin syndromes (Liang, 1996). Formation of Yin syndrome was found to be associated with increased 5-hydroxytryptamin (5-HT), decreased catecholamine, and inhibited tropic hormone releasing factors in hypothalamus while Yang syndrome was developed by increased central nervous system stimulants, increased catecholamine, and decreased 5-HT. Yang, Liang, Wang, & Ren (2002) found that the sympathetic nervous system (SNS) of rats with Yang symptoms was activated, along with the increased release of adrenocortical hormones and increased amount of fibrinogen in blood, raising the amount of plaque formed, and enhanced mechanism of T-cells. While rats with Yin symptoms had depressant nervous and endocrine systems and inhibited immune activities with a high level of fibrinogen.

Yang and Yin herbs were found to have an effect on body temperature and water intake in animal model experiments conducted by Zhao and Pan (2007). Relatively slow weight gain, low body temperature, low blood pressure, reduced activity of ATPase, increased clotting time, increased number of white blood cells and platelets, decreased alanine aminotransferase (ALT) were observed on rats which were fed Yin herbs. Opposite changes were observed in Yang group on these biomarkers. Wang and the co-authors (2005) find that body temperature is increased after the participants ate Yang food in human studies. In their animal experiments, animals which were fed lamb had increased body temperature and harder stools.

Zhang and An (2017) stated that yin herbs would decrease the amount of malonic dialdehyde (MDA) in tissues. The level of lipid peroxidation in the body was reflective of the amount of MDA. For those people undertaking physical training and fitness rehabilitation, it has been suggested they eat more Yin food. Hu et al. (2012) reported in a study using duck meat that Yin food decreased blood glucose by increasing glycogen reserves. Yang food was said to increase the activity of superoxide dismutase (SOD). The increased activity of SOD might cause glycogen to break down and promote lipid metabolism, providing energy, increased blood glucose, and increased basal metabolic rate (Hu et al., 2012).

Yin-Yang herbs affected the growth of cells and intracellular activities (Cheng, 2010; Huang et al., 2010; Sui et al., 2010; Sui et al., 2009; Sui et al., 2010). Within dorsal root ganglions, Yang components in herbs were reported to enhance the expression of TRPV1 mRNA and inhibit the expression of TRPM8 mRNA while Yin components caused opposite changes (Sui et al., 2010; Sui et al., 2009; Sui et al., 2010). In skeletal muscle fibers, expression of uncoupling protein (UCP) was found to be inhibited by Yang herbs, which induced the production of ATP for requirements of metabolism by reducing proton leak (Huang et al., 2010). Cheng and Liu (2010) did a study using fibroblast, myeloma cells, hybridoma cells and breast cancer cells (MCF-7) in vitro to explore the effect of Yin-Yang properties on cell proliferation. The researchers found that within a certain concentration range (50-800 ug/ml), Yin herbs, such as prunella vulgaris, inhibited the growth and proliferation of cells out of body, rate of inhibiting rising along with the increased concentration, while Yang herbs, such as cinnamon, promoted cell growth and proliferation within 50-200 ug/ml while inhibited it with higher concentrations (400-800 ug/ml). The same results were observed on 11 other herbs. The concentration affected the biochemical mechanism of Yin-Yang herbs. Cells in the Yang group had better growth shapes. In regard to the effect of Yin-Yang herbs on cell growth, proliferation, and metabolism, pharmacological treatments on cancer were developed. A Yin herb, cinobufotalin, was clinically important in effectively improving the immune function, inhibiting the proliferation of cancer cells, and inducing the differentiation of cancer cells and vessel vasoconstrictions (Wang, Zhou, Liu, & Hu, 2018).

Chillness and cold limbs were symptoms of lack of Yang components, which were found to be related to reduced blood flow in subcutaneous tissues (Jin & Zhang, 2012). This pathological condition was seen on patients with microcirculatory disorder, heart failure, or hypothyroidism.

Interestingly, the fifth property of food – inflammation, which caused "heat up(上火)" with typical symptoms including fever, mouth ulcers, swelling gums, dry mouth and etc, has gradually been approved by scientists (Liu, Liu, T., Ruan, Peng, & Zhang, 2009). Inflammation properties from foods was resulted from the inflammatory factors existing naturally in foods, or due to over processing, which caused acute or chronic inflammatory reactions, especially causing harm to populations with weak immune systems, such as infants or the elderly.

Chapter 3

Materials and Methods

Yin, Yang, and Neutral Food List

A list of food was categorized as Yin, Yang and neutral and the categorization was determined by several existing traditional Chinese medicine books (Hu, 2011; Shi, 1988; Liu, 1987; Sun, 1999; Zhang, 2012). *Food and Herbs* (Liu, 1987) was a comprehensive review about the basic theories of traditional herbology and a detailed introduction of the function, compatibility and contradictory, and clinical use of 378 foods. *Nutriology and Phagoiatreusiology* (Shi, 1988) summarized the developmental process of traditional Chinese food therapy and herbology, identifying the properties and clinical use of some foods. Three other books (Hu, 2011; Sun, 1999; Zhang, 2012) written by one or multiple ancient traditional Chinese medical physicians or herbalists, were utilized to develop a preliminary list of foods. In the final version of the food list used for analysis, with 193 foods in total, 63 were Yang foods, 68 were Yin foods, and 62 were neutral foods (see Appendix A).

Nutrient Analysis

The ESHA food processor nutrition analysis software was used to determine the nutrients in each food on the list. There were several considerations for selecting dietary assessment software. Commonly, dietary assessment software manages the whole process from interviewing a patient to collecting food intake information, to making an ideal meal plan for the better health of a patient. But in this study, the only function utilized was nutrient analysis for each food in the list. The first and most important consideration in this study was the data quality of databases. The nutrient composition of foods varied based on many factors, such as the method of cooking, maturity of fruits and vegetables, length and method of storage, and in most cases, one database might provide limited foods with few types of preparation methods. Researchers must determine that the values of food composition in the database they choose are consistent with the population and goals of their study (Stumbo, 2008). In this study, there were no specific requirements on the conditions of foods to be analyzed. The ESHA food processor includes several food composition databases and users can select their preferences while inputting food in their food list. The United States Department of Agriculture (USDA) Nutrient Database for Standard Reference (SR) and the USDA Food and Nutrient Database for Dietary Studies (FNDDS) were preferred for this study if the nutrient information of food was available in those two databases. USDA-SR has qualifiers such as “year-round average” which better quantifies the food composition based on general conditions (Stumbo, 2008). Another important factor on data quality is the update rate. The USDA SR is updated approximately once a year and USDA SR and FNDDS are basic sources for data in the U. S. which are referred to by other databases (Stumbo, 2008).

Each food was analyzed for nutritive properties and compounds. The individual compounds are shown in Table 1 (ESHA Research, 2016). Eighteen foods were excluded as they were not in the database (see Table 2). Nutrient analysis was completed for 175 foods shown in Appendix A.

Table 1. Independent Variables Tested in ESHA Database

Variables		
Calories	Calories from fat	calories from saturated fat
protein	carbohydrates	total dietary fiber

Variables		
total soluble fiber	dietary fiber (2016)	soluble fiber (2016)
total sugars	added sugars	monosaccharides
disaccharides	other carbs	fat
saturated fat	monounsaturated fat	polyunsaturated fat
cholesterol	water	vitamin A
retinol RE	carotenoid RE	beta carotene
vitamin B1 (thiamin)	vitamin B2 (riboflavin)	vitamin B3 (niacin)
vitamin B6	vitamin B12	biotin
vitamin C	vitamin E (a-toco)	folate
pantothenic acid	vitamin K	calcium
chromium	copper	fluoride
iodine	iron	magnesium
manganese	molybdenum	phosphorus
selenium	sodium	zinc
omega 3 fatty acids	omega 6 fatty acids	caffeine
alcohol	choline	

Table 2. Foods Excluded Due to Unavailability of Data

Foods		
canavalia	Silver or common carp	Cutlassfish
Chinese white shrimp	Yellow wine	Rive snail
Bellamya quadrata	Chinese pond mussels	Freshwater crabs
Zizania latifolia	Amaranth tricolor	Long yellow daylily
Tree fungus	Snow fungus	Ice fish
Black carp	Pond loach	Highland barley

Data Analysis

There were 0 values and missing values in the spreadsheet of nutrients. ESHA marks the nutrients which are not tested in certain foods as missing values. A 0 means that the nutrient is tested but the foods contain a minute amount of the nutrient or it cannot be detected. 0 was rewritten as 0.01 or 0.001 based on the lowest value of each variable. If the lowest value of the variable was 0.01, then 0 was written as 0.001. Otherwise 0 was written as 0.01. Total soluble fiber, soluble fiber (2016), added sugar, monosaccharides, disaccharides, cholesterol, biotin, chromium, fluoride, iodine, molybdenum, alcohol, and caffeine were dropped because of small sample size.

Data transformation: Distribution of each variable was analyzed using SPSS 24. None of these variables were normally distributed, so the data was transformed using several formulas to create a normal distribution (for histogram graphs see Appendix B). Data transformation was dependent on the shape of each histogram graph. Severity and directionality were considered to determine the mathematic procedure used for data transformation (Mertler & Vannatte, 2016). Table 3 shows the mathematic formulas for data with various distribution features.

Table 3. Formulas Used for Data Transformation to Make Normal Distribution (Mertler & Vannatte, 2016)

Original Shape	***Transformation***	***SPSS Compute Language***
Moderate positive skew	Square root	NEWX = SQRT (*X*)
Substantial positive skew	Logarithm	NEWX = LG10 (*X*)
With value < 0	Logarithm	NEWX = LG10 (*X*+*C*) [a]
Severe positive skew	Inverse	NEWX = 1/*X*
With value < 0	Inverse	NEWX = 1/ (*X*+*C*) [a]
Moderate negative skew	Reflect & square root	NEWX = SQRT (K - *X*) [b]
Substantial negative skew	Reflect & logarithm	NEWX=LG10 (K - *X*) [b]
Severe negative skew	Reflect & inverse	NEWX = 1/ (K - *X*) [b]

C= a constant added to each score in order to bring the minimum value to at least 1
K= a constant from which each score is subtracted so that the minimum score equals 1

Logarithm was used for most variables (see Appendix F). Some variables including calories from saturated fat, saturated fat, monounsaturated fat, polyunsaturated fat, vitamin K, iron, sodium, zinc, omega 3 fatty acids, and omega 6 fatty acids were transformed with two steps (see Table 4 for the formulas used for each variable).

Table 4. Transformation Mathematic Procedures for Some Variables

Variables	***Formula***
Calories from saturated fat	NEWX = SQRT [LG10(*X*)+2]
Saturated fat	NEWX = SQRT [LG10(*X*)+3]

Variables	***Formula***
Monounsaturated fat	NEWX = SQRT [LG10(*X*)+3]
Polyunsaturated fat	NEWX = SQRT [3-LG10(*X*)]
Vitamin K	NEWX = SQRT [LG10(*X*)+2]
Iron	NEWX = SQRT [2-Lg10(*X*)]
Sodium	NEWX = SQRT [LG10(*X*)+2]
Zinc	NEWX = SQRT [2.5-LG10(*X*)]
Omega 3 fatty acids	NEWX = SQRT [LG10(*X*)+3]
Omega 6 fatty acids	NEWX = SQRT [LG10(*X*)+3]

Statistical analysis: Statistical analysis included three steps: descriptive analysis, inferential analysis, and logistic regression. Descriptive analysis was done both on raw variables and transformed variables and included means, standard deviation, with the maximum and minimum. With transformed variables, one-way ANOVA was used to compare the mean of each nutrient among Yin, Yang, and Neutral group. Independent *t* tests were used to compare the mean of each nutrient between Yin and Yang groups. Neither a one-way ANOVA nor an independent *t* test were used for the raw data because normal distribution was the fundamental requirements for using those two statistical tests. Non-parametric tests, Kruskal-Wallis tests were used to compare Yin, Yang, and Neutral group and Mann-Whitney tests were used to compare Yin and Yang groups. Because logistic regression did not require variables to be normally distributed, binary logistic regression was used on raw variables to predict the Yin-Yang properties with each nutrient.

Chapter 4

Results and Discussion

Results

Results of Comparisons Among Three Groups: Among all the nutrients, significant differences between the Yin, Yang, and neutral groups were found for calories (p=.003), retinol RE (p=.036), and vitamin C (p=.045) (See Tables 5, 6, 7), which was consistent with the results of Kruskal-Wallis Test (see appendix C). Marginally significant differences among three groups were found for iron (p=.054), sodium (p=.072), beta carotene (p=.088), fat (p=.061), total sugars (p=.089), total dietary fiber (p=.079), and dietary fiber 2016 (p=.096) (see Table 5, 6, and 7). For the results of the Kruskal-Wallis Test, significant differences between the three groups were found for sodium (p=.011) and fat (p=.015) but no significant differences were found for fiber (total dietary fiber, p=.328; dietary fiber 2016, p= .218). Other significant variables found by Krustal-Wallis Tests included calories from fat (p=.015), calories from saturated fat (p= .005), protein (p=.010), saturated fat (p=.006), and calcium (p=.034) (see appendix C).

In raw data, the Yang group had the highest calories (M = 257.1 kcal) while Yin group had the lowest calories (M = 146.2 kcal). Neutral foods were found to have the highest amount of sugar (M = 10.9 grams). The sugar contained in the Yang category (M = 6.4 grams) was found to be more than the Yin category (M = 3.8 grams). Yang group had the largest amount of fat (M = 16.5 grams) and fat in Yin and neutral groups were of similar amount (M_{Yin} = 6.9 grams, M_{neutral} = 8.0 grams). The original mean of total dietary fiber in Yin and Yang groups were almost the same (M_{Yin} = 3.1g, M_{Yang} =3.1g) and neutral group had the highest amount of total dietary fiber among three groups (*M* = 3.5 grams). In regard to dietary fiber 2016, neutral group had the highest mean (*M*=3.9g) and Yang group had the lowest one (*M*=3.0g).

Results changed after variables were transformed (see Table 5). Yang foods had the significantly highest calories (*M* =2.2) while Yin foods had the significantly lowest calories (*M* = 1.8). A marginally significantly decreasing amount of sugar was found from Yin to Yang (M_{Yin} = -.09, $M_{neutral}$ = -.17, M_{Yang} = -.63). The transformed mean of fat in neutral group became the highest among three groups (*M* = -.02), that of Yang group was in the second place (*M* = -.09), and both of them were way higher than that of Yin group (*M* = -.39). A decreasing amount of total dietary fiber was also found from Yin to Yang (M_{Yin} = -.17, $M_{neutral}$ = -.54, M_{Yang} = -.70). The converted mean of dietary fiber 2016 in Yin foods was the highest (*M* = -.27) while that of Yang foods was the lowest (*M* = -.86).

Table 5. Characteristics of Macronutrients and Fiber Grouped in Three Properties

	Total	**Yin**	**Neutral**	**Yang**	**P_a**
Calories (kcal)	2.0_a 198.6_b (N=175)	1.8_a 146.2_b (n=61)	2.1_a 197.2_b (n=58)	2.2_a 257.1_b (n=56)	.003**
Calories from Fat (kcal)	92.2_b (N=175)	61.9_b (n=61)	71.6_b (n=58)	146.7_b (n=56)	.204
Calories from Saturated Fat (kcal)	27.3_b (N=159)	15.1_b (n=54)	14.5_b (n=54)	53.8_b (n=51)	.188
Protein (g)	7.7_b (N=175)	5.6_b (n=61)	9.9_b (n=58)	7.7_b (n=56)	.106
Carbohydrates (g)	19.2_b (N=175)	16.1_b (n=61)	22.8_b (n=58)	19.0_b (n=56)	.243
Total Dietary Fiber (g)	$-.46_a$ 3.3_b (N=166)	$-.17_a$ 3.1_b (n=57)	$-.54_a$ 3.7_b (n=56)	$-.70_a$ 3.1_b (n=53)	.079*

	Total	Yin	Neutral	Yang	P$_a$
Dietary Fiber 2016 (g)	-.62$_a$ 3.5$_b$ (N=136)	-.27$_a$ 3.5$_b$ (n=43)	-.72$_a$ 3.9$_b$ (n=46)	-.86$_a$ 3.0$_b$ (n=47)	.096*
Sugar (g)	-.30$_a$ 7.0$_b$ (N=150)	-.09$_a$ 3.8$_b$ (n=49)	-.17$_a$ 10.9$_b$ (n=50)	-.63$_a$ 6.4$_b$ (n=51)	.089*
Other Carbs (g)	5.7$_b$ (N=147)	5.0$_b$ (n=47)	7.0$_b$ (n=50)	5.2$_b$ (n=50)	.785
Fat (g)	-.11$_a$ 10.3$_b$ (N=175)	-.39$_a$ 6.9$_b$ (n=61)	-.02$_a$ 8.0$_b$ (n=58)	-.09$_a$ 16.5$_b$ (n=56)	.061*
Saturated Fat (g)	3.0$_b$ (N=159)	1.7$_b$ (n=54)	1.6$_b$ (n=54)	6.0$_b$ (n=49)	.247
Monounsaturated Fat (g)	3.9$_b$ (N=150)	3.0$_b$ (n=51)	2.9$_b$ (n=50)	6.0$_b$ (n=49)	.426
Polyunsaturated Fat (g)	2.8$_b$ (N=150)	1.8$_b$ (n=51)	1.9$_b$ (n=50)	4.9$_b$ (n=49)	.567
Omega 3 Fatty Acids (g)	.24$_b$ (N=149)	.10$_b$ (n=51)	.11$_b$ (n=50)	.51$_b$ (n=48)	.566
Omega 6 Fatty Acids (g)	2.2$_b$ (N=149)	1.7$_b$ (n=51)	1.8$_b$ (n=50)	3.1$_b$ (n=48)	.990

**p<.05; *.10>p=>.05, One-way ANOVA

$_a$transformed, $_b$non-transformed

After analysis (see table 6), neutral foods had the significantly highest amount of retinol (*M* = -.85) and Yang foods had a little more retinol than Yin foods (M_{Yang} = -1.1, M_{Yin} = -1.6). Yin group had the significantly highest amount of vitamin C (*M* = .24) and Yang group had the lowest (*M* = -.47). A marginally significant difference was found in beta carotene among three categories. Yin foods had more beta carotene than Yang foods (M_{Yang} = -.48, M_{Yin} = .32) and neutral foods had the lowest amount of beta carotene (*M* = -.58).

The initial mean of retinol in Yang group was the highest (*M* = 112.4 grams) and Yin group still had the lowest one (*M* = 6.8 grams). There were no large disparities in the amount of vitamin C among Yin, Yang and neutral categories (M_{Yin} = 16.0g, M_{neutral} =

17.0g, M_{Yang} = 17.1g). The amount of vitamin C in Yin group was slightly lower than that of Yang and neutral group. Neutral foods had the highest amount (M = 304.2 mcg) and Yang foods had slightly more beta carotene than Yin foods (M_{Yang} = 263.4 mcg, M_{Yin} = 261.4 mcg).

Table 6. Characteristics of Vitamins Grouped in Three Properties

	Total	**Yin**	**Neutral**	**Yang**	**P$_a$**
Vitamin A (IU)	1037.0$_b$ (N=128)	598.0$_b$ (n=41)	1492.5$_b$ (n=44)	989.5$_b$ (n=43)	.104
Carotene (mcg)	88.4$_b$ (N=127)	57.2$_b$ (n=41)	142.2$_b$ (n=44)	62.3$_b$ (n=42)	.922
Retinol (mcg)	-1.2$_a$ 43.3$_b$ (N=164)	-1.6$_a$ 6.8$_b$ (n=57)	-.85$_a$ 19.2$_b$ (n=57)	-1.1$_a$ 112.4$_b$ (n=50)	.036**
Beta Carotene (mcg)	-.23$_a$ 276.4$_b$ (N=122)	.32$_a$ 261.4$_b$ (n=44)	-.58$_a$ 304.2$_b$ (n=41)	-.48$_a$ 263.4$_b$ (n=37)	.088*
Vitamin B1 (mg)	.14$_b$ (N=138)	.10$_b$ (n=50)	.21$_b$ (n=44)	.11$_b$ (n=44)	.195
Vitamin B2 (mg)	.16$_b$ (N=141)	.11$_b$ (n=51)	.20$_b$ (n=45)	.16$_b$ (n=45)	.148
Vitamin B3 (mg)	2.0$_b$ (n=139)	1.3$_b$ (n=50)	2.3$_b$ (n=45)	2.6$_b$ (n=44)	.343
Vitamin B6 (mg)	.21$_b$ (N=133)	.16$_b$ (n=48)	.21$_b$ (n=43)	.27$_b$ (n=42)	.885
Vitamin B12 (mg)	1.1$_b$ (N=137)	1.4$_b$ (n=47)	.92$_b$ (n=46)	.85$_b$ (n=44)	.569
Vitamin C (mg)	-.11$_a$ 16.7$_b$ (N=164)	.24$_a$ 16.0$_b$ (n=57)	-.15$_a$ 17.0$_b$ (n=55)	-.47$_a$ 17.1$_b$ (n=52)	.045**
Vitamin E (mg)	1.45$_b$ (N=104)	.44$_b$ (n=35)	1.3$_b$ (n=33)	2.6$_b$ (n=36)	.328
Folate Total (mcg)	52.8$_b$ (N=130)	43.7$_b$ (n=46)	65.9$_b$ (n=43)	49.4$_b$ (n=41)	.641
Folate DFE (mcg)	49.1$_b$ (N=126)	40.7$_b$ (n=44)	66.8$_b$ (n=42)	40.0$_b$ (n=40)	.627
Vitamin K (mcg)	23.1$_b$ (N=106)	20.6$_b$ (n=36)	23.3$_b$ (n=36)	25.4$_b$ (n=34)	.623
Pantothenic Acid (mg)	.66$_b$ (N=86)	.50$_b$ (n=28)	.68$_b$ (n=28)	.78$_b$ (n=30)	.700

**p<.05; *.10>p=>.05, One-way ANOVA

[a]transformed, [b]non-ransformed

Regarding minerals, no statistically significant differences were found among three groups in one-way ANOVA tests, but there were marginally significant differences in iron and sodium among three groups. The transformed mean of iron in neutral foods was the lowest (*M*=.28) and that of Yang foods (*M*=.36) was slightly higher than Yin foods (*M*=.34), which was consistent with the relationships among the original means of iron in Yin, Yang and neutral groups because the order was flipped by manipulation. The mean of sodium in neutral group was the highest both in raw and converted data and that of Yang group was higher than that of Yin group (raw, M_{Yin} = 52.8mg, M_{neutral} = 207.8mg, M_{Yang} = 117.0mg; converted, M_{Yin} = 1.4, M_{neutral} = 1.7, M_{Yang} = 1.5) (see Table 7).

Table 7. Characteristics of Minerals and Choline Grouped in Three Properties

	Total	Yin	Neutral	Yang	P[a]
Calcium (mg)	65.0[b] (N=171)	37.9[b] (n=59)	81.8[b] (n=57)	76.5[b] (n=55)	.101
Copper (mg)	.247[b] (N=133)	.250[b] (n=48)	.254[b] (n=43)	.236[b] (n=42)	.506
Iron (mg)	.33[a] 1.8[b] (N=171)	.34[a] 1.7[b] (n=59)	.28[a] 2.4[b] (n=57)	.36[a] 1.4[b] (n=55)	.054*
Magnesium (mg)	41.2[b] (N=134)	32.9[b] (n=50)	52.5[b] (n=43)	39.6[b] (n=41)	.744
Phosphorus (mg)	132.5[b] (N=139)	92.0[b] (n=50)	184.4[b] (n=44)	126.9[b] (n=45)	.530
Potassium (mg)	280.1[b] (N=143)	251.7[b] (n=52)	326.7[b] (n=47)	263.8[b] (n=44)	.982
Sodium (mg)	1.5[a] 125.7[b] (n=168)	1.4[a] 52.8[b] (n=58)	1.7[a] 207.8[b] (n=57)	1.5[a] 117.0[b] (n=53)	.072*
Zinc (mg)	1.3[b] (N=133)	1.6[b] (n=48)	1.2[b] (n=43)	1.0[b] (n=42)	.386
Choline (mg)	38.0[b] (N=97)	28.4[b] (n=32)	44.3[b] (n=32)	41.2[b] (n=32)	.962

**p<.05; *.10>p=>.05, One-way ANOVA

[a]transformed, [b]non-ransformed

There were missing values of independent variable in each group. The percentage of foods without missing values in each group is shown in Appendix D. There were no large disparities in the independent variables among the three groups.

