MEAT-ALTERNATIVE PRODUCTS:
NUTRIENT COMPOSITION AND FOOD LABEL QUALITY

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ABSTRACT

Many people are choosing vegetarian options, however, the USDA database has limited data on meat-alternative options making it difficult to accurately estimate nutrient intake. To evaluate the nutrient composition accuracy presented on plant-based, meat-alternative food labels, 40 different meat-alternative products were purchased for chemical analysis of protein, lipid, fiber, minerals and moisture using AOAC methods. These products were selected from a survey of 245 meat-alternative products identified in Honolulu markets, and were chosen based on their protein content, food form, and manufacturer. Results showed discrepancies between analytical data and product label values identifying more than 75% (n=31) of analyzed products non-compliant with the Nutrition Labeling and Education Act 80% - 120% tolerance limits for 1 to 4 label values. Energy and protein label values were relatively consistent with analyzed values for all forty products (correlation coefficient of 0.95 and 0.96 respectively). Energy and protein label values were also most frequently within NLEA regulations (36 and 39 products respectively). In contrast, about 45% (n =18) of total fat label values were out of compliance (understated by 0.7 g to 9.1 g). Analyzed values for mineral content found both under and over stated label values. Iron content in products ranged from 5.8 mg (32% DV) less than label, to 3.8 mg (21% DV) more than label; calcium 158 mg (16% DV) less than label to 153 mg (15% DV) more than label; and sodium 310 mg less than label to 180 mg more than stated on label. Values for iron, calcium, and sodium were out of compliance for 25%, 30 % and 7.5% of labels respectively. Many of these meat-alternative convenience foods provide more calories from fat than the labels indicate and contain unpredictable amounts of iron and calcium. With the recognition of nutrition's importance to health, unreliable nutrient label information creates challenges for food purchasing decisions and for professionals assessing nutrient intake.

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LIST OF ABBREVIATIONS

AOAC	Association of Official Analytical Chemists previously under the auspices of the USDA but presently include the Association of Analytical Communities and is considered AOAC INTERNATIONAL
APP	Alternate Protein Product
B	Blank
Ca	Calcium
CFR	Code of Federal Regulation
DM	Dry matter
DV	Daily Value
EtOH	Ethyl Alcohol
FAO	Food and Agriculture Organization (United Nations)
FDA	Food and Drug Administration
Fe	Iron
g	gram
ICP - OES	Inductively Coupled Plasma Optical Emissions Spectroscopy
IDF	Insoluble Dietary Fiber
MES	2-(N-Morpholino) ethanesulfonic acid
mg	milligram
Na	Sodium
NLEA	Nutrition Labeling Education Act
PBMA	Plant-based Meat Alternative Product or Products
PDCAAS	Protein Digestibility Corrected Amino Acid Score
PPM	parts per million
r	Spearman correlation coefficient
RACC	Reference Amount Commonly Consumed
SD	Standard Deviation
SR24	Standard Reference (USDA Database version 24)
SDF	Soluble Dietary Fiber
TDF	Total Dietary Fiber
TRIS	Tris (hydroxymethyl) aminomethane
TVP	Textured Vegetable Protein
USDA	United States Department of Agriculture
VPP	Vegetable Protein Product
WHO	World Health Organization

CHAPTER I: INTRODUCTION AND LITERATURE REVIEW

Importance of Meeting Nutrient Needs

Essential nutrients are nutrients absolutely vital for basic physiological functions and are not made in the body either at all, or in sufficient quantities to meet our needs. These essential nutrients must be in the foods we eat (or supplemented) and in sufficient quantities otherwise signs of deficiency can develop over time. Functions of essential nutrients in the body include: growth and reproduction, repair and maintenance, and regulation of chemical reactions.