Results of Comparisons between Yin and Yang Group: With independent *t*-test, significant differences between Yin and Yang groups were found in the mean values for categories identified in Table 8 (complete form containing all independent variables see Appendix E). This result was consistent with the result of the Mann-Whitney *U* Test.

Yang group contained significantly higher number of calories, calories from saturated fat, fat, saturated fat, and monounsaturated fat than Yin group before and after converting raw data based on the results of the independent *t*-test (see Table 8). When including fibers which were in the list dietary fiber 2016 in analysis, Yin foods had significantly more fiber than Yang foods both before and after manipulation. However, when total dietary fiber was included in analysis, there were of similar amount fiber in Yin foods and Yang foods in raw data, but the transformed mean of Yin group was significantly higher than that of Yang group. Yin foods had significantly higher transformed mean of total sugars than Yang foods, but the original mean of total sugars in Yin group is lower than that in Yang group. Among all the vitamins, there were striking differences between the amount of vitamin C contained in Yang and Yin foods. The converted mean of Yin group was significantly lower than that of Yang group while the relationship was flipped in raw data.

Several marginal differences were found between Yin and Yang groups. Yang food had marginally significantly higher number of calories from fat than Yin group before and after data conversions (before, M_{Yang}=146.7 kcal, M_{Yin}=61.9 kcal; after, M_{Yang} = .90, M_{Yin}=.44). The transformed mean of carbohydrates in Yin group (M=.58) was marginally higher, though only slightly, than that of Yang group (M=.17), while in regard to original mean, Yang group had higher one (*M*=19.0g) than Yin group (*M*=16.1g). With manipulation, the amount of beta carotene contained in Yin groups (*M*=.32) was found higher than that in Yang groups (*M*=-.48) while the relationship was flipped in raw data (M_{Yang}=263.4 mcg, M_{Yin}=261.4 mcg).

Table 8. Characteristics of Nutrients Grouped in Yin and Yang

	Total	**Yin**	**Yang**	**P_b**
Calories (kcal)	199.3_a (N=117)	1.8_b 146.2_a (n=61)	2.2_b 257.1_a (n=56)	.001**
Calories from Fat (kcal)	102.5_a (N=117)	$.44_b$ 61.9_a (n=61)	$.90_b$ 146.7_a (n=56)	.084*
Calories from Saturated Fat (kcal)	33.9_a (N=105)	$-.33_b$ 15.1_a (n=54)	$.38_b$ 53.8_a (n=51)	.008**
Carbohydrates (g)	17.5_a (N=117)	$.58_b$ 16.1_a (n=61)	$.17_b$ 19.0_a (n=56)	.096*
Total Dietary Fiber (g)	3.2_a (N=110)	$-.17_b$ 3.1_a (n=57)	$-.70_b$ 3.1_a (n=53)	.026**
Dietary Fiber 2016 (g)	3.3_a (N=90)	$-.27_b$ 3.5_a (n=43)	$-.86_b$ 3.0_a (n=47)	.032**
Total Sugars (g)	5.1_a (N=100)	$-.09_b$ 3.8_a (n=49)	$-.63_b$ 6.4_a (n=51)	.037**
Fat (g)	11.5_a (N=117)	$-.39_b$ 6.9_a	$.09_b$ 16.5_a	.028**

	Total	**Yin**	**Yang**	**P$_b$**
		(n=61)	(n=56)	
Saturated Fat (g)	3.8$_a$	-1.3$_b$	-.62$_b$	.013**
	(N=105)	1.7$_a$	6.0$_a$	
		(n=54)	(n=49)	
Monounsaturated	4.5$_a$	-1.4$_b$	-.77$_b$	.037**
Fat (g)	(N=100)	3.0$_a$	6.0$_a$	
		(n=51)	(n=49)	
Beta Carotene	262.3$_a$	.32$_b$	-.48$_b$	.087*
(mcg)	(N=81)	261.4$_a$	263.4$_a$	
		(n=44)	(n=37)	
Vitamin C	16.5$_a$	.24$_b$	-.47$_b$	.017**
	(N=109)	16.0$_a$	17.1$_a$	
		(n=57)	(n=52)	

**p<.05; *.10>p=>.05, Independent *t* test

$_a$non-transformed, $_b$transformed

Results of Binary Logistic Regression As the number of calories increased by one unit, Yang components in foods increased by 2% as shown in the binary logistic regression (OR=1.020, 95% CI: 1.004~1.036) (see table 9). While as the amount of calories from fat, carbohydrate, and monounsaturated fat rose, the Yang components in foods decreased by 1.4%, 7.6%, and 8.7% respectively (calories from fat OR=.986, 95% CI: .970~1.003; carbohydrate OR=.924, 95% CI: .861~.991; monounsaturated fat OR=.913, 95% CI: .809~1.030). Calories from saturated fat was found to positively predict Yang property (Calories in saturated fat OR=868578161.0, 95% CI: .214~3.525E+1).

Table 9. Results of Binary Logistic Regression in Raw Data

	P	**OR (95% CI)**	**Adjusted P-Value**	**Adjusted OR (95% CI)**
Calories	.020**	1.023 (1.004~1.042)	.013**	1.020(1.004~1.036)
Calories from Fat	.680	.965 (.814~1.144)	.109	.986(.970~1.003)

	P	OR (95% CI)	Adjusted P-Value	Adjusted OR (95% CI)
Calories from Saturated Fat	.139	58255088.76(.003~ 1.152E+18)	.068*	868578161.0 (.214~3.525E+18)
Carbohydrate	.094*	.885 (.767~1.021)	.027**	.924(.861~.991)
Total Dietary Fiber	.425	1.147 (.819~1.606)		
Sugar	.599	.946(.770~1.162)		
Total Fat	.822	1.179(.281~4.948)		
Total Saturated Fat	.139	.000(.000~6.054E+ 22)	.068*	.000(.000~1069913. 115)
Monounsaturated Fat	.240	.926(.815~1.053)	.139	.913(.809~1.030)
Beta Carotene	.720	1.000(.999~1.001)		
Vitamin C	.333	1.011(.989~1.033)		

**p<.05; *.10>p=>.05
Reference: Yin

Discussion

Compared to previous studies, this project found few significant relationships between nutrients and Yin-Yang property, possibly because previous studies considered a<0.10 as significant (Zhang & Zhao, 2008), whereas *p*<.05 was used in this project. Fat, saturated fat, and monosaturated fat were reported as significant determinants for Yin-Yang properties, in contrast with what Zhang and Zhao (2008) found. Several studies found significant relationships between Yin-Yang properties and carbohydrate or protein (Zhang & Zhao, 2008; Yue, Cao, &Yao, 2010; Cao et al., 2011; Feng et al., 2010), which was not seen in this project. Only one significant vitamin was found – vitamin C. The result from the raw data was consistent with previous findings (Zhang & Zhao, 2008). In regard to minerals, magnesium, copper, zinc, phosphorus, and iron were found to be related to Yin-Yang property by researchers (Ni et al., 2005; Zhao, 2018). However, this project only found marginal significance in iron and sodium. Yang foods contained more sodium and iron than Yin foods, which was consistent with existing studies (Ni et al., 2005) (see Figure 1, 2, and 3).

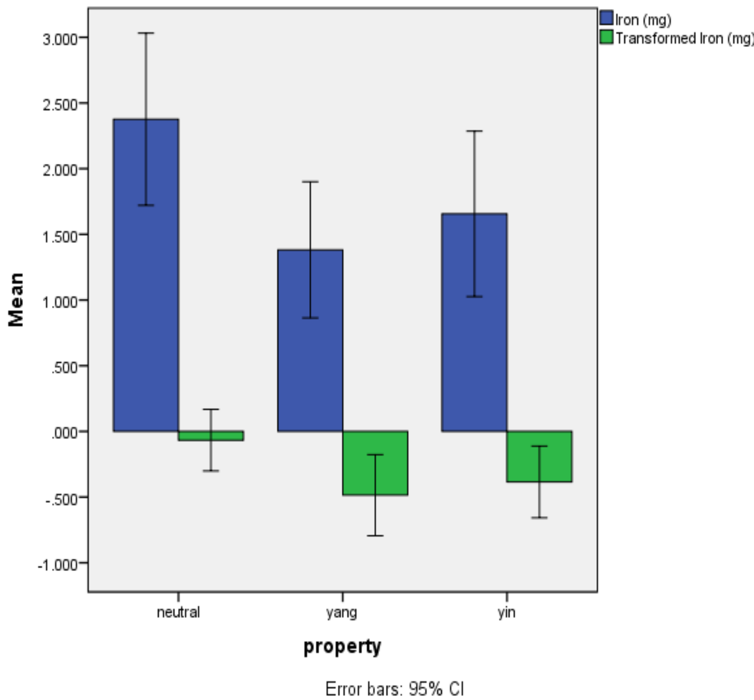


Figure 1. Mean of Iron Contained in Three groups

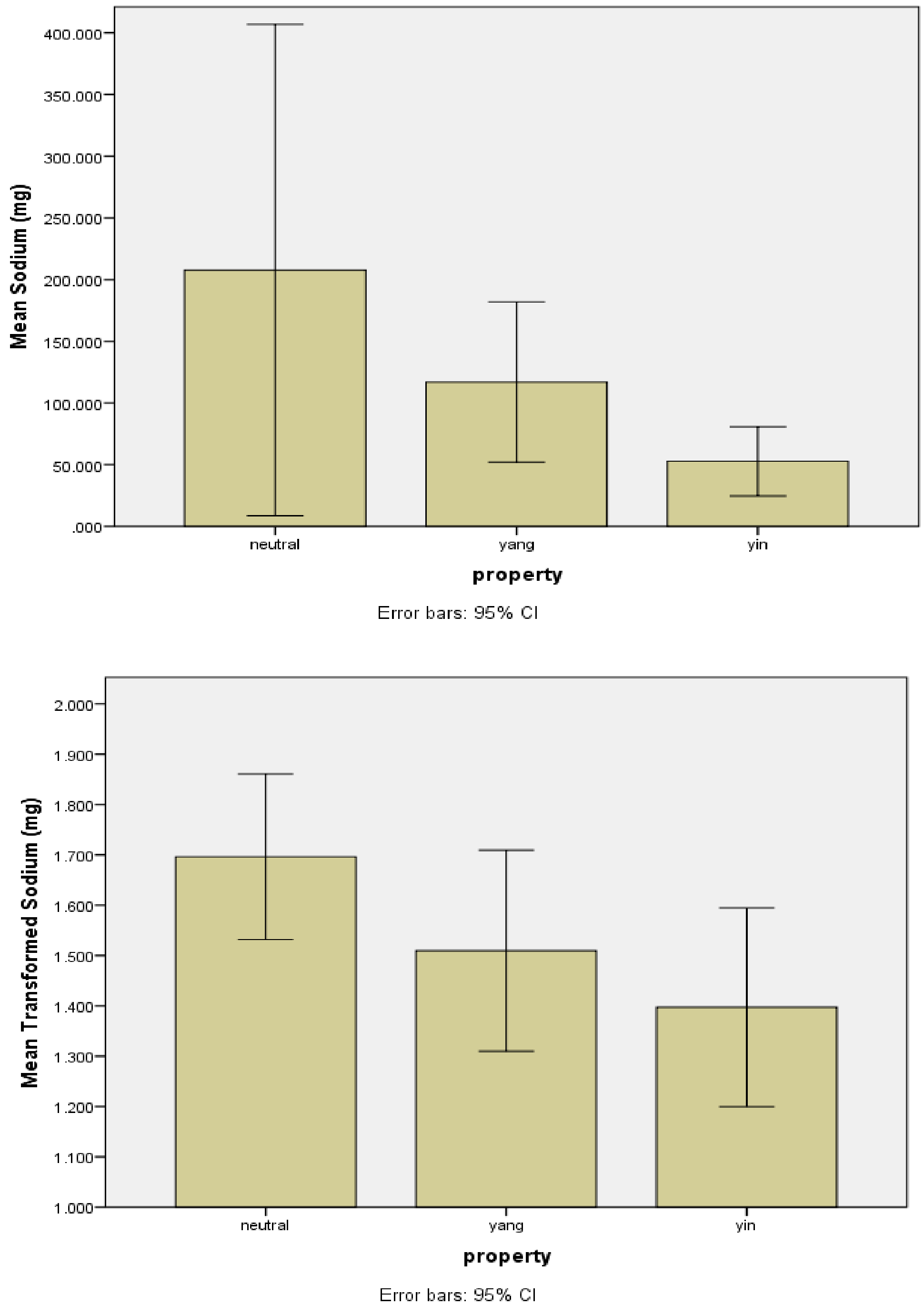


Figure 2. Mean of Sodium in Three Groups (Raw and Transformed)

Yin-Yang properties affecting bacterial resilience in the human gut

Microbiota: In 2016, U.S. Food and Drugs Administration (FDA) defined dietary fiber as “non-digestible soluble and insoluble carbohydrates (with three or more monomeric units), and lignin that are intrinsic and intact in plants determined to have physiological effects that are beneficial to human health”. This is known as “dietary fiber 2016” (FDA, 2018). The physiological effects approved by FDA include lowering blood glucose and cholesterol levels, lowering blood pressure, improving laxation and bowel function, increasing mineral absorption in the intestinal tract, reducing energy intake due to an increased feeling of fullness, and other effects continually added by research findings. Before FDA’s 2016 ruling, Nutrition Facts/Supplement Facts labels were required to list total dietary fiber no matter whether they had benefits to health or not.

The prebiotic effect of fermentable fiber promotes the growth of bifidobackteria and lactobacilli to improve gut barrier function (Costabile et al., 2010; Ramnani, 2010). Instead of a prebiotic effect, some dietary fibers are beneficial to gut health by producing short chain fatty acids (SCFAs), such as acetate, propionate, and butyrate. Butyrate provides energy to colonic epithelial cells, improves cell differentiation, and proliferation. Sodium-water balance and absorption of minerals, such as calcium, are facilitated by SDFAs. SDFAs are part of acid/base balance, which is needed for growth of bifibacteria and lactobacilli, and potential pathogens cannot survive under that pH (Salvin, 2013).

People with constipation should increase intake of Yin components in their diet because of high dietary fiber content in Yin foods (see Figure 4 and 5). Constipation was considered a main symptom of “on heat (上火)”, which meant excessive heat, and should be treated with Yin foods or herbs, possibly due to fiber increasing stool weight for the ease of defecation (Slavin, 2013).

Benefits of Yin foods on cardiovascular diseases and diabetes: Fat was found to be a significant nutrient determining Yin-Yang properties. Yang food had higher total fat, saturated fat,

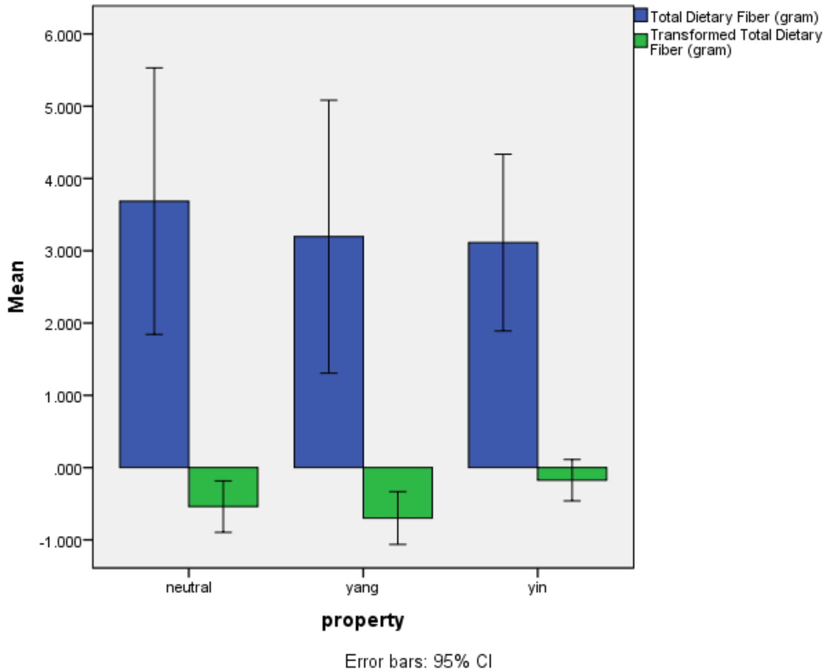


Figure 3. Means of Total Dietary Fiber in Three Groups

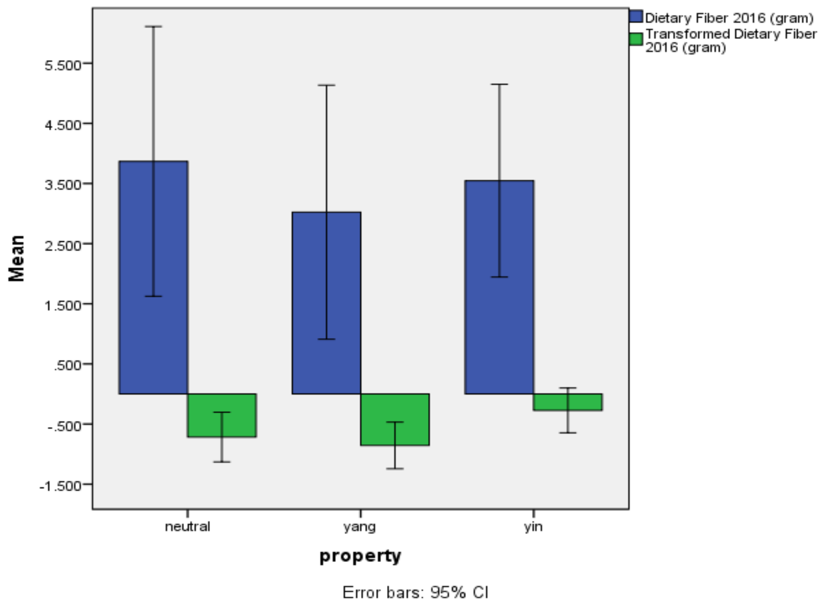
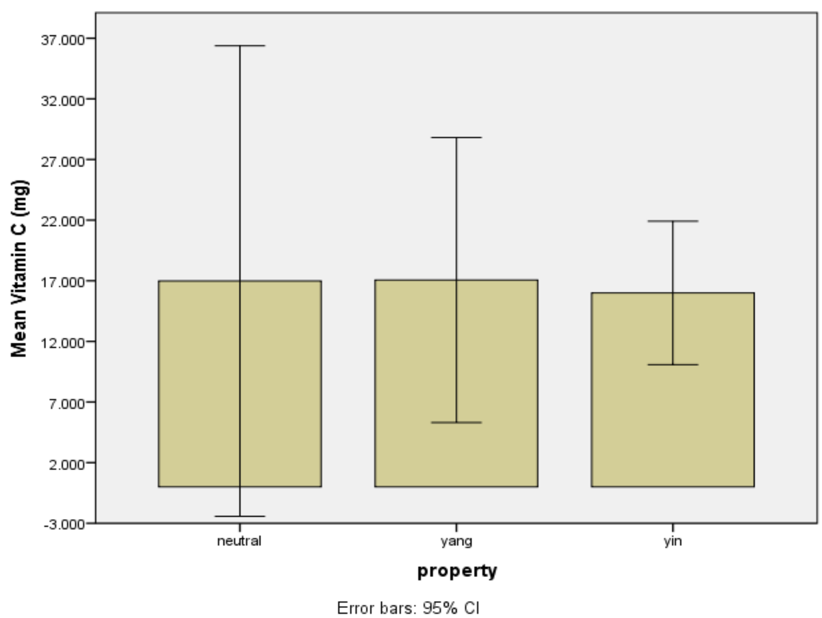


Figure 4. Means of Dietary Fiber 2016 in Three Groups

and monosaturated fat than Yin foods. Saturated fat has been found to trigger immune response causing systemic inflammation, which is thought to increase the risk of cardiovascular disease (CVD) and diabetes (Libby, Ridker, & Maseri, 2002; Albert et al., 2002; Pickup, 2004; Vasan et al., 2003). Saturated fat intake has been found to be positively associated with blood pressure (Stamler, 1996) and increased plasma LDL-C (Joint FAO/WHO Expert Consultation, 2008). People with intake of excessive Yang foods in their diets, which is higher in saturated fat, may have higher risk for CVD. Replacing saturated fat with polyunsaturated fat has been thought to reduce CVD risks and mortality (Mozaffarian, Micha, & Wallace, 2010; Jackbsen et al., 2009; Li et al., 2015; Schwab et al., 2014) while lowering intake of saturated fat decreased the risk of CVD, but not the mortality rate (Mensink, 2016). This may indicate that people with high risk of CVD would benefit from reduced intake of Yang foods or consuming more Yin foods in their diets. Another nutrient with Yin-Yang properties that may be associated with CVD risk was fiber. Consistent fiber intake reduces the risks of CVD by lowering LDL levels (Slavin, 2008). Among hypertensive patients, Yin diets, with low fat, low sodium, low cholesterol, and high fiber, may reduce and facilitate stabilization of blood pressure (Appel et al., 1997; Ard et al., 2004).

Saturated fat has been reported to be a risk factor for insulin resistance and diabetes mellitus (Eyre et al., 2004; Vessby et al., 2001; Perez-Jimenez et al., 2001). Regular consumption of fiber could decrease glucose absorption rate, facilitating glucose control among people with elevated blood glucose, as there seems to be a negative correlation between dietary fiber intake and Type II diabetes development in several cohort studies (Hopping et al., 2010; Meyer et al., 2000). Patients on insulin interventions may be helped by avoiding excessive Yang food intake and their diets could benefit from more Yin components than Yang.

Yin-Yang property and vitamin C: Vitamin C is a natural antioxidant and an essential nutrient in human body. The most common and serious disease caused by vitamin C deficiency is scurvy. Smokers (Schectman et al., 1991; Lykkesfeldt et al., 2000; Smith & Hodges, 1987; Kallner et al.,1981; Schectman et al., 1989) and diabetic patients (Chen et al., 2006; Kaviarasan et al., 2005; Tu et al., 2015) are reported to have less vitamin C in plasma than non-smokers possibly due to the increased need for antioxidants present in vitamin C. People who smoke may benefit from more Yin food with higher vitamin C content than Yang foods based on transformed data (see Figure 6). Previous findings support the idea that Yang foods have more vitamin C than Yin foods, which was consistent with the results on raw data (see Figure 7). However, considering high fat and low fiber in Yang food, people with diabetes might prefer to take vitamin C supplements rather than eat more Yang foods to raise their vitamin C intake. Vitamin C deficiency is associated with process of some acute illnesses, such as myocardial infarction (Hume et al., 1972; Riemersma et al., 2000), acute pancreatitis (Bonham et al., 1999; Scott et al., 1993), and sepsis (Fowler et al., 2014), which addressed the use of vitamin C in critical care (Berger & Oudemans-van Straaten, 2015). Patients with these diseases may benefit from Yin diets to keep adequate intake of vitamin C.



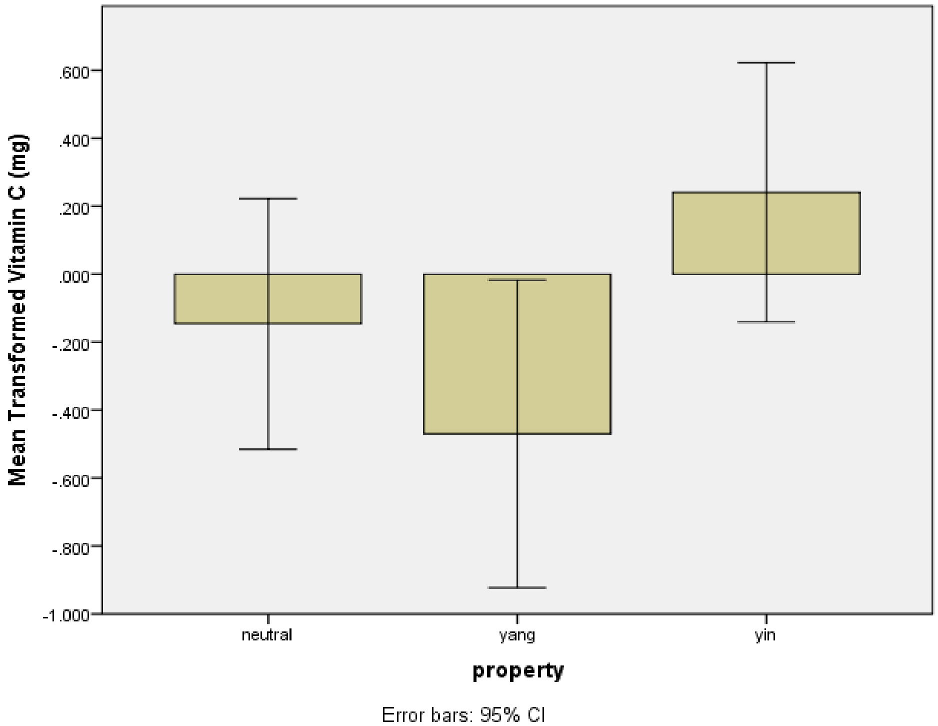


Figure 5. Means of Vitamin C in Three Groups (Raw and Transformed)

Yang and Yin food affecting sleep patterns: Sleep disturbance causes multiple adverse health outcomes including increased mortality risk, obesity, diabetes, elevations in inflammatory cytokine, hypertension, dementia, and poor mental health (Grandner, 2017). The results of this thesis showed that based on transformed means of each food group, Yang food had higher fat and lower carbohydrates than Yin food. A low-fat, high-carbohydrate (Yin) meal may decrease non-rapid eye movement (NREM) sleep, when the body repaired tissues, built bones and muscles, and strengthened the immune system. Also, a Yang meal may raise the rate of rapid eye movement (REM) compared to balanced diets or low-carbohydrate, high-fat (Yang) diets according to several pilot studies (Philips et al., 1975; Porter & Horne, 1981; Afaghi, O'Connor, & Chow, 2008). Effect of Yin-Yang foods on sleep patterns might be related to the metabolic reactions to dietary fat which causes the release of cholecystokinin (Wells, Read, Uvnas-Moberg, & Alster, 1997). Previous studies have not shown consistent results on the effect of fats on sleep duration. A Greek study found higher energy intake from fat extended sleep duration while other studies contradict these findings (Weiss et al., 2010; Al-Disi et al., 2010; Imaki, Hatanaka, Ogawa, Yoshida, & Tanada, 2002; Grandner, Kripke, Naidoo, & Langer, 2010; Shi, McEvoy, Luu, & Attia, 2008; Diethelm, Remer, Jilani, Kunz, & Buyken, 2011; Rontoyanni, Baic, & Cooper, 2007). Fat appears to have a clear biological connection to sleep due to the role of very long-chain fatty acids in the pineal gland and melatonin production (Catala, 2010). Combined with this, higher niacin (vitamin B3) in Yang food might increase proportions of REM by increasing the amount of tryptophan available for the synthesis of serotonin and melatonin (Robinson, Pegram, Hyde, Beaton, & Smythies, 1977).

Yin-Yang balanced diet improving quality of life: Shen, Pang, Kwong, & Cheng (2009) implemented Chinese Food Therapy (CFT) on hypertensive patients with Yin-efficiency found that overall health-related quality of life among hypertensive patients was improved by Yin-Yang balanced dietary intervention. This may have been due to reduced physical symptoms and eliminated irritability by nourishing Yin components in human body. This study provided evidence supporting Yin foods as having positive effect on mental health. Quality of life is often a minor dependent variable attached to improved physical conditions in most clinical trials on diets and nutrients (Winkvist, Bärebring, Gjertsson, Ellegård, & Lindqvist, 2018). A causality relationship between nutrients and quality of life could not be determined. This relationship is complicated by the confounding factor improved symptoms. Interestingly, Ling et al. (2003) and Cheung et al., (2005) compared Traditional Chinese Medicine (TCM) interventions to pure western pharmacological treatments on hypertensive patients, both of which found that TCM and pharmacological treatments had the same effect on controlling blood pressure but the TCM group had significantly higher quality of life than the control group. These findings further addressed the significance of TCM dietary therapy as an alternative medicine to improve overall health rather than treat one disease. This leads to skepticism regarding the statement that pharmacological therapy is always the principal choice in clinical practice.

Limitations: This project had several limitations. First, nutrient compositions of foods were affected by multiple factors, including cooking methods, production locations, time, level of ripeness, and etc. Foods included in the nutrient analysis were raw but some foods on the list were not eaten in raw form by humans. Second, the nutrients, as independent variables, might have subcategories and these subcategories might have different metabolic effects in the human body. For example, concerning the effect of carbohydrates on sleep, different sugar chains might affect it in varying ways (Peuhkuri, Sihvola, & Korpela, 2012). This project stopped at protein level and did not analyze amino acids.

Chapter 5

Conclusions and Recommendations

Having a healthy diet by restoring Yin-Yang balance is a cost-effective method to maintain overall health with positive effect on CVD, diabetes, gut microbiota, smoking therapy, sleep patterns, and some acute illnesses due to the determinant nutrients including fat, fiber, sodium, and vitamin C. While dietary fiber and sodium were not significant in this study. At a $p<.10$, fiber and sodium would have been significant. A Yin-Yang paradigm not only provides an alternative medicine intervention for patients by reducing economic burden, as well as improving symptoms and quality of life, but also is beneficial to healthy people by preventing disease. Yin-Yang balanced dietary therapy has a comprehensive effect on health and should be a significant component of health education.

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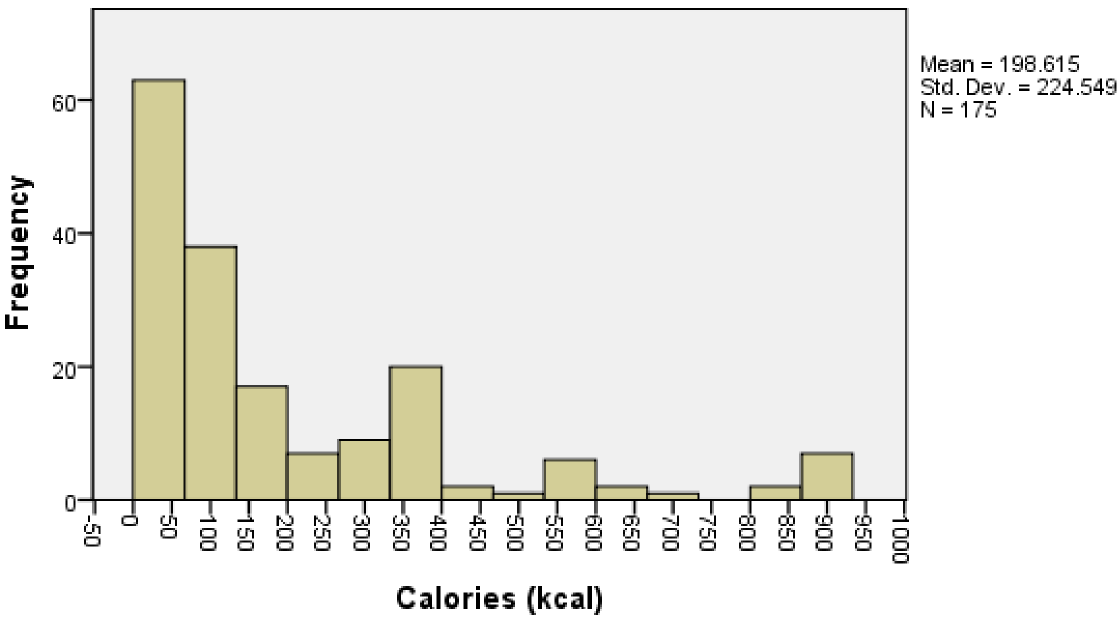
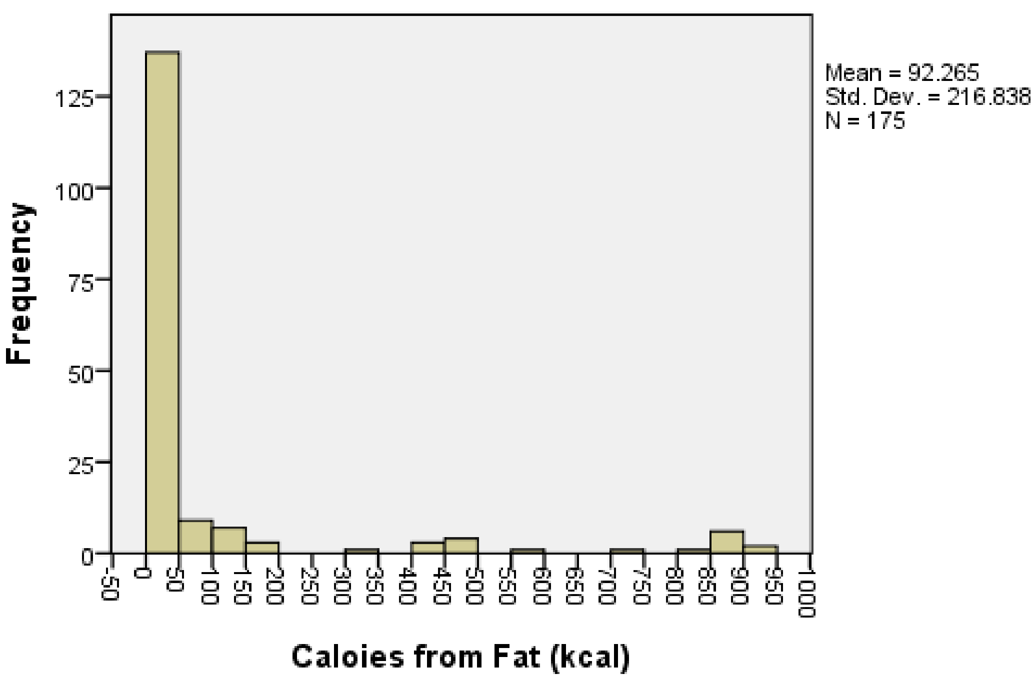
Appendix A. Yin, Yang and Neutral Food List

Property	***Yin***	***Yang***	***Neutral***
Food list	Monk fruit	Chili pepper	Soybeans
	Nori	Black pepper	Bread
	Wheat	Star anise	Pigeon
	Barley	Fennel seeds	Raisin
	Long yellow daylily	Sichuan pepper	Brown rice
	Buckwheat	Walnut (dried)	Black turtle bean
	Mung bean	Cherries	Sweet potato
	Proso millet	Hyacinth bean	Chinese yam
	Mulberries	Chinese date (dried)	Carrot
	Pears	Sorghum	Peach
	Millet	Garlic chives	Armenian plum
	Bitter melon	Ginger	Pineapple
	Celery	Welsh onion	Ricebean
	Persimmon	Chinese mustard	Garland chrysanthemum
	Eggplant	Coriander	Peanuts
	Lemon	Chestnut (dried)	Sunflower seed
	Lotus root	Garlic cloves	Chinese bayberry
	Celery stalk	Purple yam	Pomegranate
	Apple	Onion	Pea pods
	Banana	Hawthorne	Olive
	Daikon	Indica rice	Common fig
	Chinese cabbage	Oyster mushrooms	Lotus nut
	Plum	Green pepper	Corn
	Gourd	Chinese date (fresh)	Rice
	Kiwi fruit	Canavalia	Potato
	Amaranth tricolor	Glutinous rice	Grape
	Mushrooms	Pumpkin	Abalone
	Zizania latifolia	Lychee	Cuttlefish
	Bamboo shoot	Ginkgo nuts	Highland barley
	Spinach	Lamb	Broad bean
	Lily	Dog meat	Soy sauce
	Water chestnut	Chicken thigh	Octopus
	Pearl barley	Goose egg	White sugar
	Horse meat	Carp	Honey
	Rabbit meat	Eel	Peanut oil
	Duck meat	Silver carp	Vinegar
	Duck egg	Scabbardfish	Sea salt
	Freshwater crab	Chinese white shrimp	Milk
	Crab	Shrimp	Breast milk
	Chinese pond mussel	Lobster	Yogurt
	Whelk	Sea cucumber	Cream

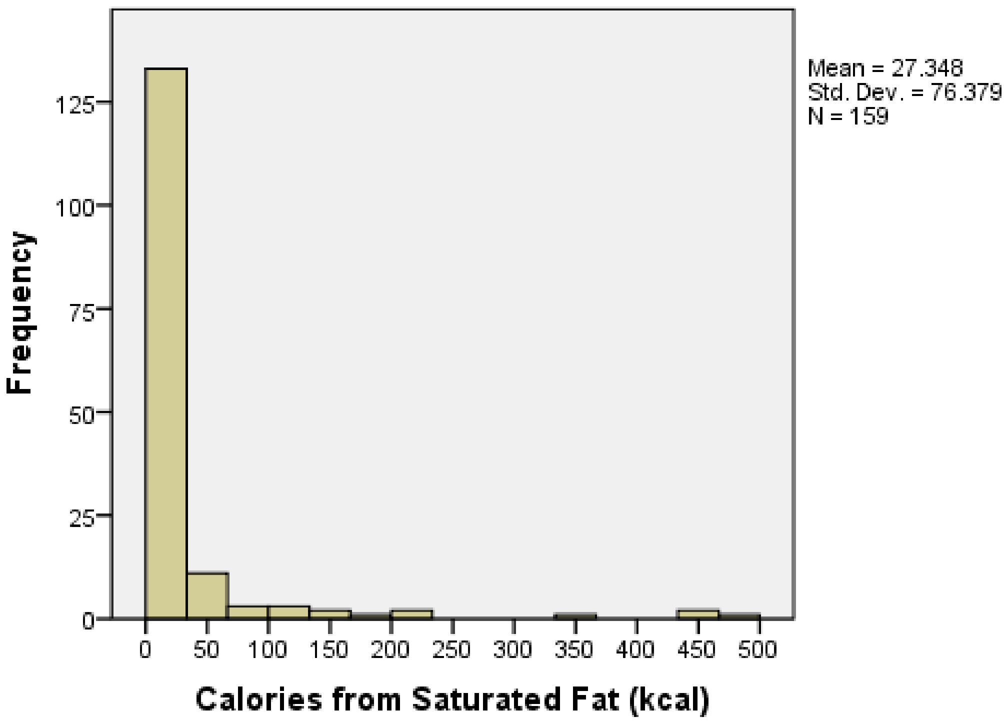
Property	*Yin*	*Yang*	*Neutral*
	Bellamya quadrata	Beer	Chicken egg
	River snail	Wine	Common carp
	Lard	Yellow wine	Pond loach
	Tea seed oil	Rice wine	Black carp
	Sesame oil	Brown sugar	Chinese perch
	Wax gourd	Tallow	Ice fish or noodle fish
	Luffa	Suet	Butterfish
	Orange	Canola oil	Snow fungus
	Sugar cane juice	Soybean oil	Tree fungus
	Celtuce	Cottonseed oil	Bass
	Tomato	Butter	Goji berries
	Cucumber	Cheese	Pumpkin seeks
	Mandarin orange	Chicken liver	Cowpeas
	Shaddock	Chocolate	Pork
	Watermelon	Coffee	Goose meat
	Almond	Smoked fish	Common quail
	Asparagus	Ham	Quail egg
	Bean sprouts	Leeks	Rock candy
	Bean curd	Peanut butter	
	Broccoli	Roasted peanut	
	Clams	Turkey	
	Corn flour	Whiskey	
	Grapefruits		
	Mussels		
	Oysters		
	Peppermint tea		
	Strawberries		

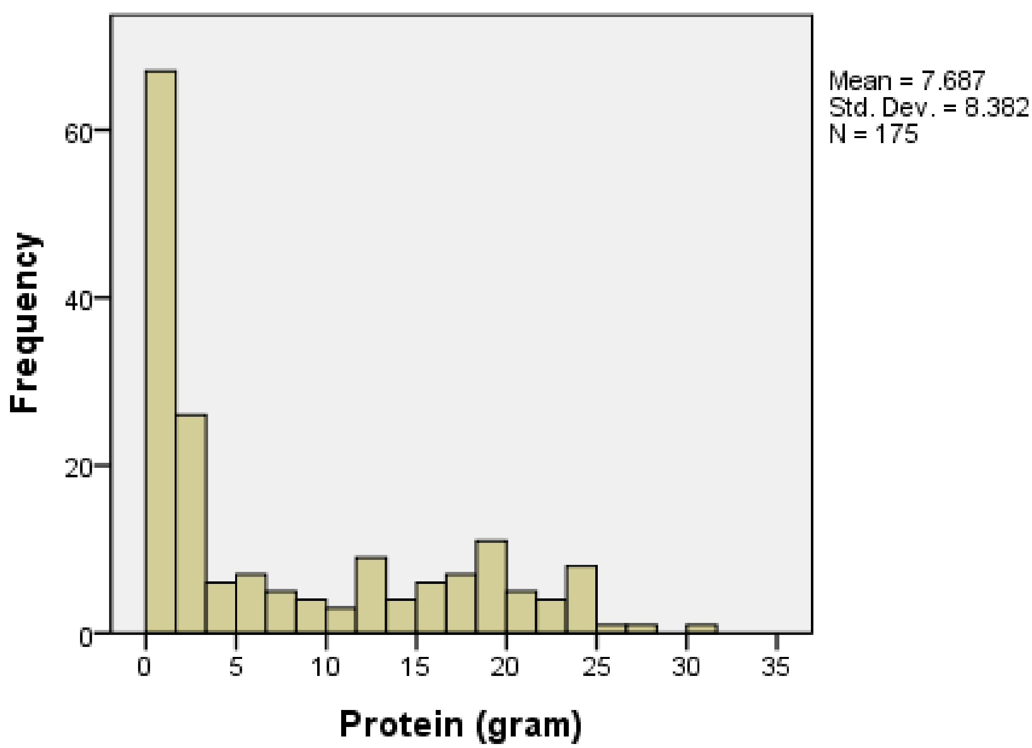
Appendix B. Histogram Graphs of Data before Transformation



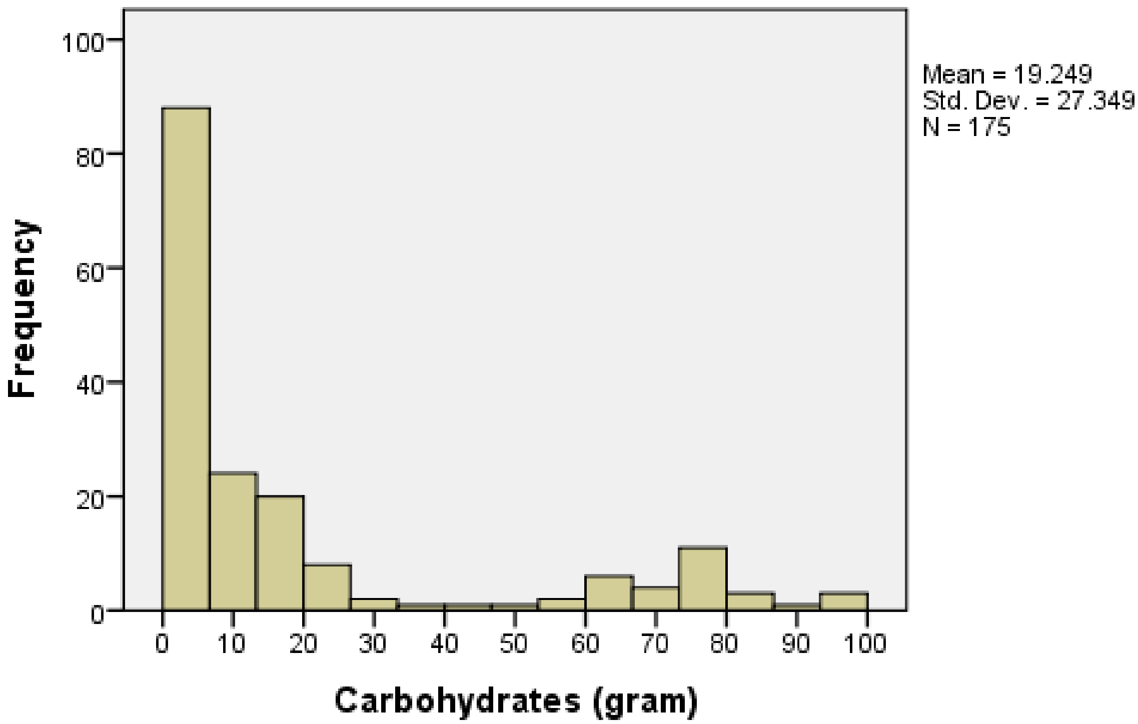


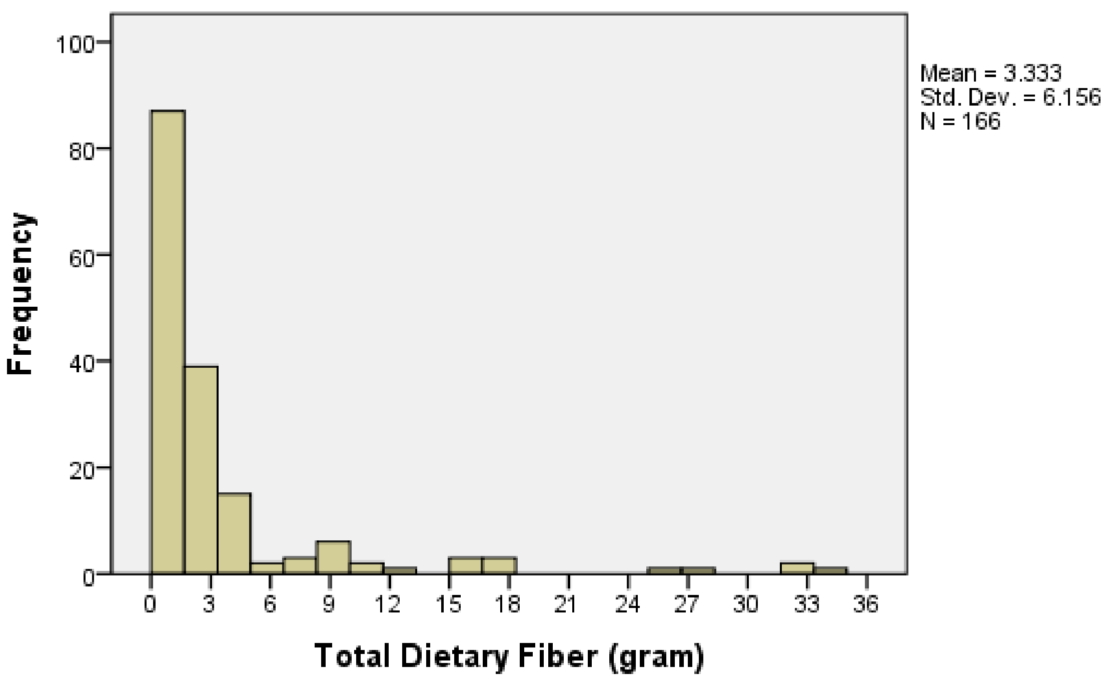
Appendix B (Continued)