Over the last three decades, nutrition research has expanded to include the evaluation of essential nutrients as related to preventing chronic disease and promoting long-term health (Riccioni et al. 2007). For example, vitamin C (ascorbic acid) is not only important to prevent the symptoms associated with its deficiency (bleeding gums, impaired wound healing, fatigue) (National Research Council 2000) but also functions in reducing inflammation and oxidation characteristic of chronic diseases such as cardiovascular disease (Alleva et al. 2012, Riccioni et al. 2012) .

There are approximately 50 essential nutrients that are contained in six different nutrient classes. Macronutrients include water, protein, lipid, and carbohydrate and micronutrients including vitamins and minerals. Because foods contain various proportions of these essential nutrients, ensuring adequate consumption of all nutrients can be difficult.

Meeting Nutrient Needs Using Food Guidance Systems

For nearly a century, the United States Department of Agriculture (USDA) Food Guidance systems have been designed to help people select foods in reasonable proportions and amounts to maximize the odds of meeting nutrient needs from the diet. Each food group has key nutrient strengths and weaknesses and consuming reasonable

combinations of foods from all groups is highly likely to meet the nutrient needs of a normal healthy individual who is meeting their energy needs with these foods.

The food group that often has been called the 'Meat and Bean Group' includes red meat, fish, poultry, eggs, beans and nuts. The current USDA food guidance system, MyPlate, now refers to this group as 'Protein Foods.' According to MyPlate online information, this food group provides key nutrients that include "protein, B vitamins, (niacin, thiamin, riboflavin and vitamin B6, vitamin E, iron, zinc and magnesium (USDA. 2012)." Other key nutrients provided by this group of foods are cobalamin, choline and the long chain omega-3 fatty acids EPA and DHA. Each individual food within the protein food group is unlikely to be a good source of all of these key nutrients, however, when a variety of these foods is selected, the odds of meeting these key nutrient needs are increased.

Public health messages have been encouraging a shift in protein group consumption from animal protein to more plant-based protein. Other societal influences that encourage this plant-based protein shift include: animal rights, religion, proposed weight loss benefits and more recently global issues of environmental and human population sustainability (Hayes and Ross 1987, Kim et al. 1999, Janda and Trocchia 2001, de Boer et al. 2004, Hoek et al. 2004, Lea et al. 2006, Boer et al. 2007, Marlow et al. 2009, Hoek et al. 2011).

Plant-based Meat Alternatives

In shifting to more plant-based proteins, there has been an increase in food products that would be considered plant-based 'meat' alternatives (PBMA). These PBMA products are available in the market in both traditional and non-traditional forms. Traditional PBMA forms, those that have been consumed in Asia for centuries and several decades in the U.S., include tofu (bean curd), tempeh (fermented soybean cake) natto (fermented soybean), and seitan (gluten). Non-traditional PBMA products are those that are the results of advancement in food technology and take on the appearance of

various types of meat. These contemporary PBMA are described in *Food Lover's Companion* (Herbst 2001) as:

> ". . . a category of meat-like products created from various soybean by-products including TVP (textured vegetable protein), soy protein concentrate and sometimes tempeh (soy bean cake) or tofu (soybean curd). Meat analogs come in a myriad of forms including bits, strips, links, patties and hotdogs. Patties may contain grains or vegetables. They can be prepared as one would prepare meat (grilled, sautéed, broiled)."

As PBMA products are often identified as meat substitutes, one would expect these meat-alternatives to provide the key nutrients associated with red meat or animal foods in the Protein Foods group. This is especially true for contemporary products that take on the appearance of various types of meat. A nutritional definition such as the following might be expected: a product that provides the key nutrients of animal protein (primarily meat, chicken or fish), at comparable amounts. These key nutrients include: protein, iron, zinc, as well as six B-vitamins: thiamin, riboflavin, niacin, pyridoxine, cobalamin and choline (Committee on the Scientific Evaluation of Dietary Reference Intakes et al. 1998, Panel on Micronutrients et al. 2001). Since the introduction of PBMA in the U.S. and international market, there have been various nutritional standards equating PBMA to meat.