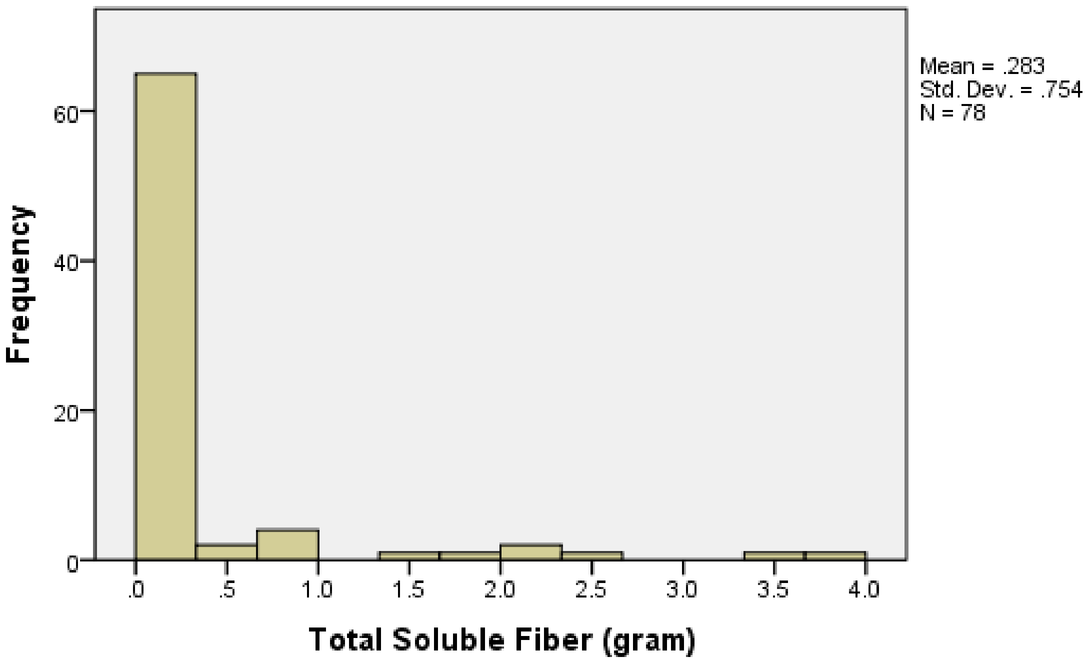


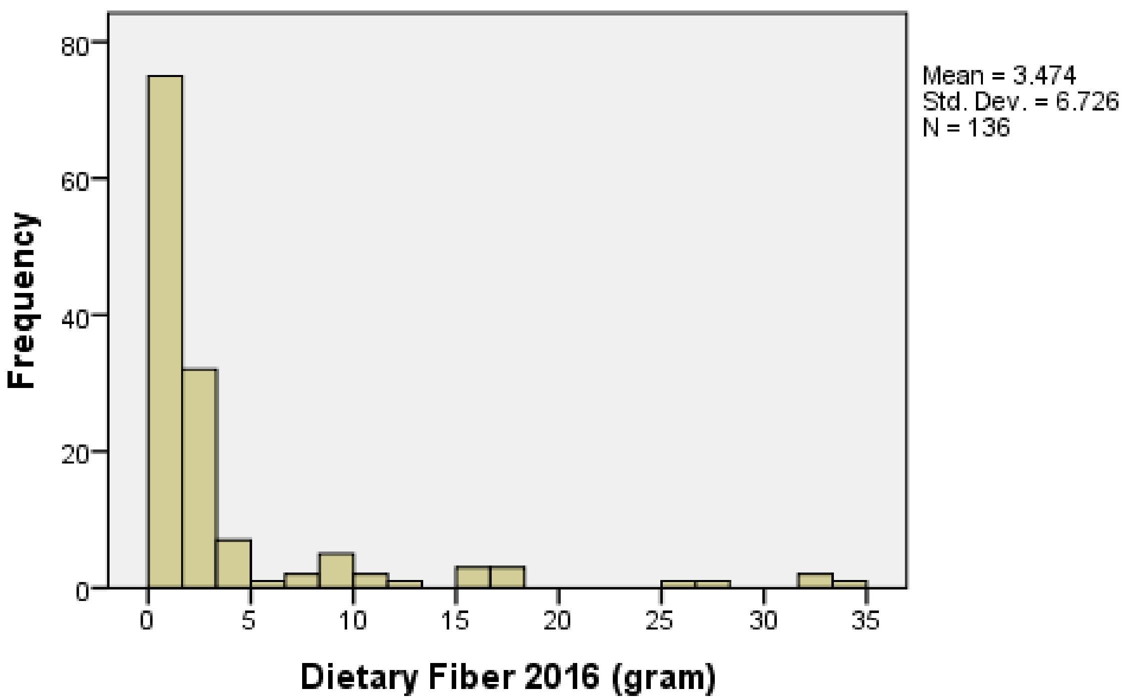
Appendix B (Continued)



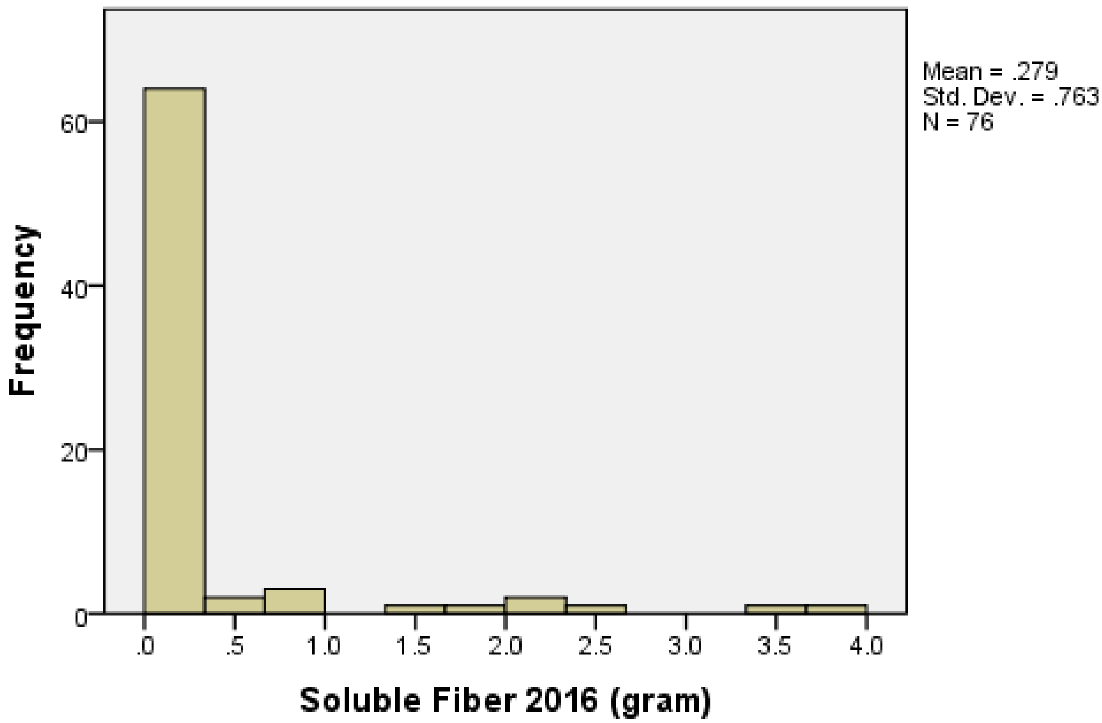


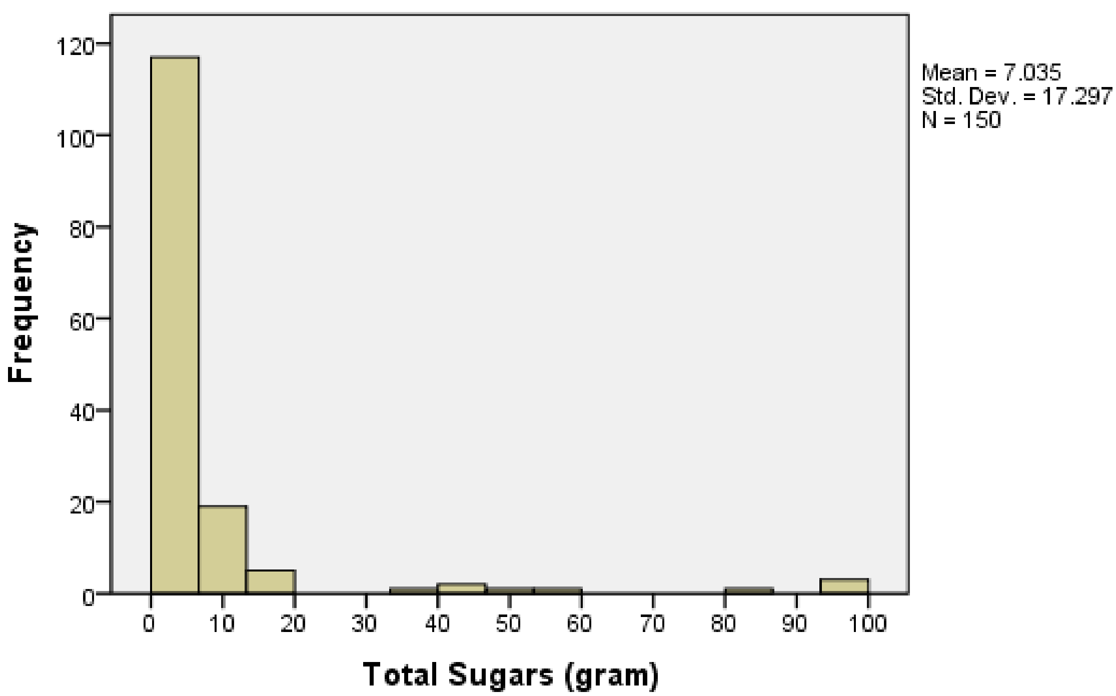
Appendix B (Continued)



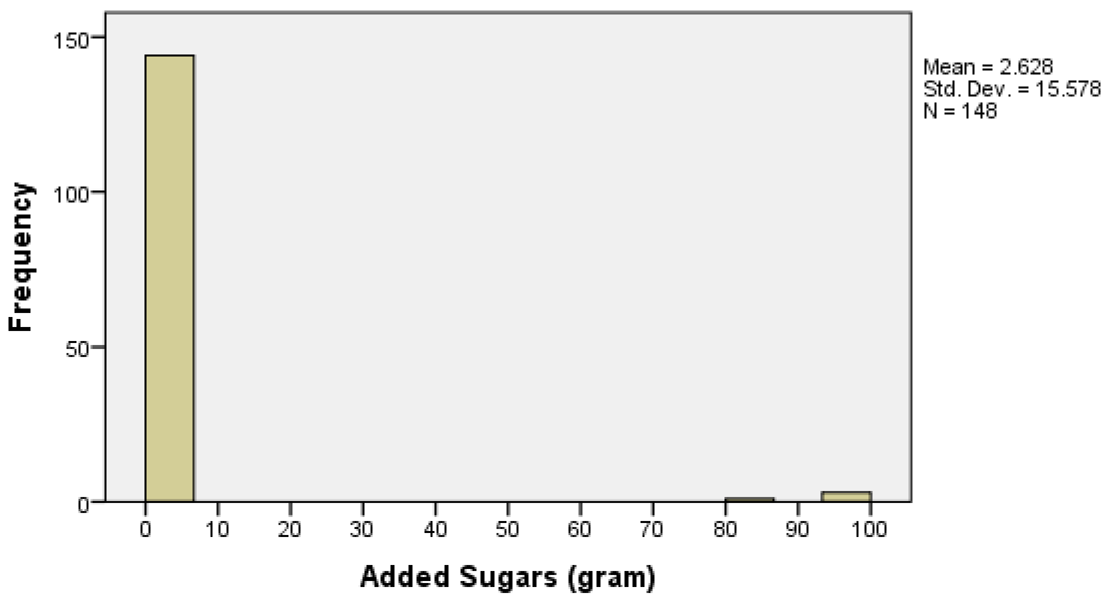


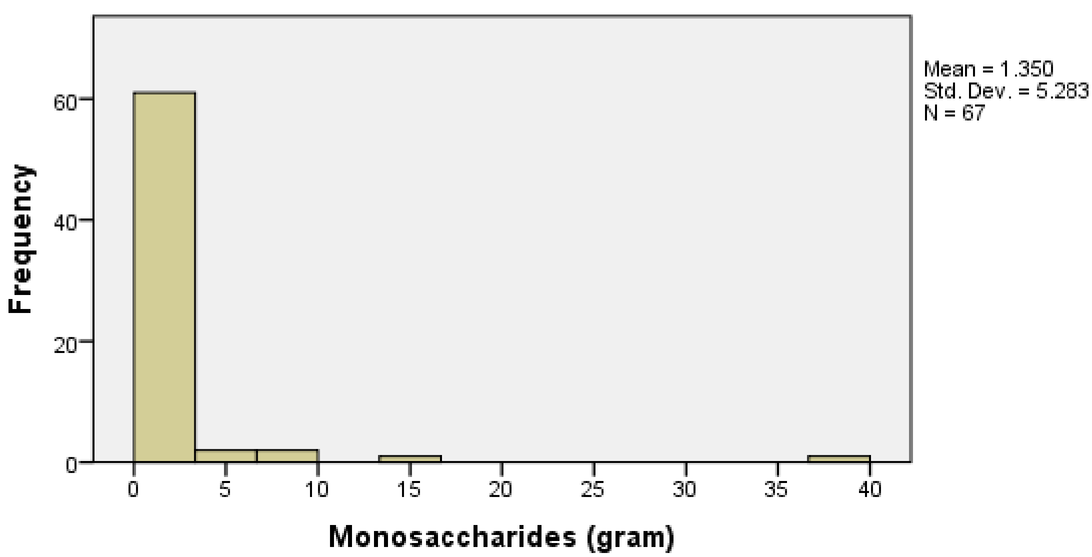
Appendix B (Continued)

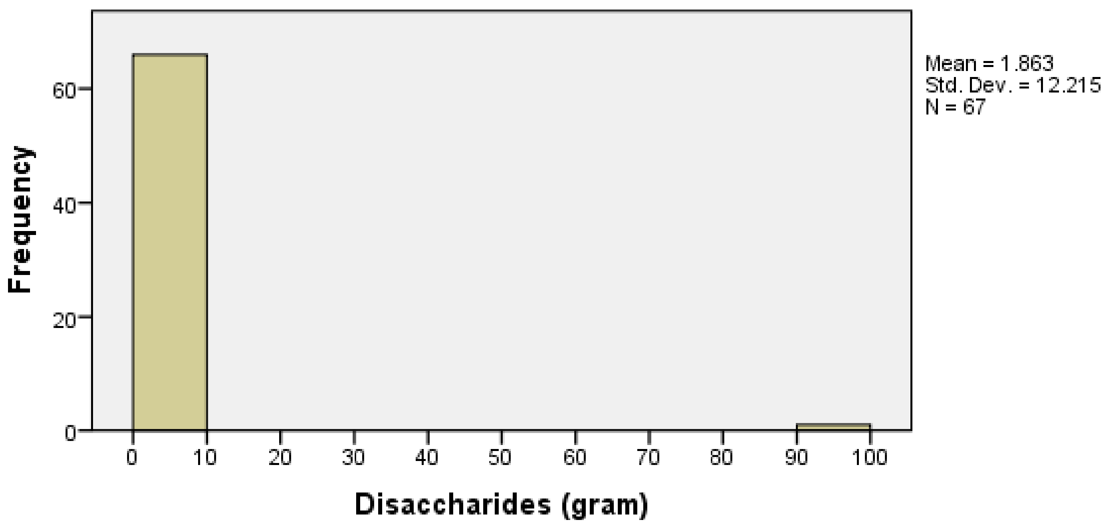




Appendix B (Continued)



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Std. Dev. = 12.215
N = 67
Frequency
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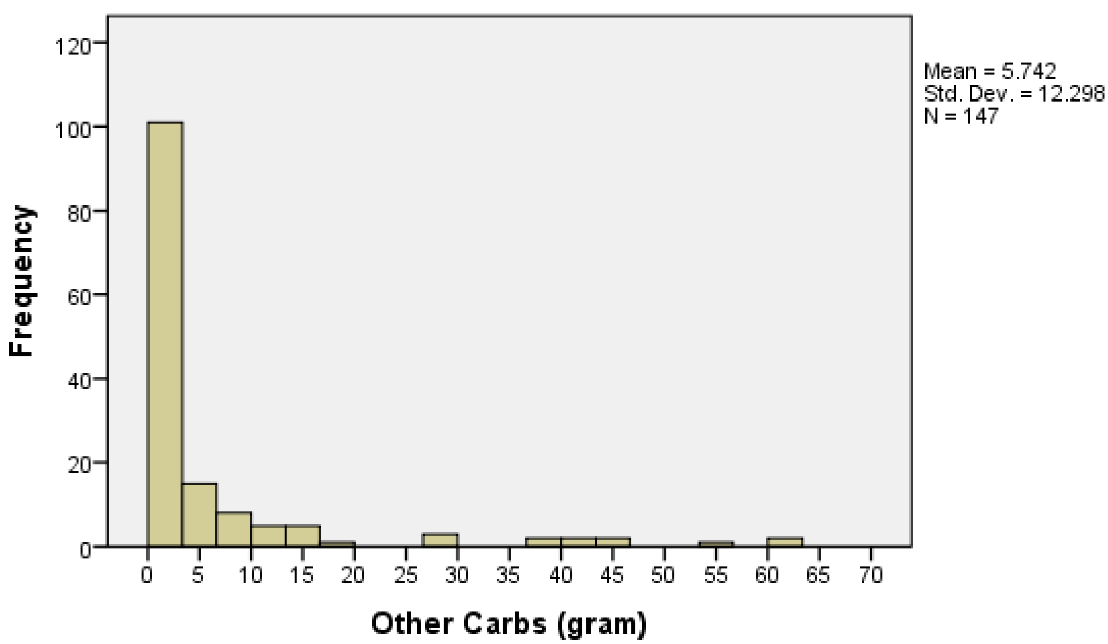
40
60
0
10
20
30
40
50
60
70
80
90
100
Disaccharides (gram)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Std. Dev. = 12.298
N = 147
Frequency
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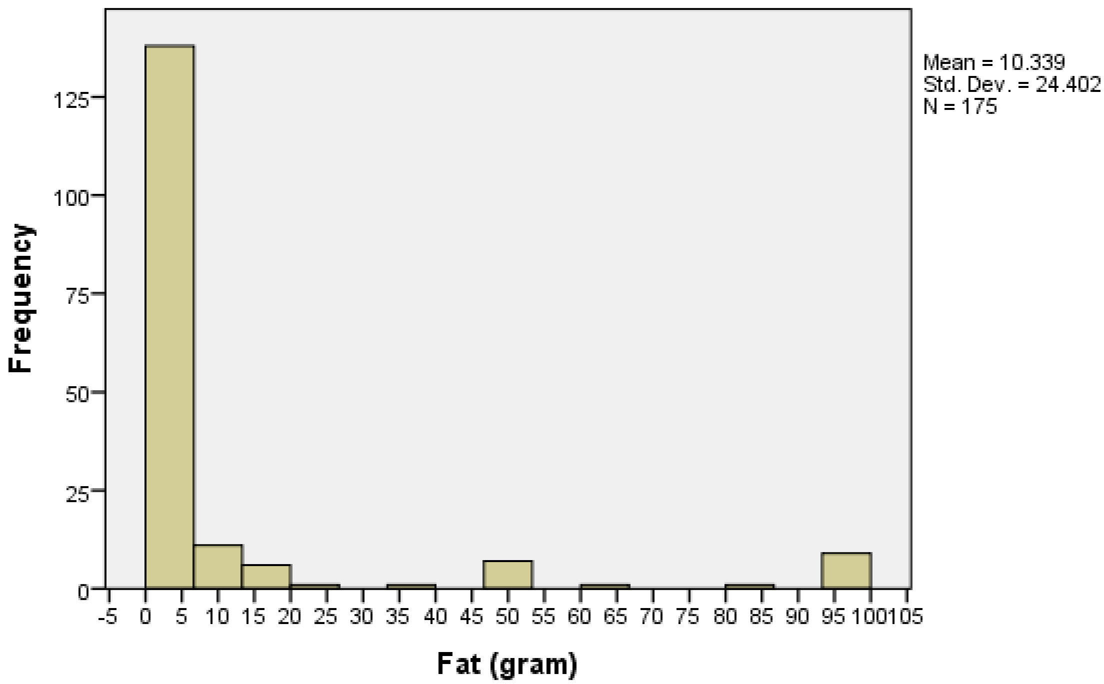
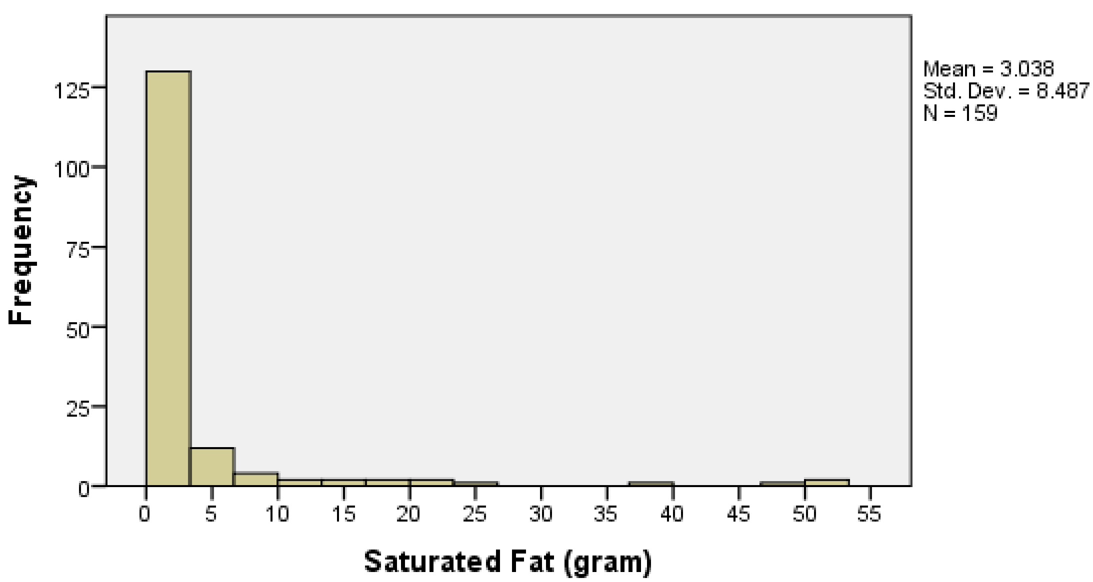
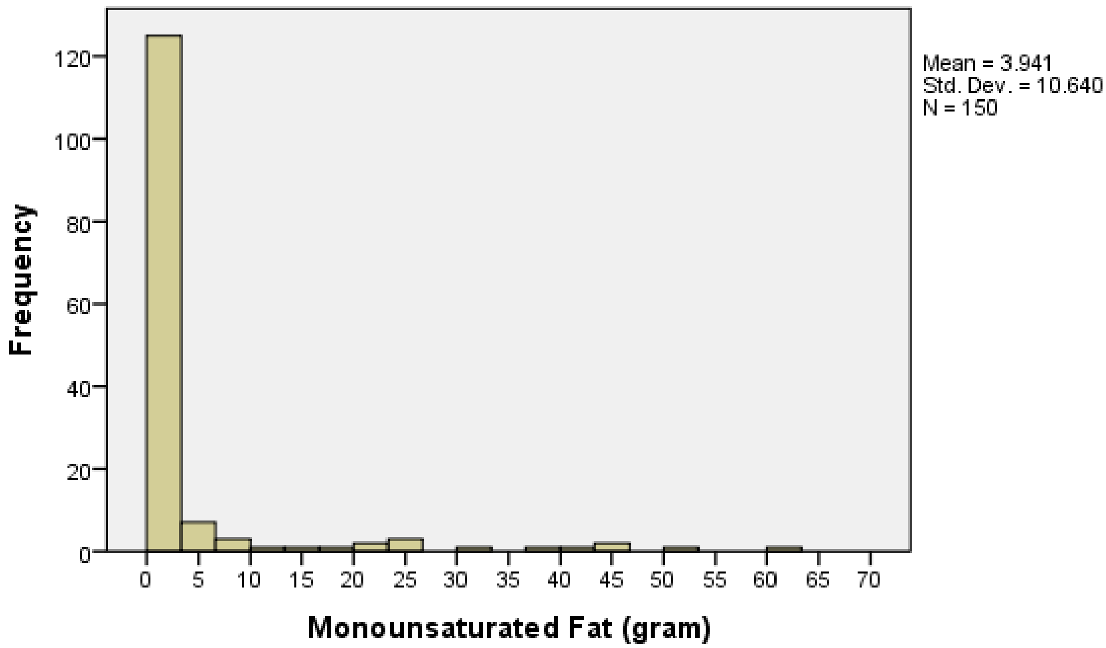
20
40
60
80
100
120
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Other Carbs (gram)