Plant-based Meat Alternative Nutritional Comparison with Animal Protein

In 1979, Roberts (1979) described a FDA regulatory outlook addressing standards for 'Vegetable Protein Products' (VPP) in regards to their nutritional equivalence to animal protein products. 'Vegetable Protein Products' was the term selected for product labeling identifying the variety of processed plant protein foods used to substitute animal protein. Along with nomenclature for vegetable protein ingredients and products, the FDA also proposed that plant-based products be nutritionally equivalent to the original foods they were substituting to avoid being called 'imitation.' Nutrient profiles of six classes of animal protein foods were created. The proposed regulation also

required that the protein quality of these vegetable-protein replacements be 100% that of casein (Roberts 1979, USDA 1982). **Table 1.1** provides the proposed nutrient profile guideline for meat, chicken and fish analogs.

Table 1.1. Vegetable protein criteria for animal meat, chicken or fish equivalence[a]

Key Nutrients	Minimum Amount
Protein Biological Quality (% of casein)	100%
	Nutrient per Gram of Protein
Iron (mg)	0.15
Zinc (mg)	0.5
Thiamin (mg)	0.02
Riboflavin (mg)	0.01
Niacin (mg)	0.3
Pyridoxine (mg)	0.02
Cobalamin (mcg)	0.1

[a]adapted from Roberts (1979)

Although this proposed standard of nutritional equivalency to meat was not adopted by the FDA for final VPP products available to U.S. consumers, nomenclature creating food standards of identity for primary VPP were adopted for label ingredient statements. This nomenclature nutritionally defined VPP ingredients by its protein content (percent protein calculated on a dry weight basis). For example, soy protein (soy bean food products produced by the removal of the major non-protein constituents - water, oil, carbohydrates), requires a protein (N x 6.25) content of $\geq$50% and <65% to be identified as soy protein flour; $\geq$65% and <90% to be identified as soy protein concentrate ; and $\geq$90% to be identified as soy protein isolate (Roberts 1979). These nutritional standards were also recognized internationally by the Codex Committee on Plant Proteins established in 1978 by the Food and Agriculture Organization (FAO) and World Health Organization (WHO) Codex Alimetarius Commission. The addition of

vitamins, minerals and amino acids was considered optional for the finished product (Codex Alimentarius 2007).

Since 1971 the USDA National School Lunch Program has included non-animal meat protein, termed as 'Vegetable Protein Products' and 'Alternate Protein Products' (APP), in its meal plan (USDA Food and Nutrition Service 1978). **Table 1.2** summarizes the modifications in terminology and standards for non-animal meat protein used as a 'meat equivalent' by the USDA Food and Nutrition Service from 1971 till 2012.

Table 1.2. Vegetable Protein Product (VPP), Alternate Protein Product (APP) and tofu nutritional equivalence to meat in the USDA National School Lunch Program

Date	Standards of 1 oz. meat equivalence
1971	1 oz. Vegetable Protein Product (VPP)[a] • Protein quality must be ≥ 80% of casein • 18% protein by weight when hydrated • Fortified with iron and zinc • 30%(by weight) blend limit with meat
2000	1 oz. Alternate Protein Product (APP)[b] • Protein quality must be ≥ 80% of casein • 18% protein by weight when hydrated • No fortification with iron and zinc • 100% APP (no blend with meat required)
2012	1/4 cup (2.2 oz.) tofu[c] • 5 grams protein

[a](U.S. Code of Federal Regulations 1982)

[b](Food and Nutrition Service 2000, USDA 2012a)

[c](USDA 2012b)

In April of 2000, the term VVP was replaced with a new term, "Alternate Protein Product" (APP) to indicate that such products were no longer required to be only vegetable-based (i.e. could include whey protein, for example). At the same time it should be noted that the 30% limit on the amount of vegetable protein incorporated in a meat/meat alternative blend was removed allowing a one oz. equivalent of meat

alternative to replace one oz. of meat by up to 100%. In addition the requirement for iron and zinc fortification was no longer mandatory. Guidelines continued to require that the biological quality of meat-alternative protein be at least 80% that of casein and when hydrated at least 18% protein by weight (USDA Food and Nutrition Services 2000, USDA 2012a). Along with the evolving PBMA standards of nutritional equivalency to meat, PBMA innovative research and marketing aimed at expanding the role of these protein sources in the U.S. food supply continue to develop.

U.S. Market Sales of Plant-base Meat Alternative Products

Since the U.S. introduction to soy- meat alternatives back in the early 1940's, PBMA products have grown to become mainstream, convenience food options. In 2009 the North American market for meat substitutes was valued at $326 million (Heller 2010). The U.S. product database found that 110 new meat-substitute products were introduced in 2010 and 2011 with frozen meat substitute sales alone reaching $267 million (Barclay 2012). Datamonitor, a marketing research firm, forecast meat substitute sales in 2014 to increase to $368 million (Heller 2010). As the quantity and varieties of PBMA products become more available to consumers, nutrient facts information becomes important to aid consumers in making appropriate food choices.

Nutrient Facts Panel Use by Plant-based Meat Alternative Consumers

People choose to purchase foods for many reasons. Glanz et al. (1998) reported that consumers choose food primarily based on taste and cost rather than nutritional concerns. Although research has not documented what percent of consumers make their food purchasing decisions based on nutrition and/or health concerns, there are studies indicating that some consumers read food labels for this reason.

Neuhouser et al. (1999) reported results from a phone survey of over 1450 adults in Washington State that food labels were used by those concerned about consuming a lower fat diet and had the belief that there is an association between diet and cancer.

Data from this study indicated that for those reading labels, the primary focus was on label grams of fat and calorie information, read by more than 75% and 68% of participants, respectively. These data were supported by Ollberding et al. (2010) who found that fat and energy were the most frequently read parts of the nutrition facts panel.

Satia et al. (2005) reported that healthful eating self-efficacy, strong belief in a diet-cancer relationship, and trying to lose weight were strong psychosocial predictors of nutrition label use in a North Carolina African American population. Blitstein and Evans (2006) reported that 53% of adults across the United States, living with one or more children, read labels in order to maintain a healthy body weight. Women were more likely than men to read labels.

Another group of consumers that would likely read food labels includes those choosing to not consume animal flesh. In 2000, it was reported that 2.5% of the U.S. adult population consumed a vegetarian diet and 1% of those polled indicated that they were vegans (American Dietetics Association 2003). In 2006, 2.3% of the U.S. adult population consumed a vegetarian diet and 1.4% of those polled indicated that they were vegans (Craig et al. 2009). Although the total percent of vegetarians slightly decreased, the total number of vegetarians increased by approximately one million individuals. The majority of those choosing vegetarian lifestyle are female (Harris Interactive 2009).

Although there are no specific studies on what percentage of vegetarians use nutrition facts panels to obtain nutrient information, Hoek et al.(2004) found that Dutch vegetarians had more positive attitudes towards the importance of product information compared to non-vegetarians. It is probable that percent of individuals from vegetarian populations would likely be similar or greater than the general population because of their concern for maintaining weight (Thedford and Raj 2011, Timko et al. 2012), and preventing chronic disease (Segasothy and Phillips 1999, Craig et al. 2009).

Reliability of Nutrition Facts Labels

Nutrition Facts labels can be a valuable tools for making appropriate food choices. The value, however, is based on the concept that nutrients presented on food labels are both accurate and reliable. In 2008, the U.S. Government Accountability Office (GAO) reported that between fiscal years 2000 and 2006 the FDA collected targeted samples of 868 domestic products and 783 imported products for tests of compliance with nutrition labeling regulations. Findings indicate that 21% to 24% of products tested for label accuracy by the FDA were found to be in non-compliance (GAO 2008). This report also stated that due to limited resources and a growing number of food firms, enforcement efforts by the FDA cannot keep pace. Therefore, the FDA can provide little assurance that companies comply with food labeling laws and regulations.