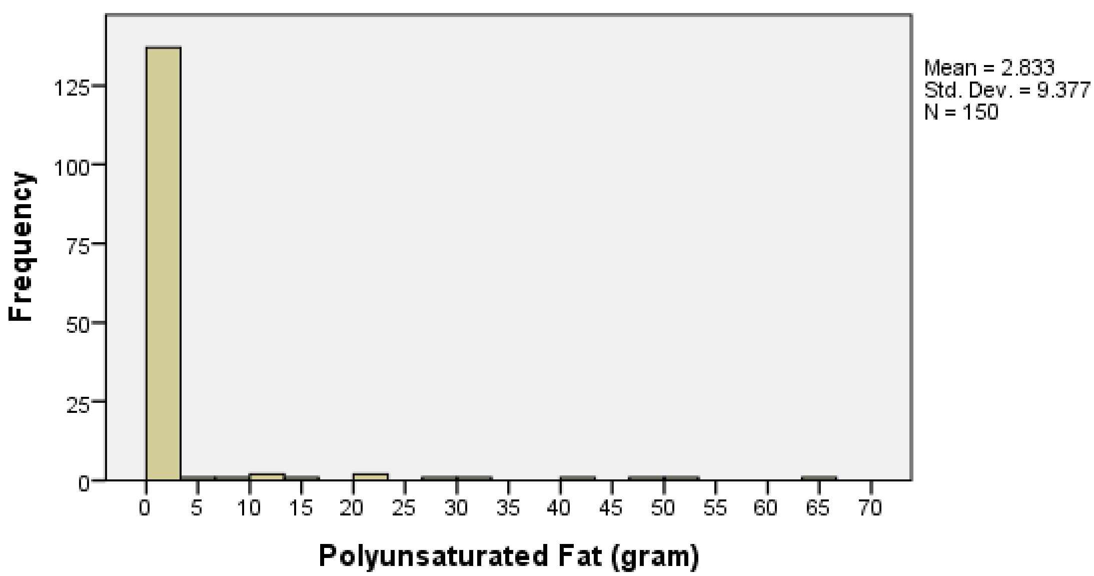
Appendix B (Continued)

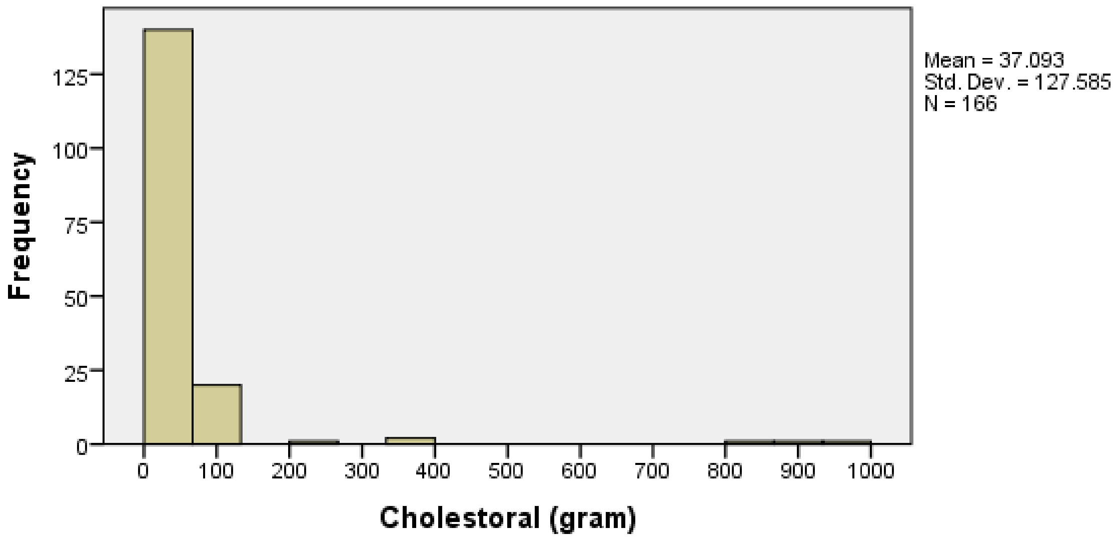




Appendix B (Continued)



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Frequency
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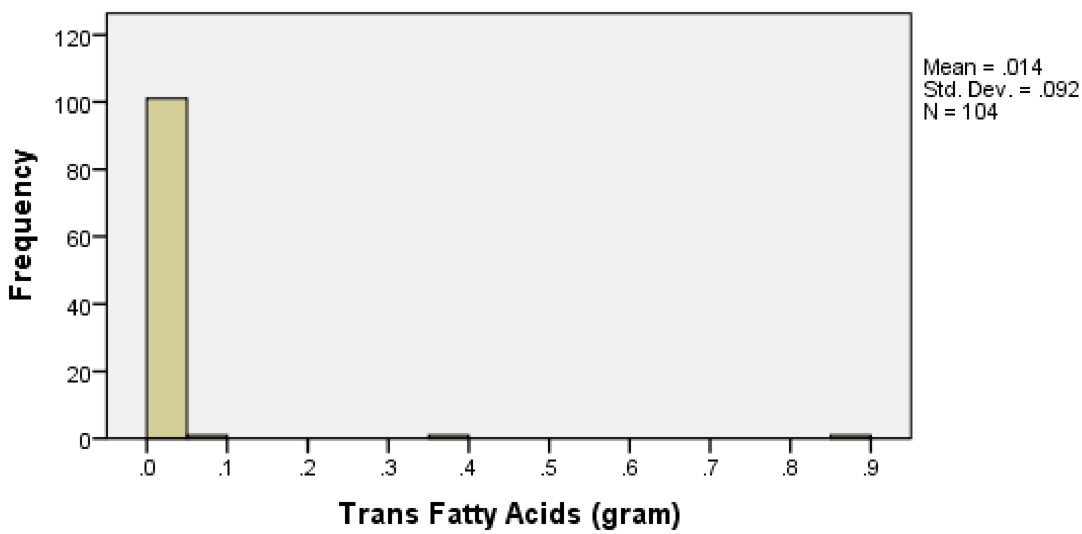
50
75
100
125
0
100
200
300
400
500
600
700
800
900
1000
Cholestoral (gram)


Mean = .014
Std. Dev. = .092
N = 104
Frequency
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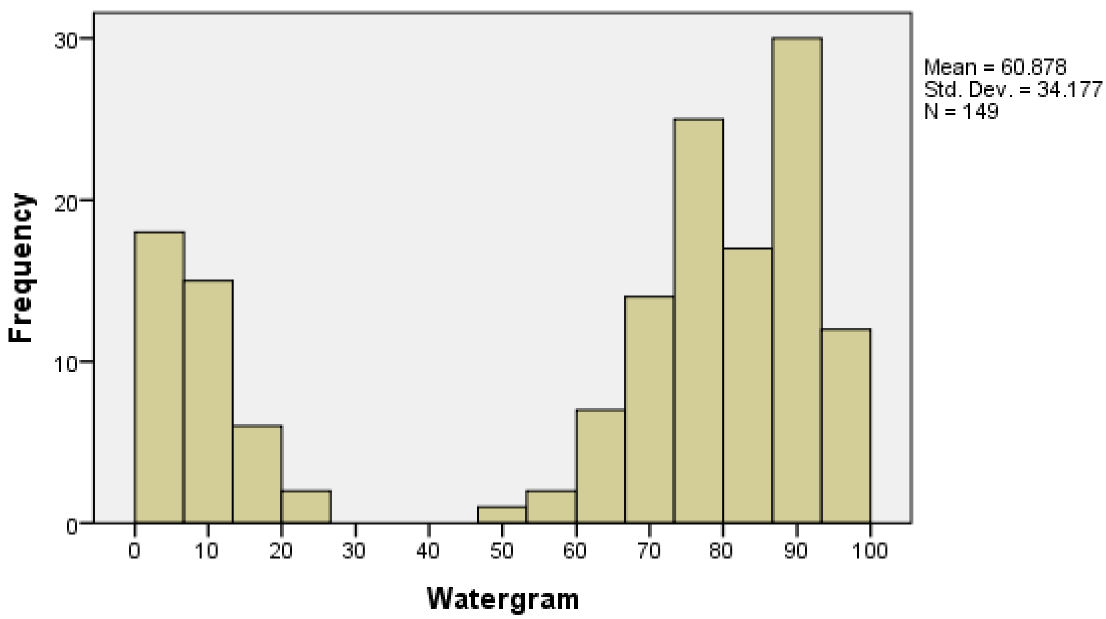
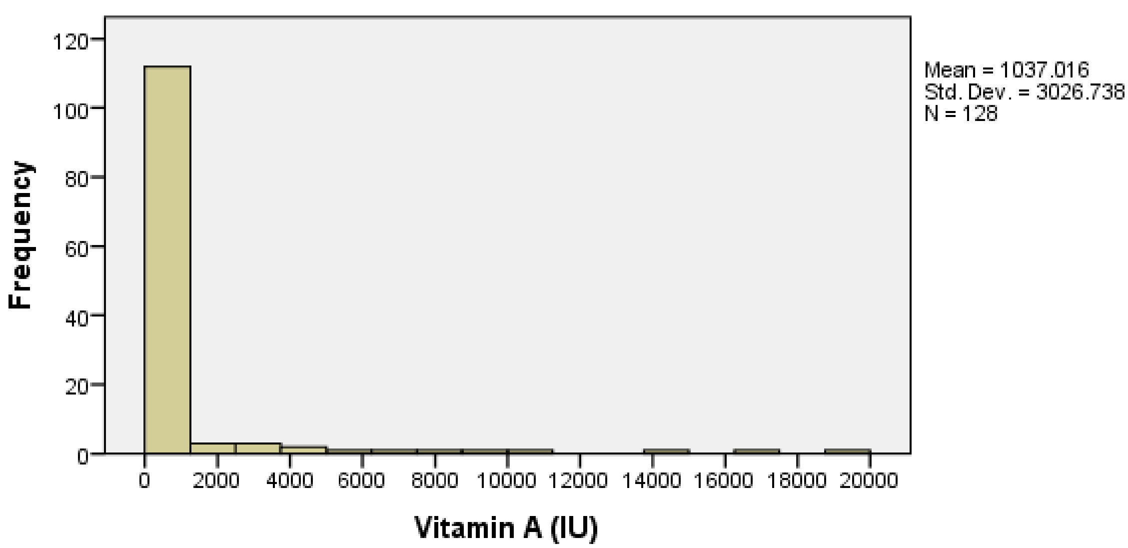
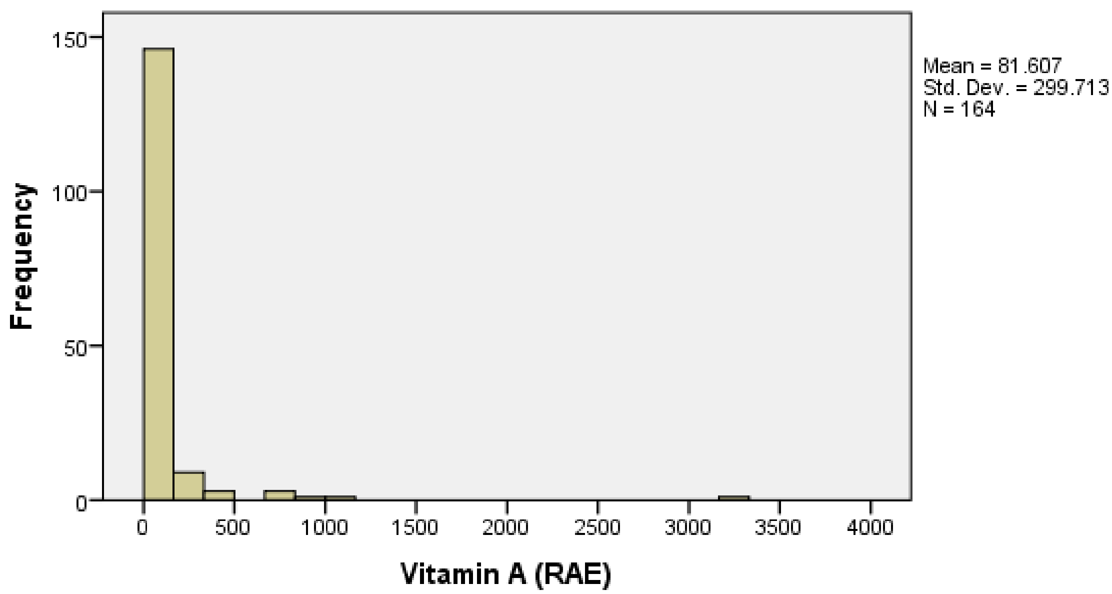
20
40
60
80
100
120
.0
.1
.2
.3
.4
.5
.6
.7
.8
.9
Trans Fatty Acids (gram)

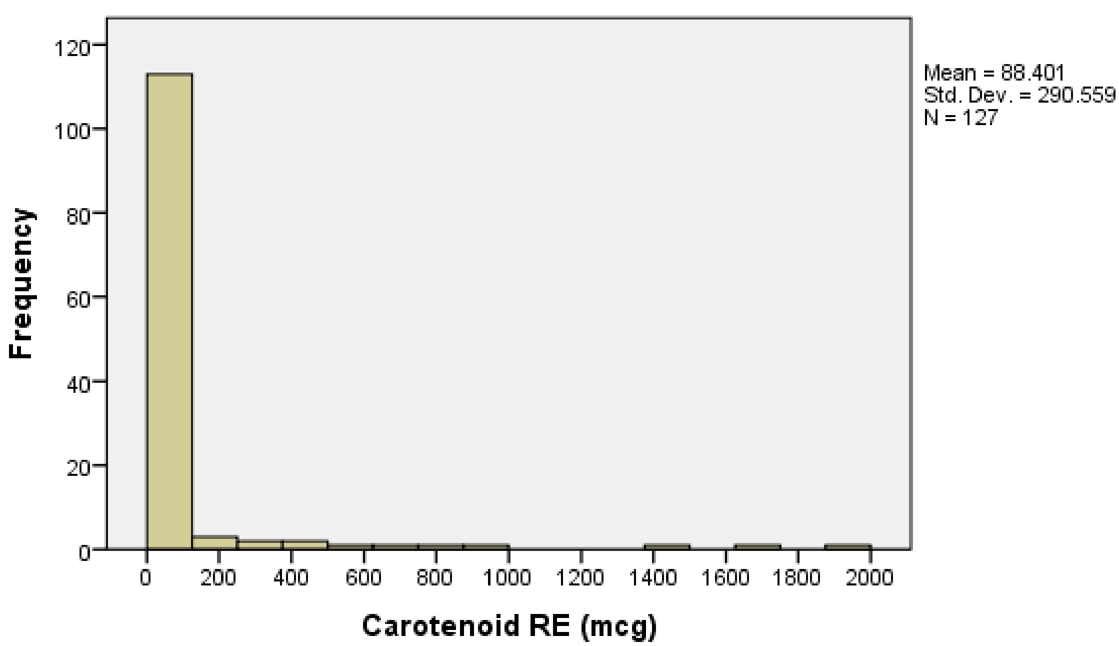
Appendix B (Continued)



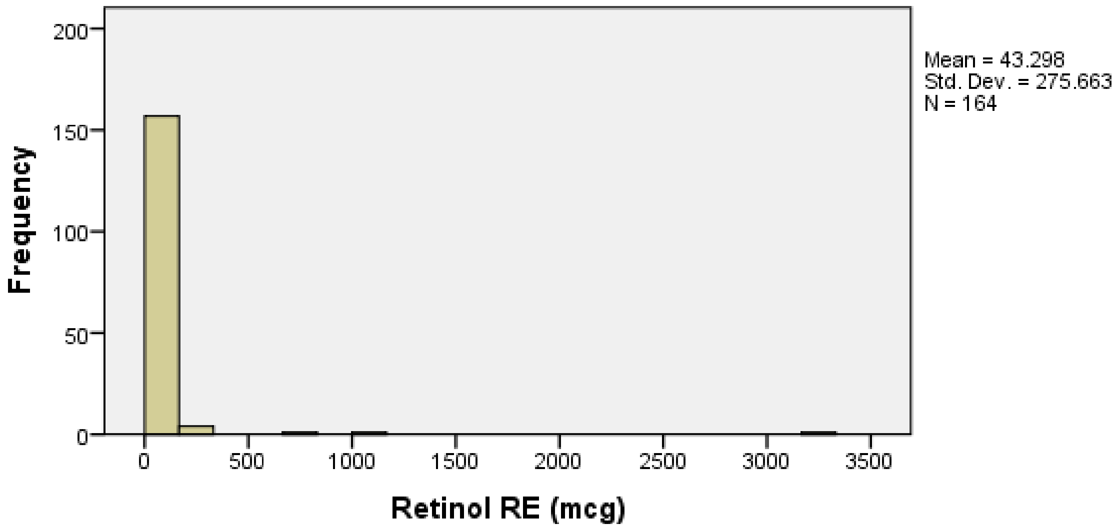


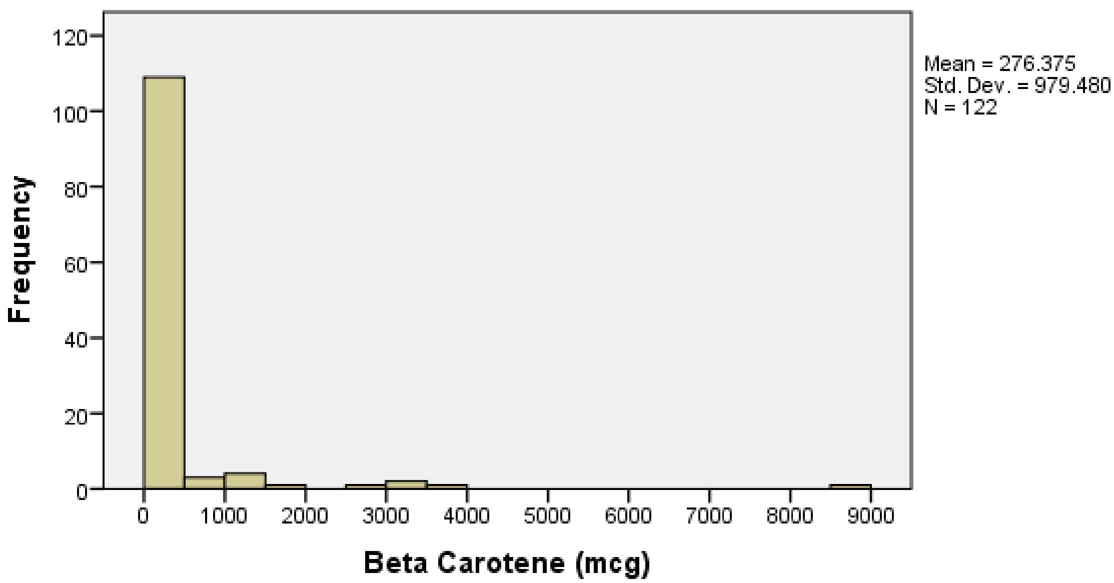
Appendix B (Continued)



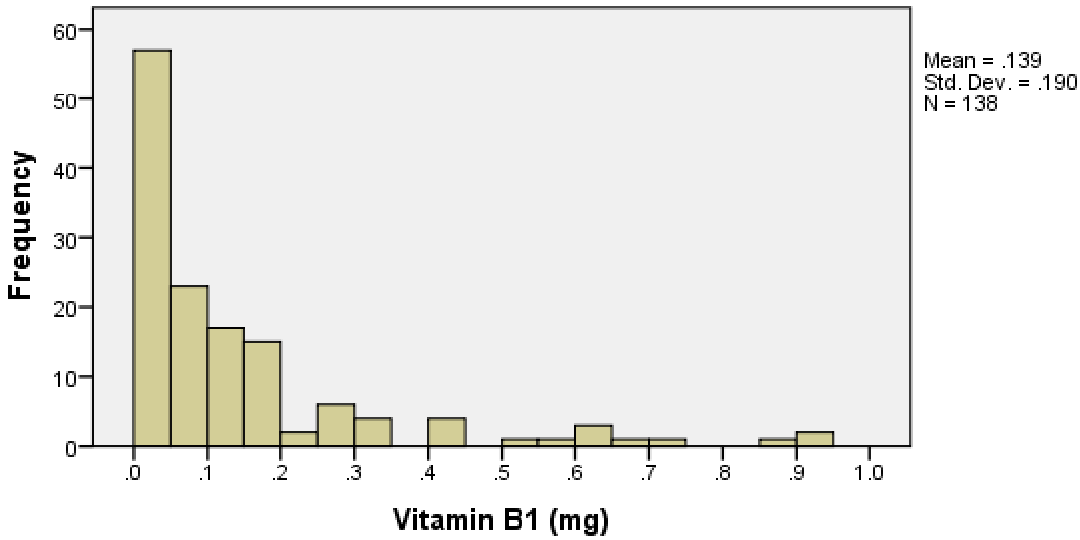


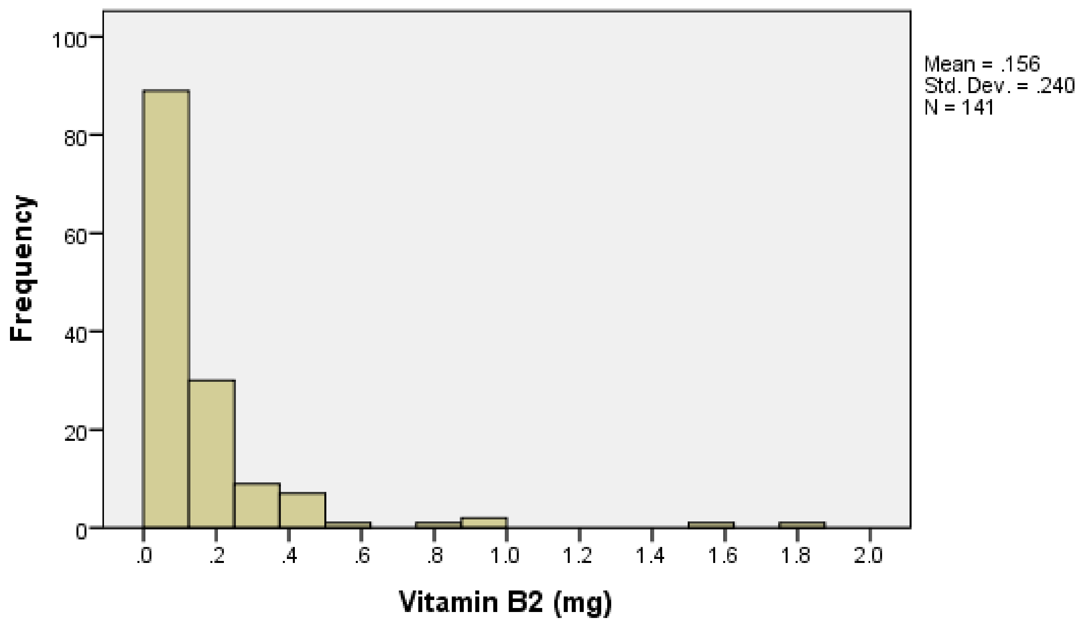
Appendix B (Continued)



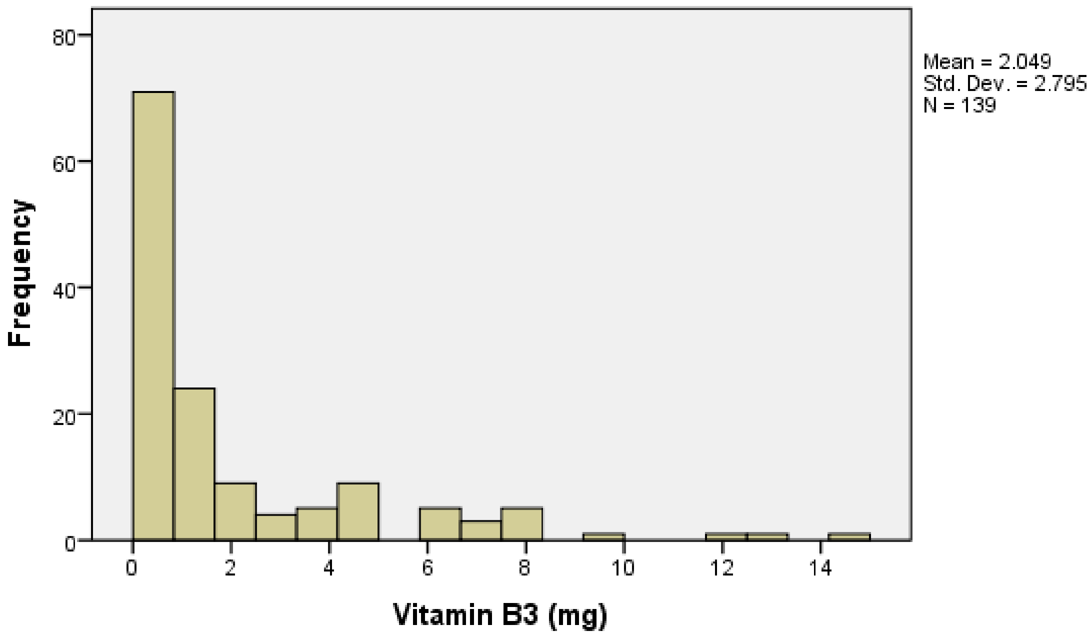


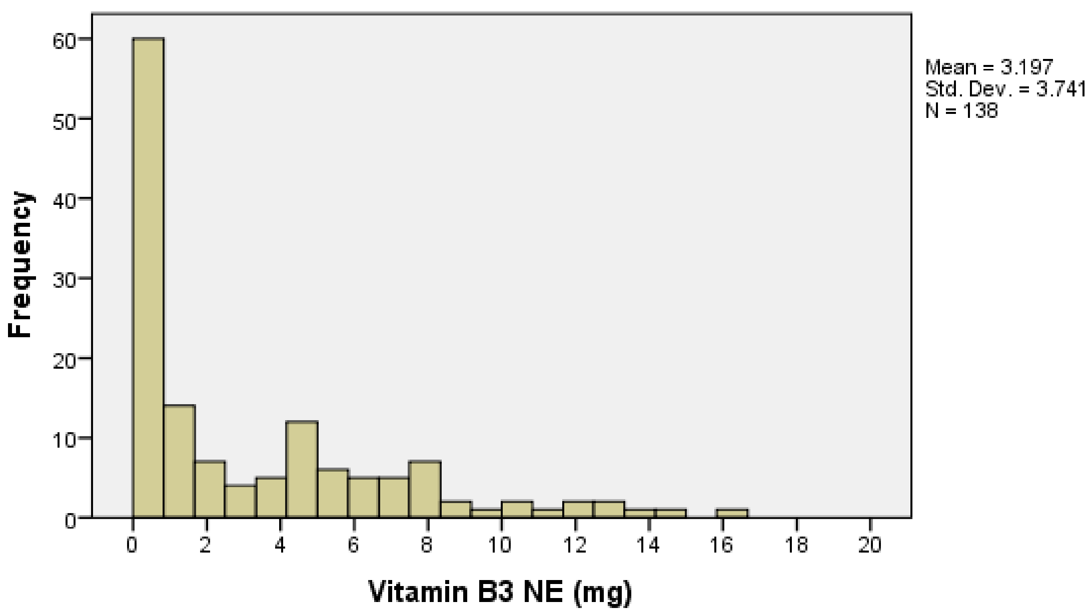
Appendix B (Continued)

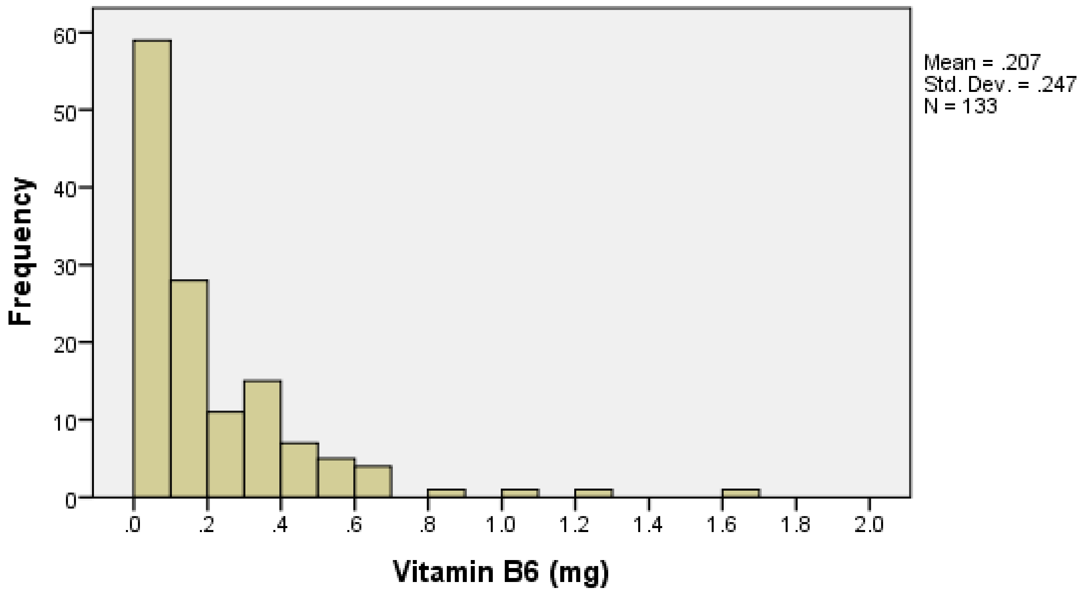




Appendix B (Continued)






Mean = .207
Std. Dev. = .247
N = 133
Frequency
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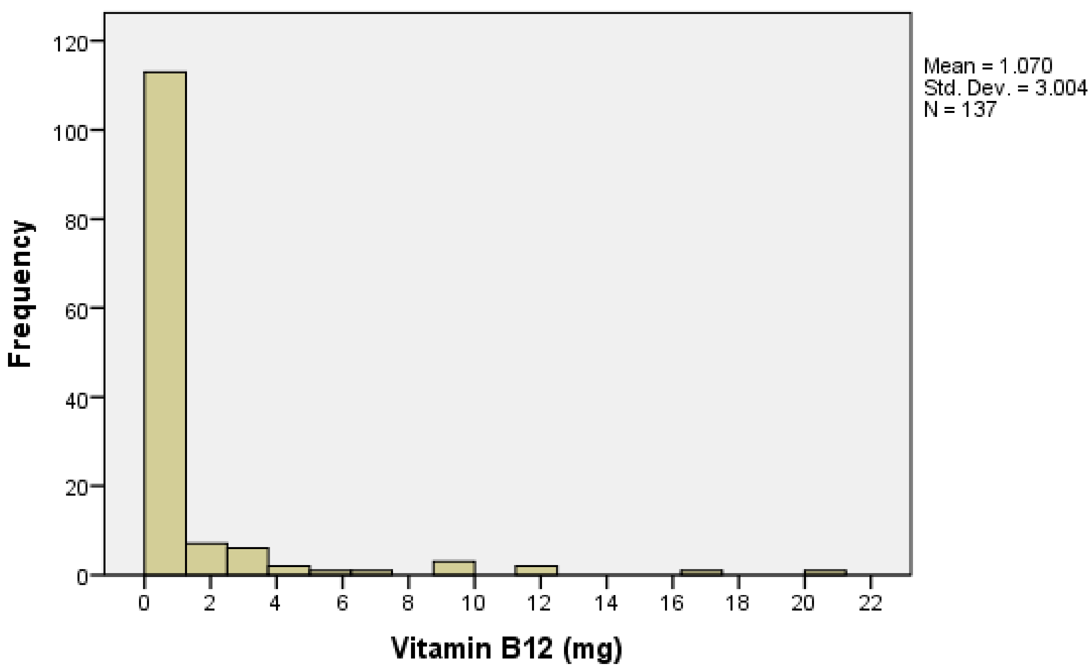
50
40
30
20
10
0
.0
.2
.4
.6
.8
1.0
1.2
1.4
1.6
1.8
2.0
Vitamin B6 (mg)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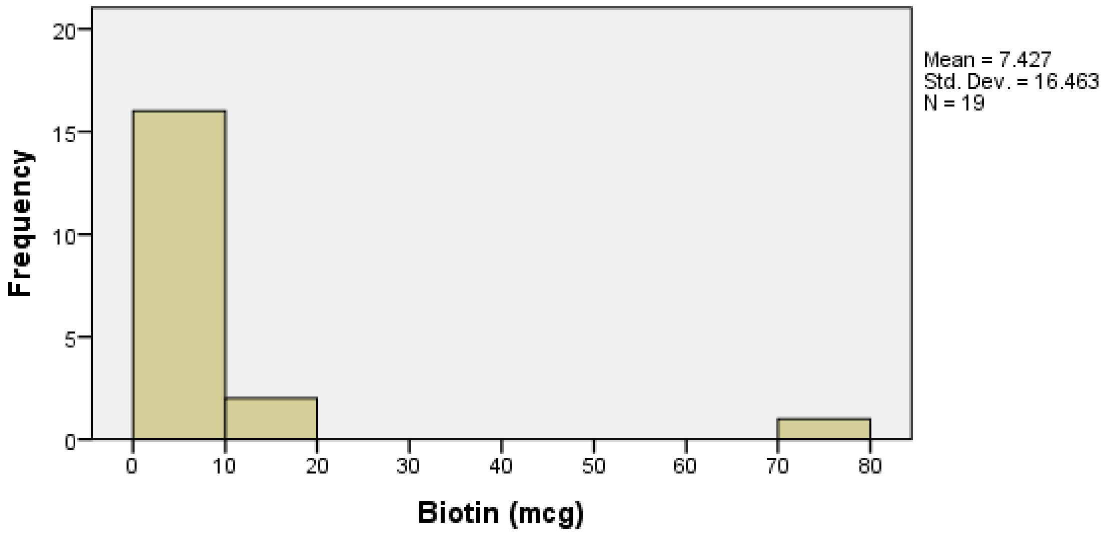
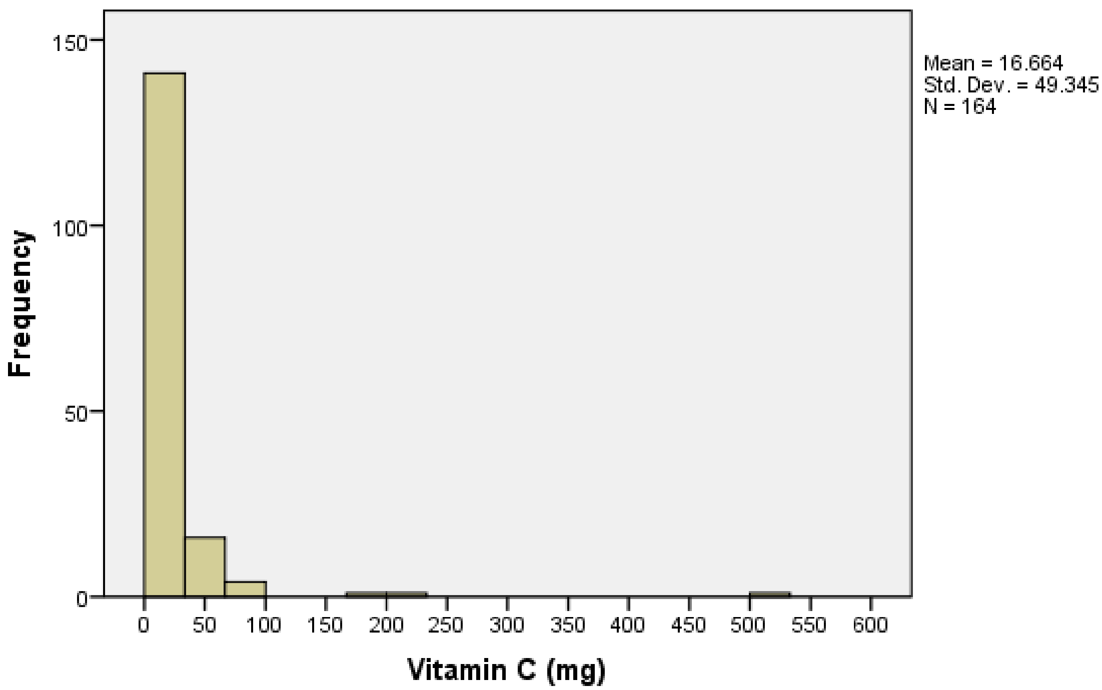
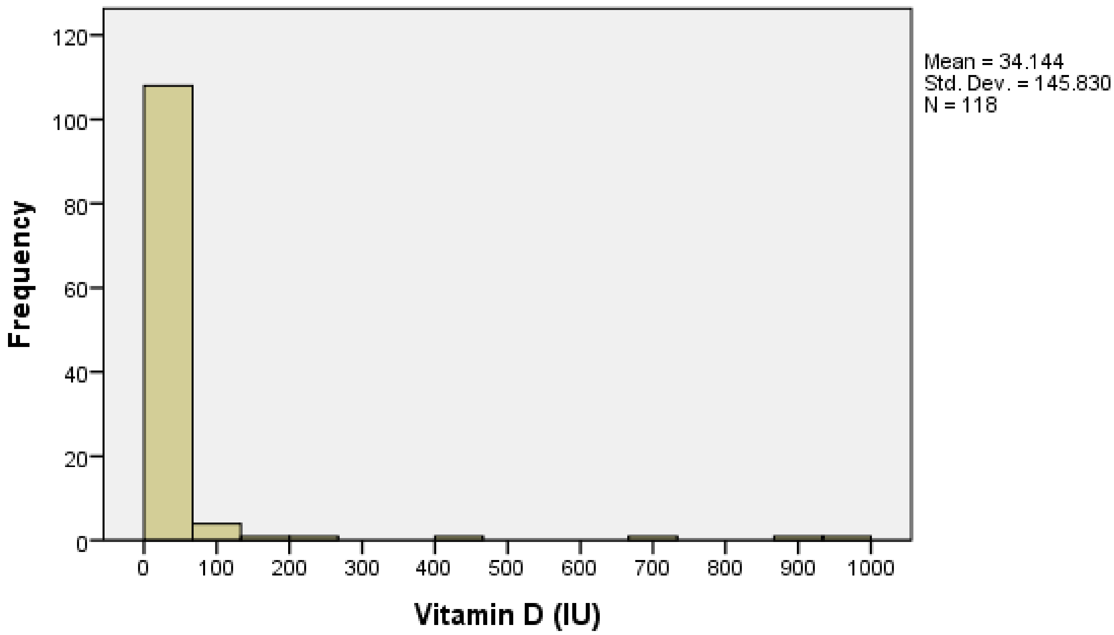
Std. Dev. = 3.004
N = 137
Frequency
120
100
80
60
40
20
0
0
2
4
6
8
10
12
14
16
18
20
22
Vitamin B12 (mg)

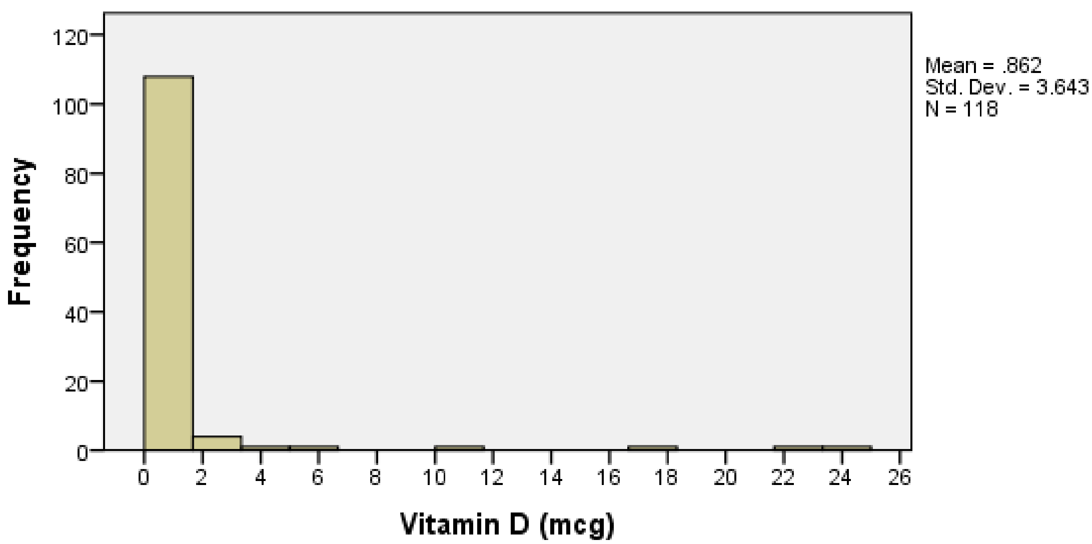
Appendix B (Continued)



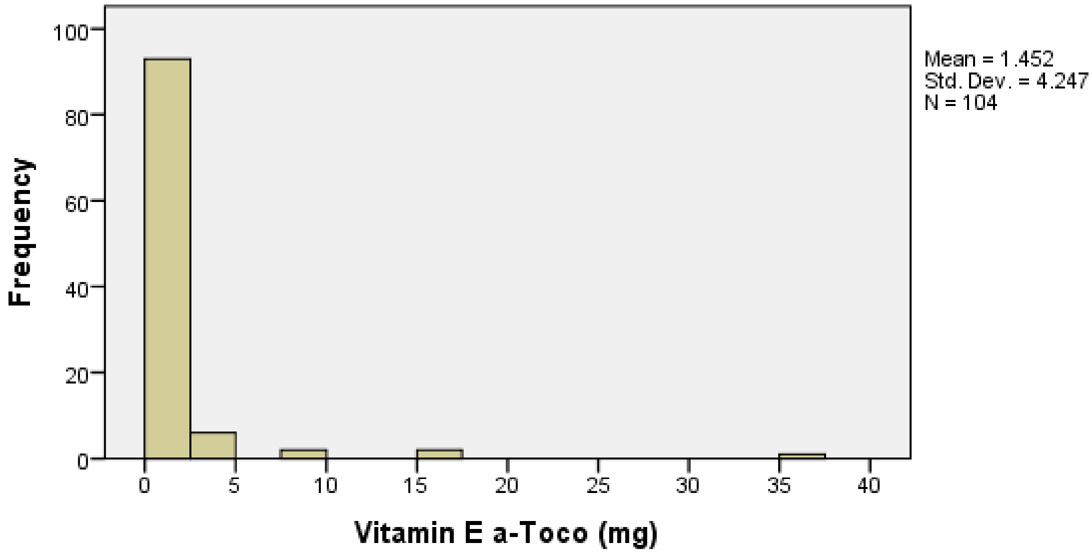


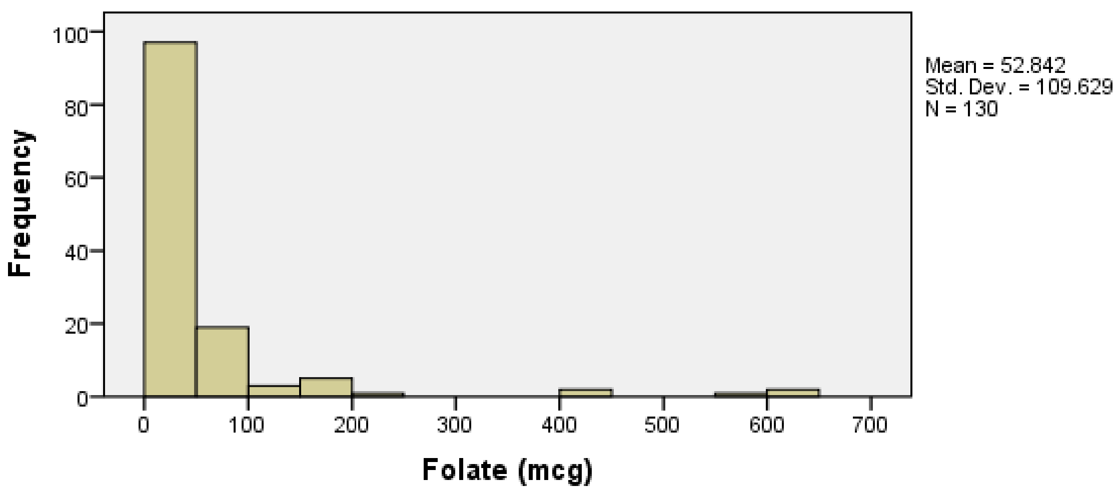
Appendix B (Continued)



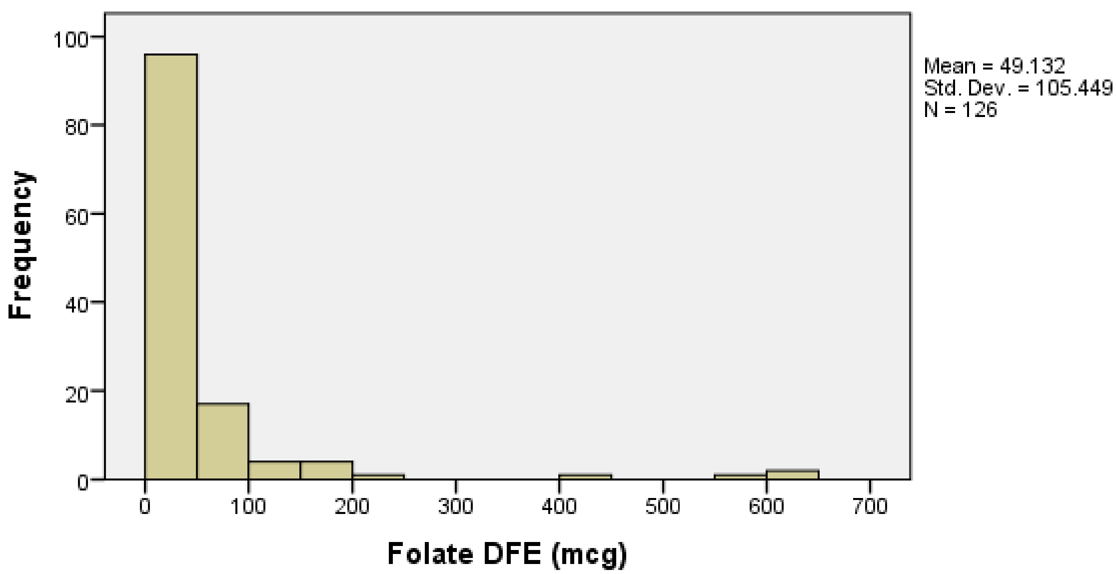


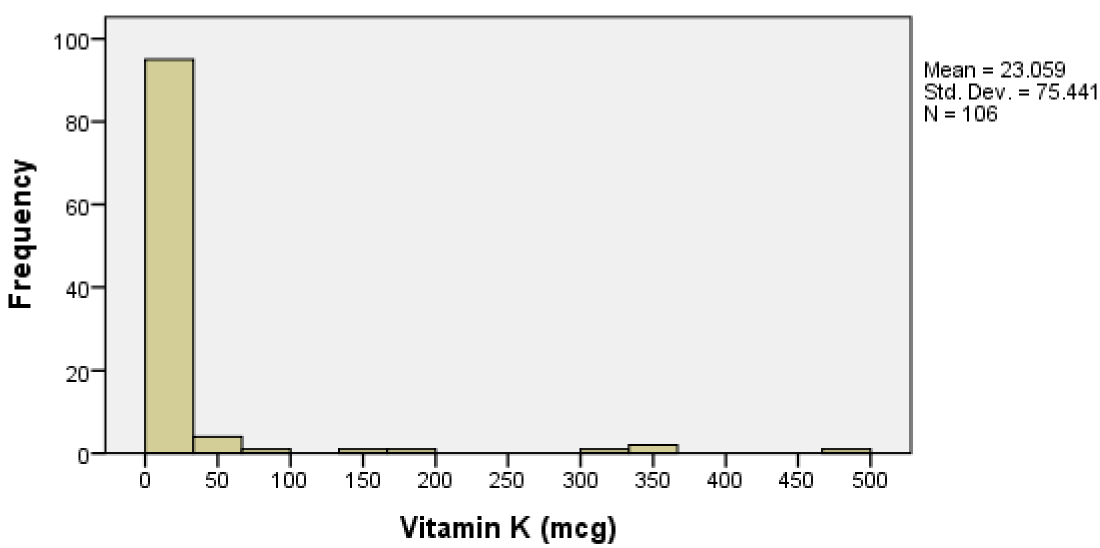
Appendix B (Continued)



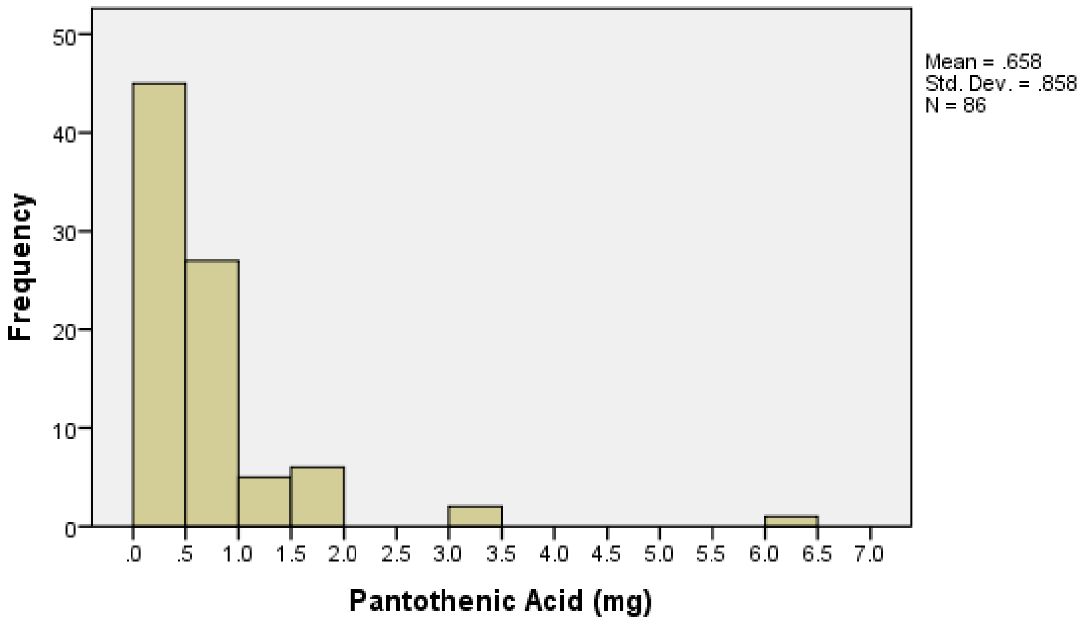


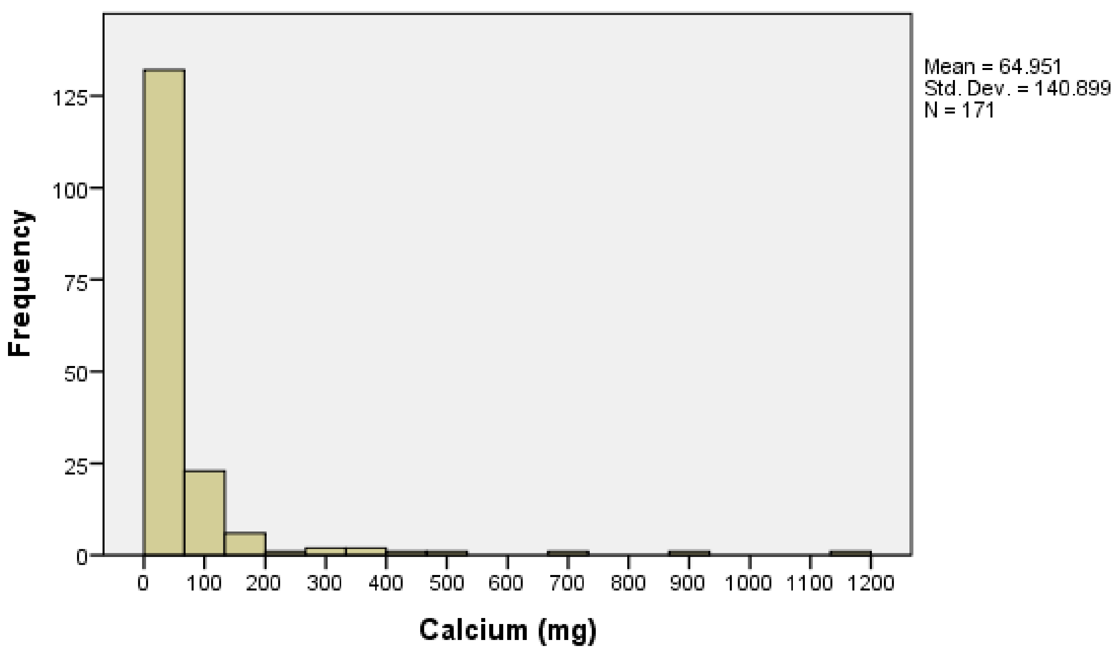
Appendix B (Continued)



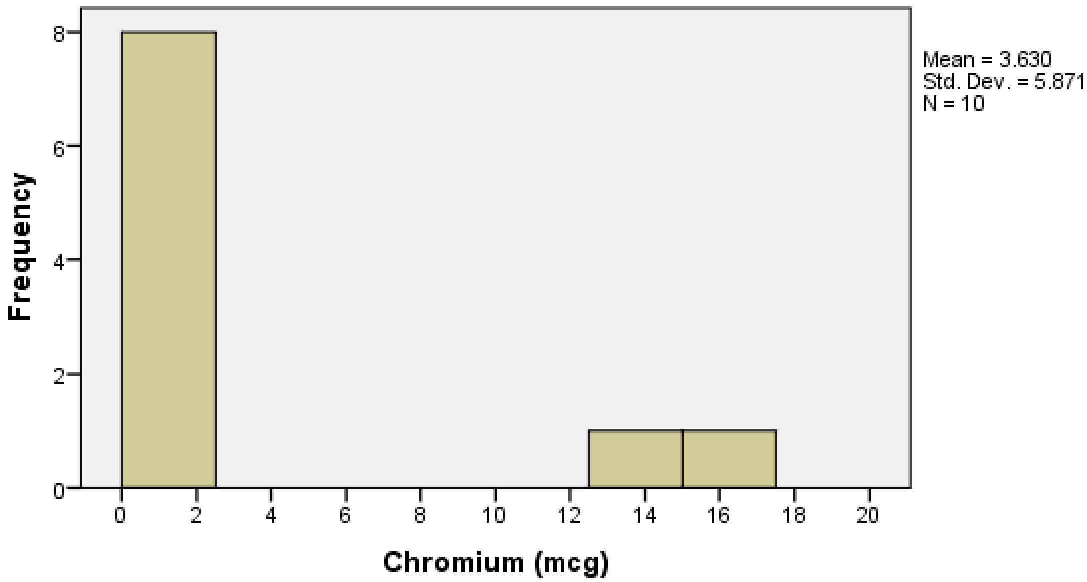


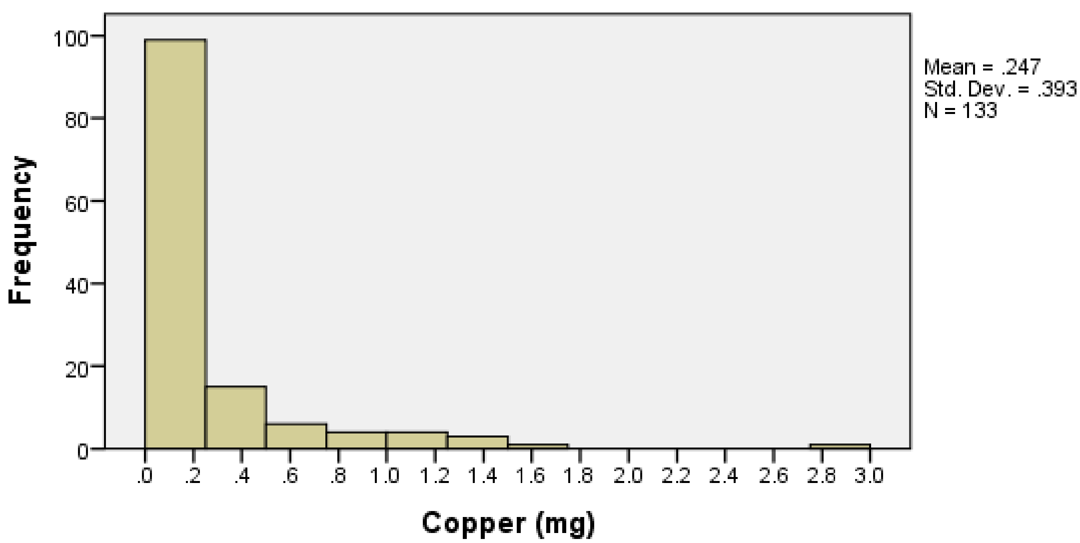
Appendix B (Continued)

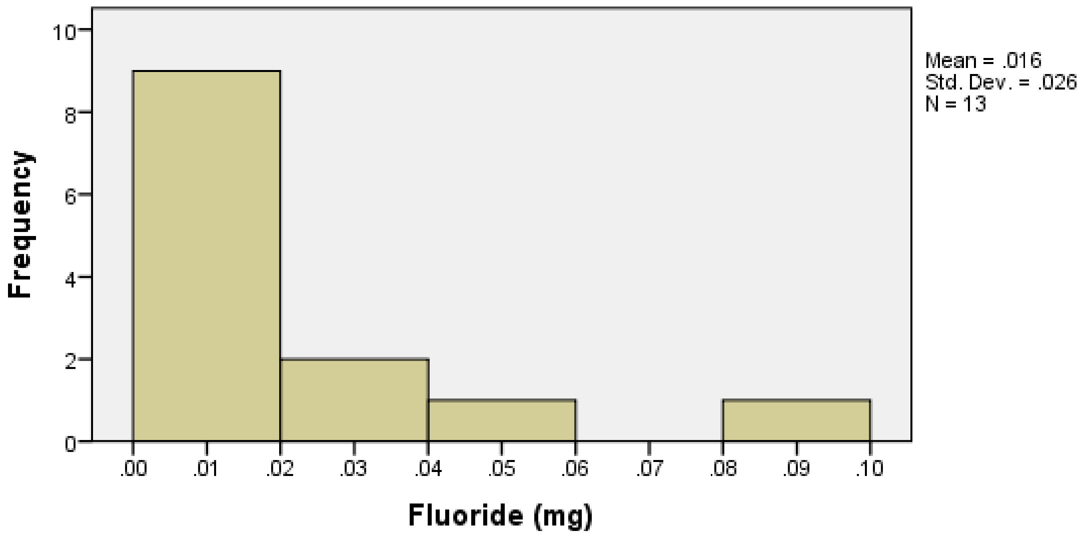


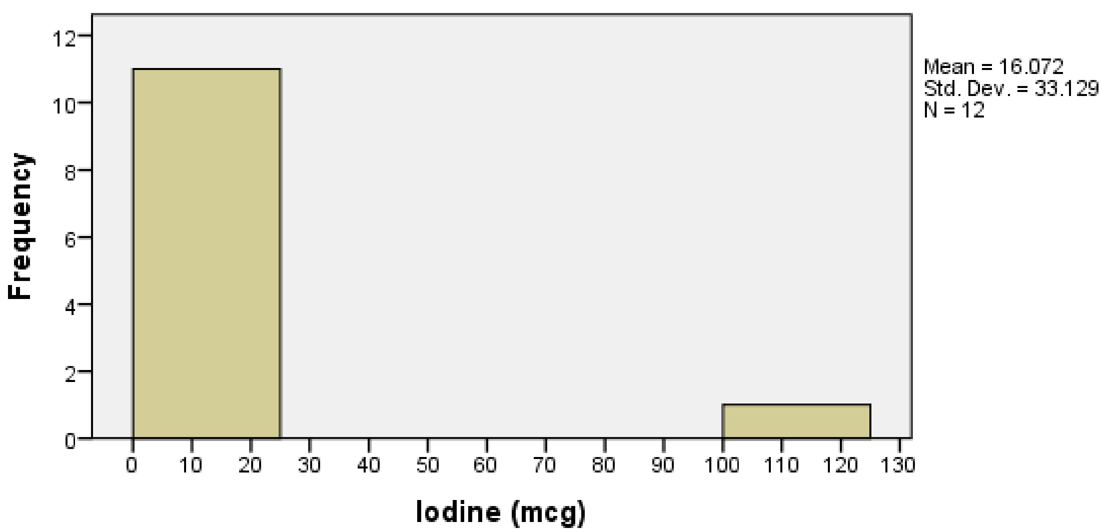


Appendix B (Continued)






Mean = .016
Std. Dev. = .026
N = 13
Frequency
0
2
4
6
8
10
.00
.01
.02
.03
.04
.05
.06
.07
.08
.09
.10
Fluoride (mg)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Std. Dev. = 33.129
N = 12
Frequency
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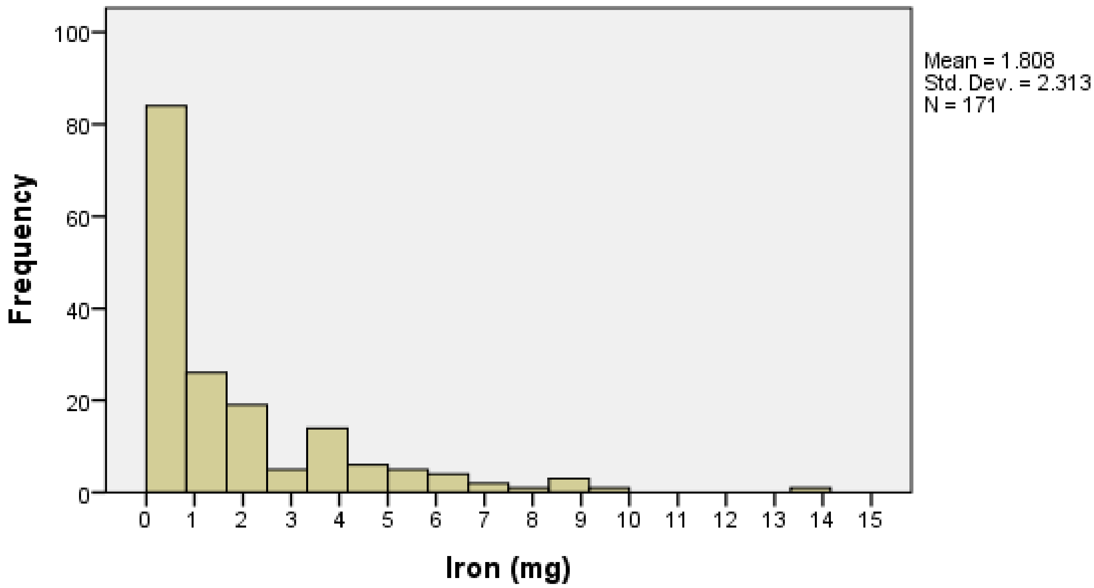
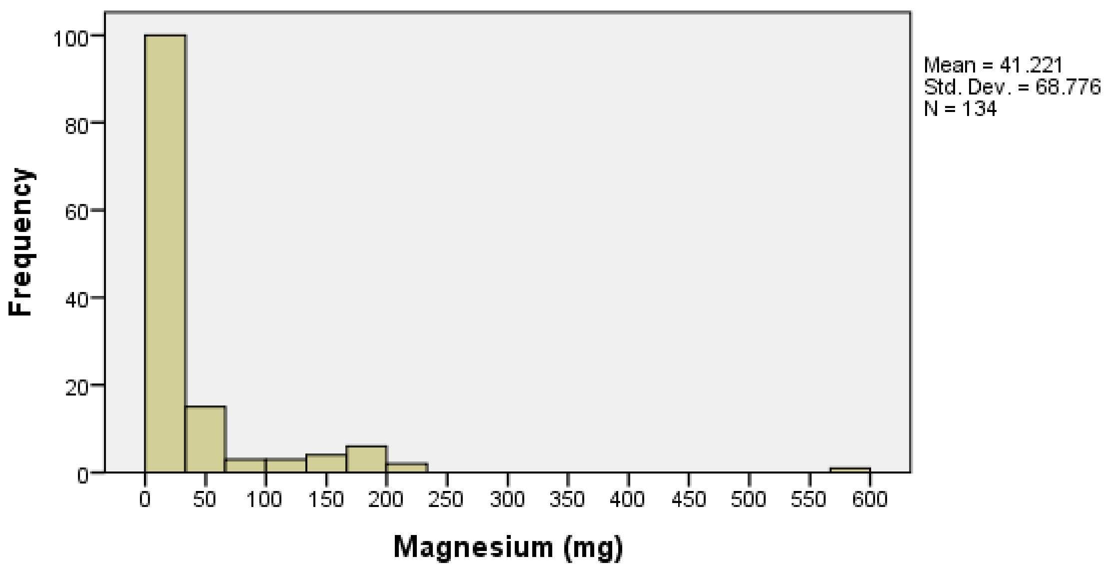
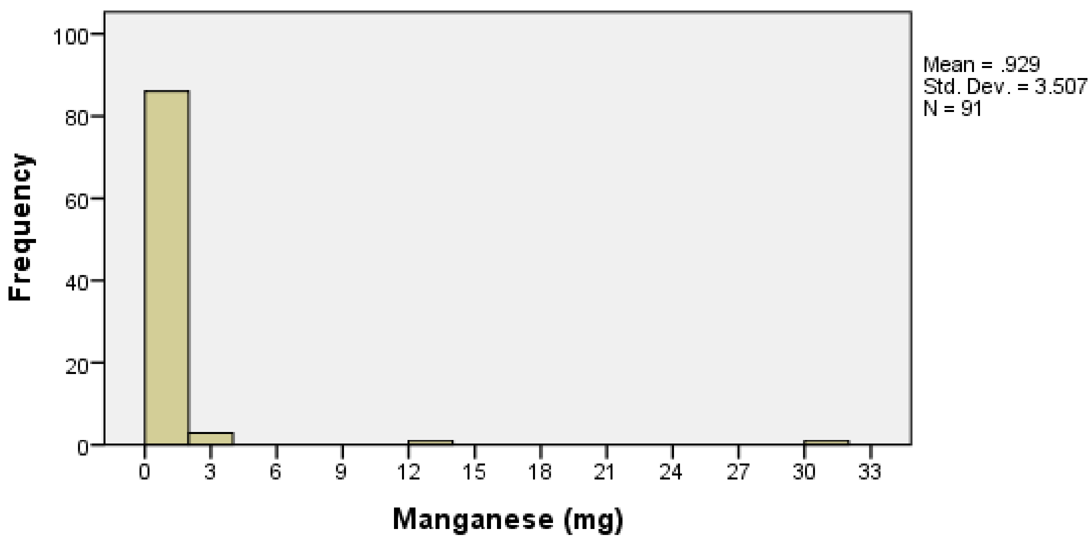
2
4
6
8
10
12
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Iodine (mcg)

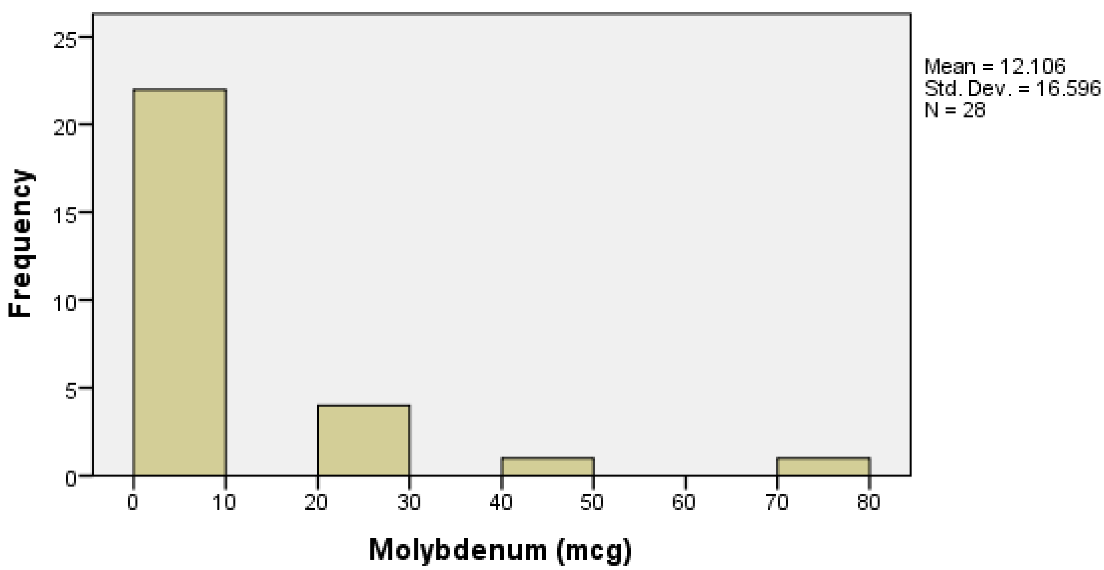
Appendix B (Continued)



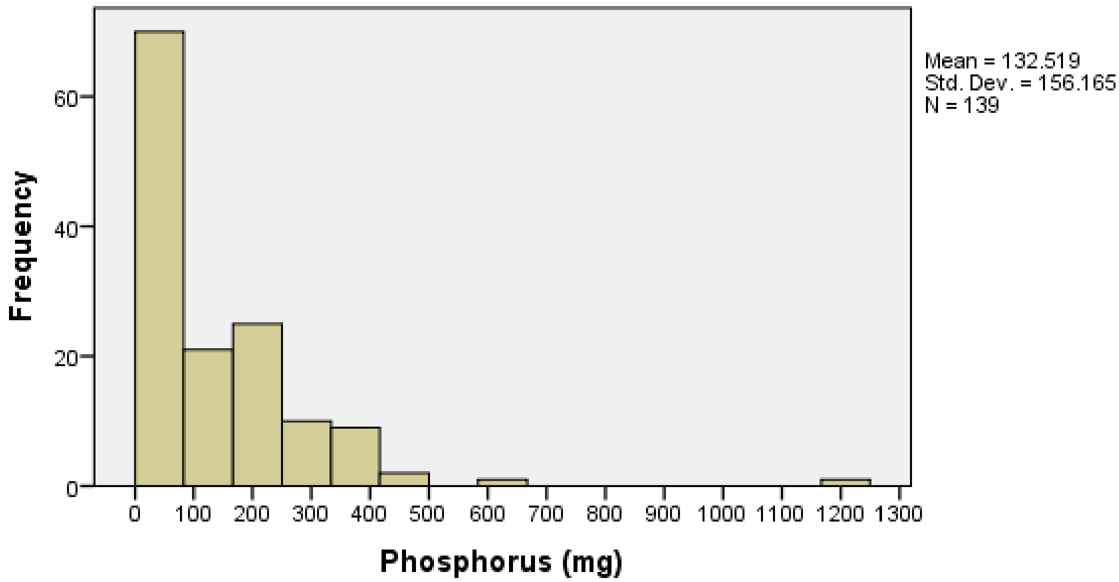


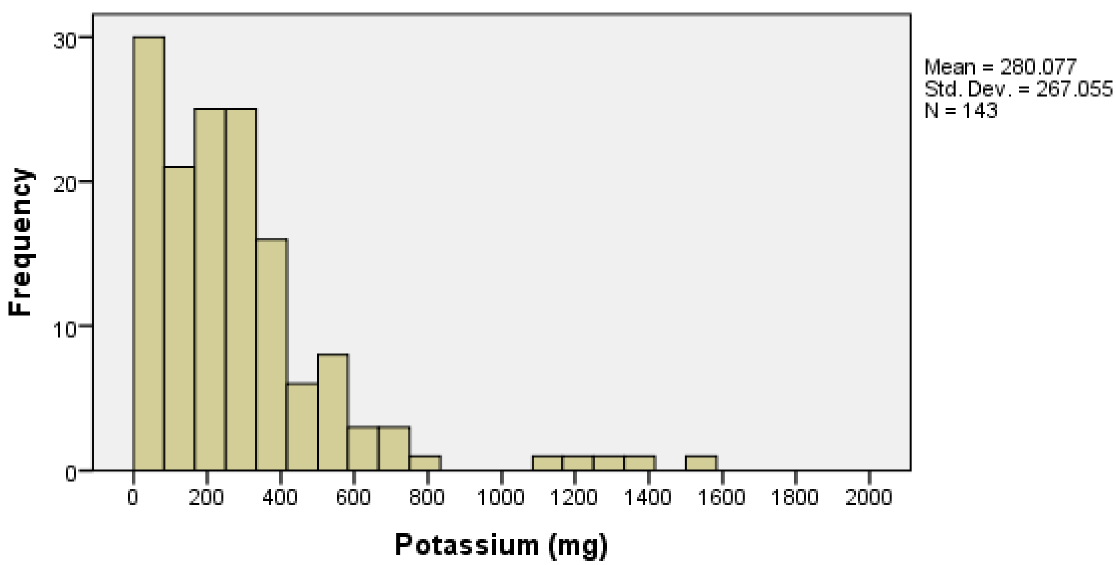
Appendix B (Continued)



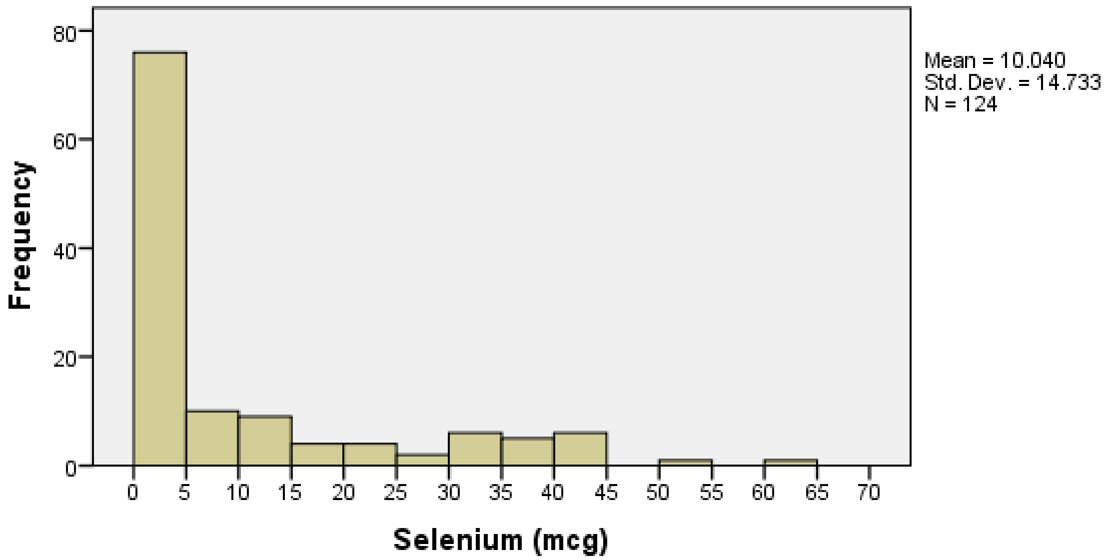


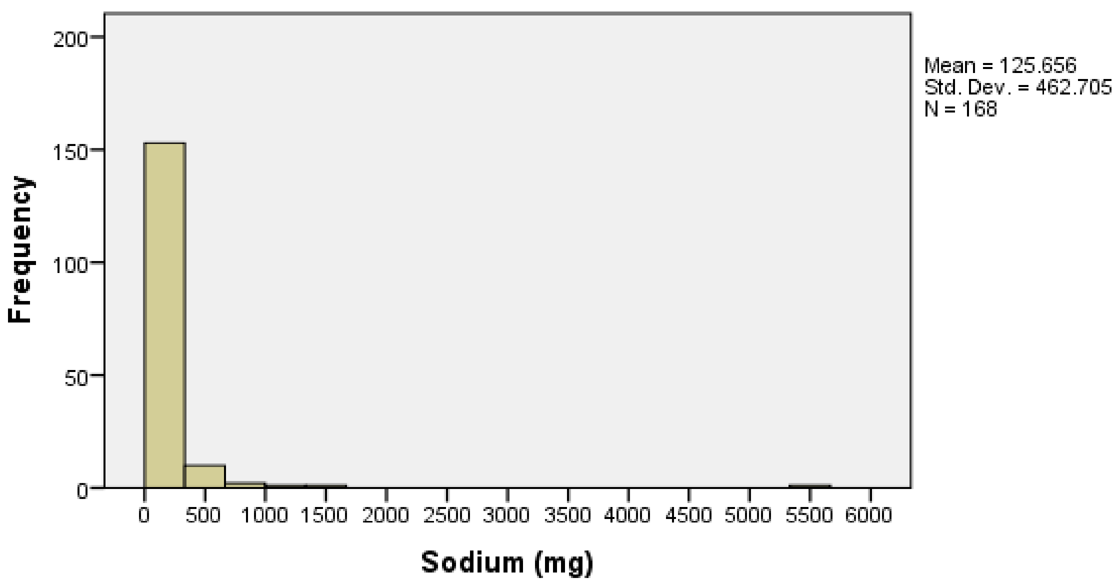
Appendix B (Continued)



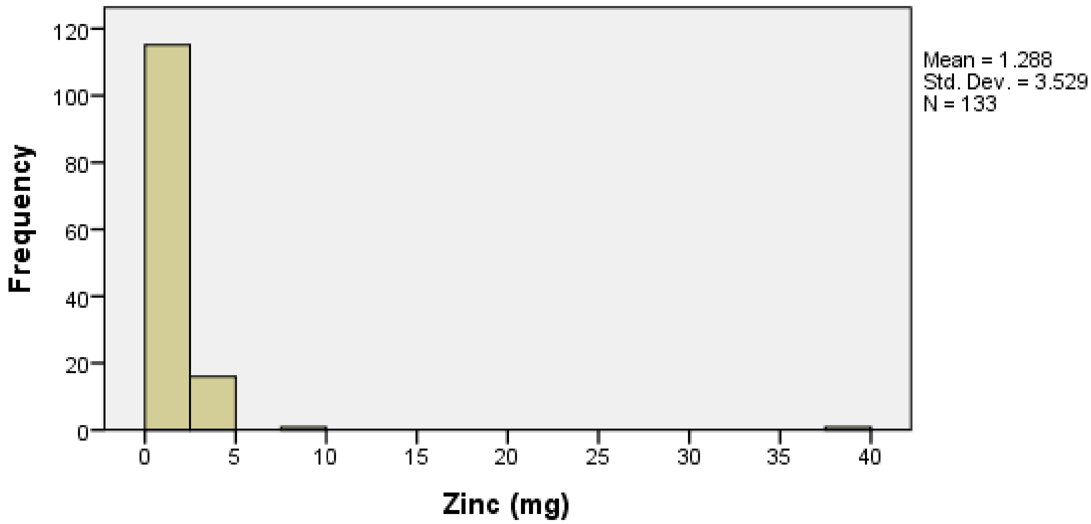


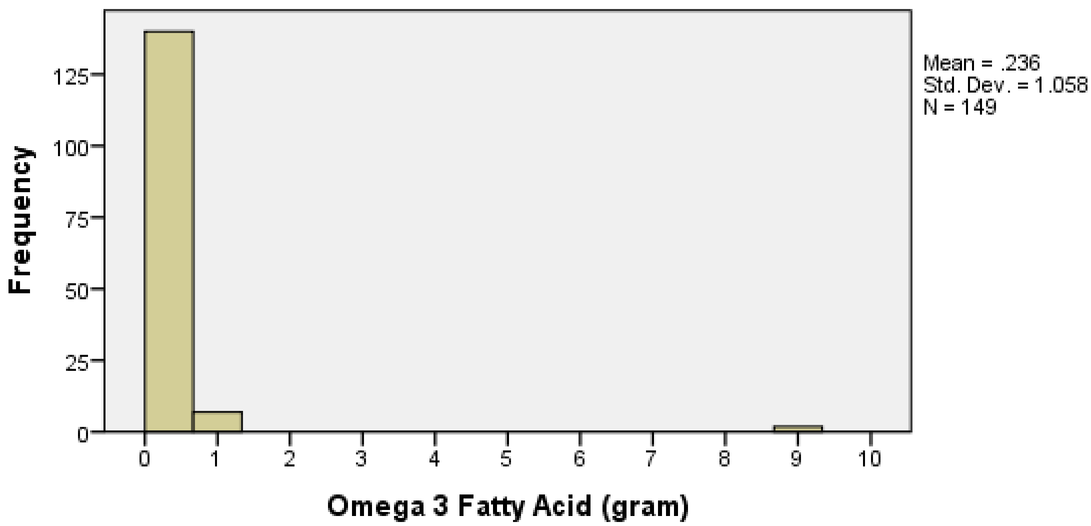
Appendix B (Continued)



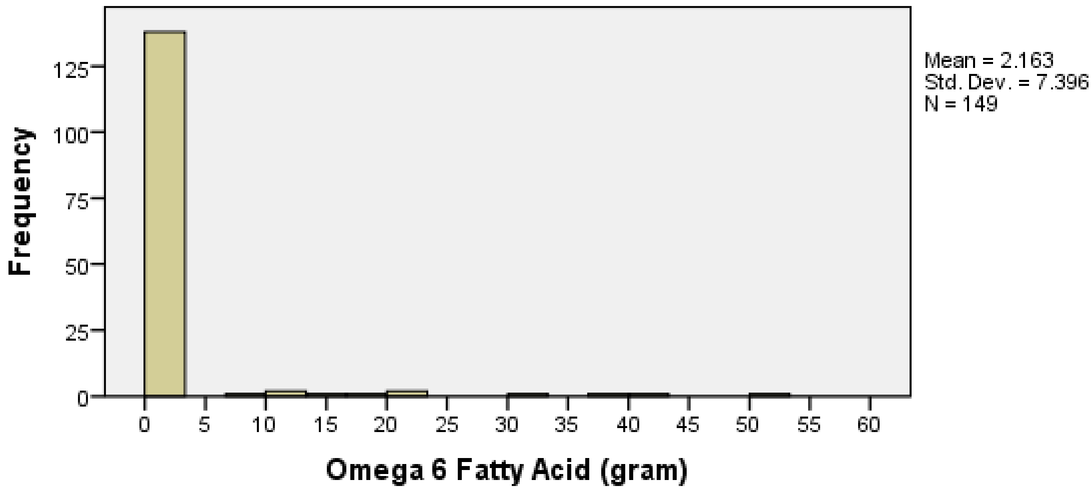


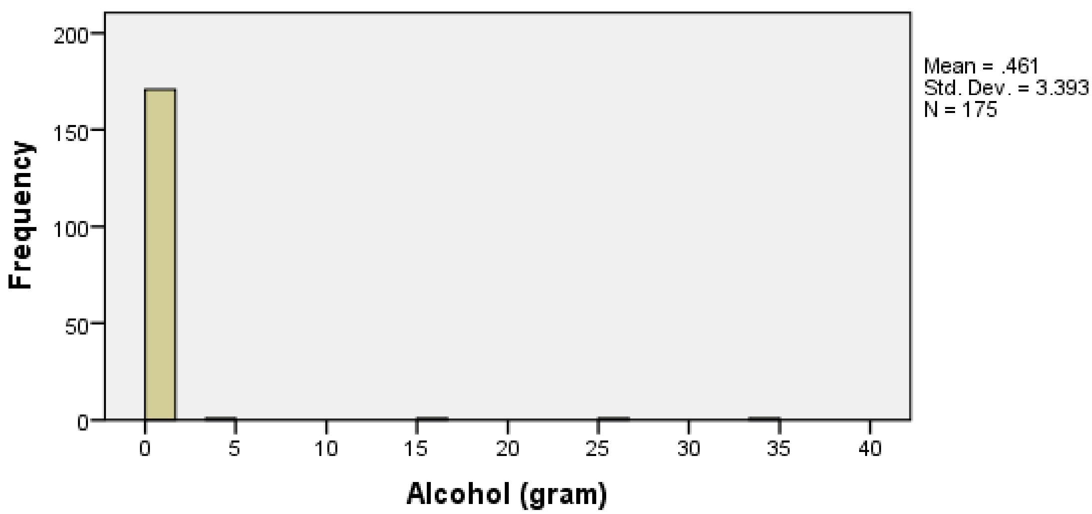
Appendix B (Continued)



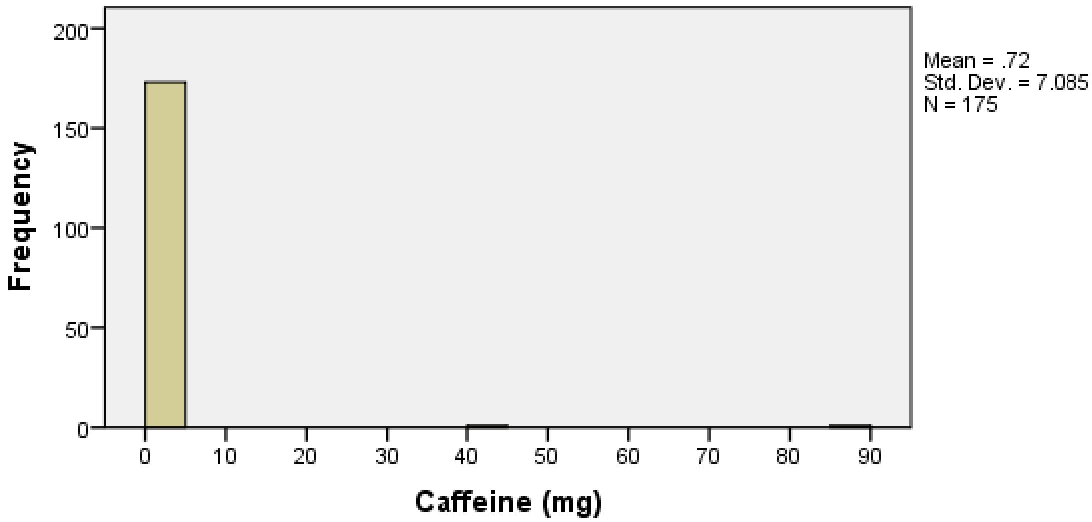


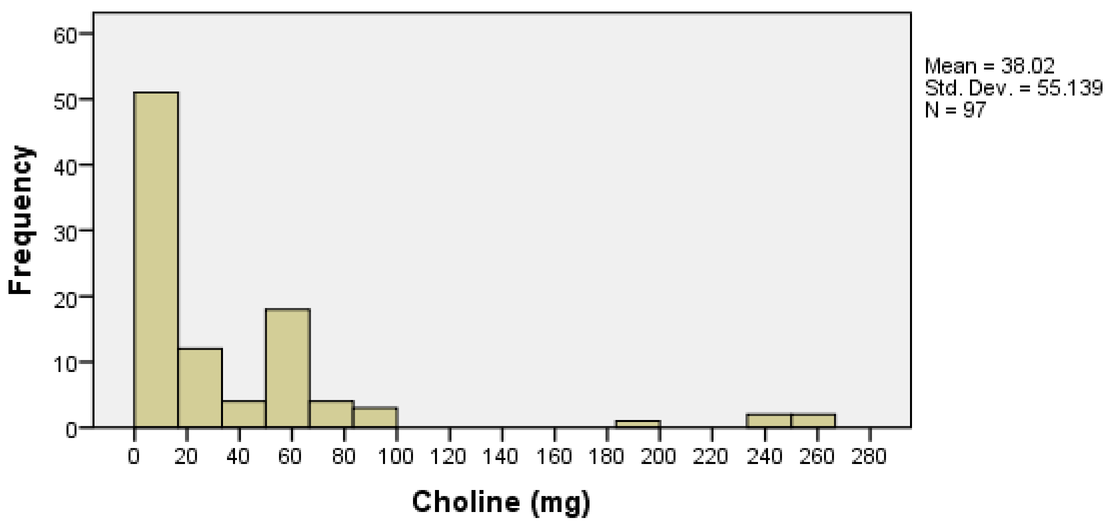
Appendix B (Continued)





Appendix B (Continued)





Appendix C. Results of Nonparametric Tests among Three Groups

	P_a
Calories (kcal)	.000**
Calories from Fat (Kcal)	.015**
Calories from Saturated Fat(kcal)	.005**
Protein (g)	.010*
Carbohydrate (g)	.515
Total Dietary Fiber (g)	.328
Total Soluble Fiber (g)	.124
Dietary Fiber 2016 (g)	.218
Soluble Fiber 2016 (g)	.164
Total Sugar (g)	.080*
Other Carbs	.689
Fat (g)	.015**
Saturated Fat (g)	.006**
Monounsaturated Fat (g)	.076*
Polyunsaturated Fat (g)	.223
Omega 3 Fatty Acids (g)	.532
Omega 6 Fatty Acids (g)	.321
Vitamin A (IU)	.115
Vitamin A (RAE)	.468
Carotene (mcg)	.922
Retinol (mcg)	.030**
Beta Carotene (mcg)	.092*
Vitamin B1 (mg)	.059*
Vitamin B2 (mg)	.102
Vitamin B3 (mg)	.082*
Vitamin B6 (mg)	.340
Vitamin B12 (mg)	.347
Vitamin C (mg)	.047**
Vitamin D (mcg)	.086*
Vitamin E (mg)	.084*
Folate Total (mcg)	.734
Folate DFE (mcg)	.746
Vitamin K (mcg)	.557
Pantothenic Acids (mg)	.500
Calcium (mg)	.034**
Copper (mg)	.809
Iron (mg)	.056*
Magnesium (mg)	.181

Phosphorus (mg)	.052*
Potassium (mg)	.686
Selenium (mcg)	.064*
Sodium (mg)	.011**
Zinc (mg)	.300
Choline (mg)	.308

**p<.05; *.10>p=>.05, Kruskal-Wallis Test

[a]non-transformed

Appendix D. Attrition Rate in Three Groups

	Yin	**Neutral**	**Yang**
Calories	100%	100%	100%
Calories from Fat	100%	100%	100%
Calories from Saturated Fat	90.2%	93.1%	91.1%
Protein	100%	100%	100%
Carbohydrate	100%	100%	100%
Total Dietary Fiber	93.4%	96.6%	94.6%
Dietary Fiber 2016	72.1%	79.3%	83.9%
Sugar	80.3%	86.2%	91.1%
Other Carbs	77.0%	86.2%	89.3%
Total Fat	100%	100%	100%
Saturated Fat	88.5%	93.1%	91.1%
Monounsaturated Fat	83.6%	86.2%	87.5%
Polyunsaturated Fat	83.6%	86.2%	87.5%
Omega 3 Fatty Acids	83.6%	86.2%	85.7%
Omega 6 Fatty Acids	83.6%	86.2%	85.7%

Appendix E. Characteristics of All the Nutrients Grouped in Yin and Yang

Characteristics of Macronutrients Grouped in Yin, Yang

	Total	**Yin**	**Yang**	**P_b**
Calories (kcal)	199.3_a (N=117)	1.8_b 146.2_a (n=61)	2.2_b 257.1_a (n=56)	.001**
Calories from Fat (kcal)	102.5_a (N=117)	$.44_b$ 61.9_a (n=61)	$.90_b$ 146.7_a (n=56)	.084*
Calories from Saturated Fat (kcal)	33.9_a (N=105)	$-.33_b$ 15.1_a (n=54)	$.38_b$ 53.8_a (n=51)	.008**
Protein (g)	6.6_a (N=117)	5.6_a (n=61)	7.7_a (n=56)	.814
Carbohydrates (g)	17.5_a (N=117)	$.58_b$ 16.1_a (n=61)	$.17_b$ 19.0_a (n=56)	.096*
Total Dietary Fiber (g)	3.2_a (N=110)	$-.17_b$ 3.1_a (n=57)	$-.70_b$ 3.1_a (n=53)	.026**
Dietary Fiber 2016 (g)	3.3_a (N=90)	$-.27_b$ 3.5_a (n=43)	$-.86_b$ 3.0_a (n=47)	.032**
Total Sugars (g)	5.1_a (N=100)	$-.09_b$ 3.8_a (n=49)	$-.63_b$ 6.4_a (n=51)	.037**
Other Carbs (g)	5.1_a (N=97)	5.0_a (n=47)	5.2_a (n=50)	.651
Fat (g)	11.5_a (N=117)	$-.39_b$ 6.9_a (n=61)	$.09_b$ 16.5_a (n=56)	.028**
Saturated Fat (g)	3.8_a (N=105)	-1.3_b 1.7_a (n=54)	$-.62_b$ 6.0_a (n=49)	.013**
Monounsaturated Fat (g)	4.5_a (N=100)	-1.4_b 3.0_a (n=51)	$-.77_b$ 6.0_a (n=49)	.037**
Polyunsaturated Fat (g)	3.3_a (N=100)	1.8_a (n=51)	4.9_a (n=49)	.302
Omega 6 Fatty Acids (g)	2.4_a (N=99)	1.7_a (n=51)	3.1_a (n=48)	.353

**p<.05; *.10>p=>.05, Independent t test

[a]non-transformed, [b]transformed

Characteristics of Vitamins in Yin and Yang Groups

	Total	**Yin**	**Yang**	**P[b]**
Vitamin A (IU)	798.4[a] (N=84)	598.0[a] (n=41)	989.5[a] (n=43)	.368
Beta Carotene (mcg)	262.3[a] (N=81)	.32[b] 261.4[a] (n=44)	-.48[b] 263.4[a] (n=37)	.087*
Vitamin B1 (mg)	.10[a] (N=94)	.10[a] (n=50)	.11[a] (n=44)	.639
Vitamin B2 (mg)	.14[a] (N=96)	.11[a] (n=51)	.16[a] (n=45)	.985
Vitamin B3 (mg)	1.9[a] (N=94)	1.3[a] (n=50)	2.6[a] (n=44)	.271
Vitamin B6 (mg)	.21[a] (N=90)	.16[a] (n=48)	.27[a] (n=42)	.293
Vitamin C (mg)	16.5[a] (N=109)	.24[b] 16.0[a] (n=57)	-.47[b] 17.1[a] (n=52)	.017**
Vitamin E (mg)	1.5[a] (N=71)	.44[a] (n=35)	2.6[a] (n=36)	.204
Folate Total (mcg)	46.4[a] (N=87)	43.7[a] (n=46)	49.4[a] (n=41)	.333
Folate DFE (mcg)	40.3[a] (N=84)	40.7[a] (n=44)	40.0[a] (n=40)	.322
Pantothenic Acid (mg)	.65[a] (N=58)	.50[a] (n=28)	.78[a] (n=30)	.580

**p<.05; *.10>p=>.05, Independent t test

[a]non-transformed, [b]transformed

Characteristics of Minerals and Choline Grouped in Properties

	Total	**Yin**	**Yang**	**P[b]**
Calcium (mg)	56.5[a] (N=114)	37.9[a] (n=59)	76.5[a] (n=55)	.945
Copper	.243[a]	.250[a]	.236[a]	.441

	Total	Yin	Yang	P_b
(mg)	(N=90)	(n=48)	(n=42)	
Iron (mg)	1.5_a (N=114)	1.7_a (n=59)	1.4_a (n=55)	.626
Magnesium (mg)	35.9_a (N=91)	32.9_a (n=50)	39.6_a (n=41)	.752
Potassium (mg)	257.2_a (N=96)	251.7_a (n=52)	263.8_a (n=44)	.882
Sodium (mg)	83.5_a (N=111)	52.8_a (n=58)	117.0_a (n=53)	.363
Zinc (mg)	1.3_a (N=90)	1.6_a (n=48)	1.0_a (n=42)	.967
Choline (mg)	34.9_a (N=65)	28.4_a (n=32)	41.2_a (n=32)	.766

**p<.05; *.10>p=>.05, Independent t test

$_a$non-transformed, $_b$transformed

Results of Nonparametric tests between Yin and Yang Group

Variables	P_a
Calories (kcal)	.000**
Calories from Fat (Kcal)	.011**
Calories from Saturated Fat(kcal)	.004**
Protein (g)	.213
Carbohydrate (g)	.547
Total Dietary Fiber (g)	.125
Total Soluble Fiber (g)	.046**
Dietary Fiber 2016 (g)	.080*
Soluble Fiber 2016 (g)	.075*
Sugar (g)	.048**
Other Carbs	.676
Total Fat (g)	.011**
Saturated Fat (g)	.005**
Monounsaturated Fat (g)	.047**
Polyunsaturated Fat (g)	.119
Omega 3 Fatty Acids (g)	.302
Omega 6 Fatty Acids (g)	.147
Vitamin A (IU)	.288
Vitamin A (RAE)	.786
Carotene (mcg)	.937

Variables	P[a]
Retinol (mcg)	.102
Beta Carotene (mcg)	.109
Vitamin B1 (mg)	.849
Vitamin B2 (mg)	.780
Vitamin B3 (mg)	.067*
Vitamin B6 (mg)	.154
Vitamin B12 (mg)	.464
Vitamin C (mg)	.038**
Vitamin D (mcg)	.048**
Vitamin E (mg)	.045**
Folate Total (mcg)	.459
Folate DFE (mcg)	.468
Vitamin K (mcg)	.397
Pantothenic Acids (mg)	.474
Calcium (mg)	.865
Copper (mg)	.849
Iron (mg)	.925
Magnesium (mg)	.416
Phosphorus (mg)	.172
Potassium (mg)	.825
Selenium (mcg)	.128
Sodium (mg)	.250
Zinc (mg)	.582
Choline (mg)	.201

**p<.05; *.10>p=>.05, Mann-Whitney U Test

[a]non-transformed

Appendix F. Variables transformed using logarithm

calories, calories from fat, protein, carbohydrates, total dietary fiber, dietary fiber (2016), total sugars, other carbs, fat, water, vitamin A, carotenoid RE, beta carotene, retinol, vitamin B1 (thiamin), vitamin B2 (riboflavin), vitamin B3 (niacin), vitamin B6, vitamin B12, vitamin C, vitamin D, vitamin E (a-toco), folate (total), pantothenic acid, calcium, copper, magnesium, manganese, phosphorus, potassium, and choline.