Additional recent studies testing compliance with labeling regulations also confirm similar findings. Lai et al. (2009) reported that 15 out of 26 packaged clam products sold in Hawai'i contained iron that was $\geq$ 200% of the value stated on the Nutrition Facts Panel. Also, some products contained as low as 80% of the stated label values while others contained as much as 800% of their labeled value.

Lobanco et al. (2009) evaluated food labels of 153 salty and sweet processed snacks typically consumed by children and adolescents in Sao Paulo, Brazil. Chemical nutrient analysis of products revealed noncompliance of one or more food label nutrient values for every product type. More than 50% of cookies (n=20) were non-compliant for saturated fat content. Corn snacks (n=25) showed the highest frequency of overall non-compliance for dietary fiber (69%), sodium (72%), total fat (85%) and saturated fat (41%).

Urban et al. (2010) assessed label energy values of 10 frozen convenience meals purchase from supermarkets in the Boston MA area. Findings indicated that 30% (n = 3) meals were out of Nutrition Labeling Education Act (NLEA) label compliance for energy content with measured values greater that stated values by 21 to 31%.

The Health Canada's Trans Fat Monitoring Program (Pantazopoulos et al. 2011) looked at trans-fat and saturated fat content in selected foods. In contrast to the results of

the above research, this study found no significant difference between laboratory and food label values for trans-fat or saturated fat for over 380 cookies, crackers, granola bars, breakfast bars and frozen foods.

Study Objectives

With increasing awareness of the importance of proper nutrition in the prevention of short term and chronic disease, choosing foods based on their nutrient content becomes more meaningful. As PBMA products become more readily available as an alternative to animal proteins, knowledge of their nutrient content may be essential for those replacing meat with this option. Nutrient labels are designed to assist consumers and professionals in making nutritionally appropriate food choices, yet previous research indicates that some nutrient facts information may not be reliable. The reliability of PBMA nutrient labels has not yet been assessed.

Therefore, the objectives of this study are:

1. To identify and characterize the types of meat-alternative products available in the Honolulu market and evaluate nutrient label data for nutrients typically found in meat.

2. To evaluate the nutrient composition accuracy presented on plant-based, meat-alternative food labels.

CHAPTER II: METHODS

OVERVIEW

To identify plant-based meat alternative products (PBMA) in the market and evaluate label nutrient data for nutrients typically found in animal meat products, both the consumer and nutrient-based definitions were used to define PBMA (described in Chapter 1 and summarized in the **Glossary**).

Based on the consumer definition describing the function, form, and typical ingredients of PBMAs, both 'traditional' and 'non-traditional' forms of PBMAs were considered as part of this study. Processed soy and wheat products such as tofu (soybean curd), tempeh (fermented soybean cake), natto (fermented soy bean) and seitan (wheat gluten) were included as traditional PBMAs. Products having the characteristics and forms that mimic the texture, flavor and appearance of animal meat, were included as non-traditional PBMA forms. Non-traditional meat-analog or 'faux-meat' (Mangels et al. 2011), included varieties of semi-prepared soy-, wheat-, seed- and fungus- based products. Analogs that contained dairy or egg components were also included. Legumes, nuts or seeds in their natural, unprocessed state were not a part of this research. Selected PBMA identified in the market were then evaluated for nutrient composition food label accuracy. A general methods schematic is shown in **Figure 2.1.**

PART 1 - NUTRIENT AND INGREDIENT COMPOSITION OF PLANT-BASED MEAT-ALTERNATIVE PRODUCTS (PBMA)

Market Survey of PBMA

PBMA products were identified on a single day (March 4, 2010) in six markets located in Honolulu, Hawai'i. The markets that were surveyed represented the primary

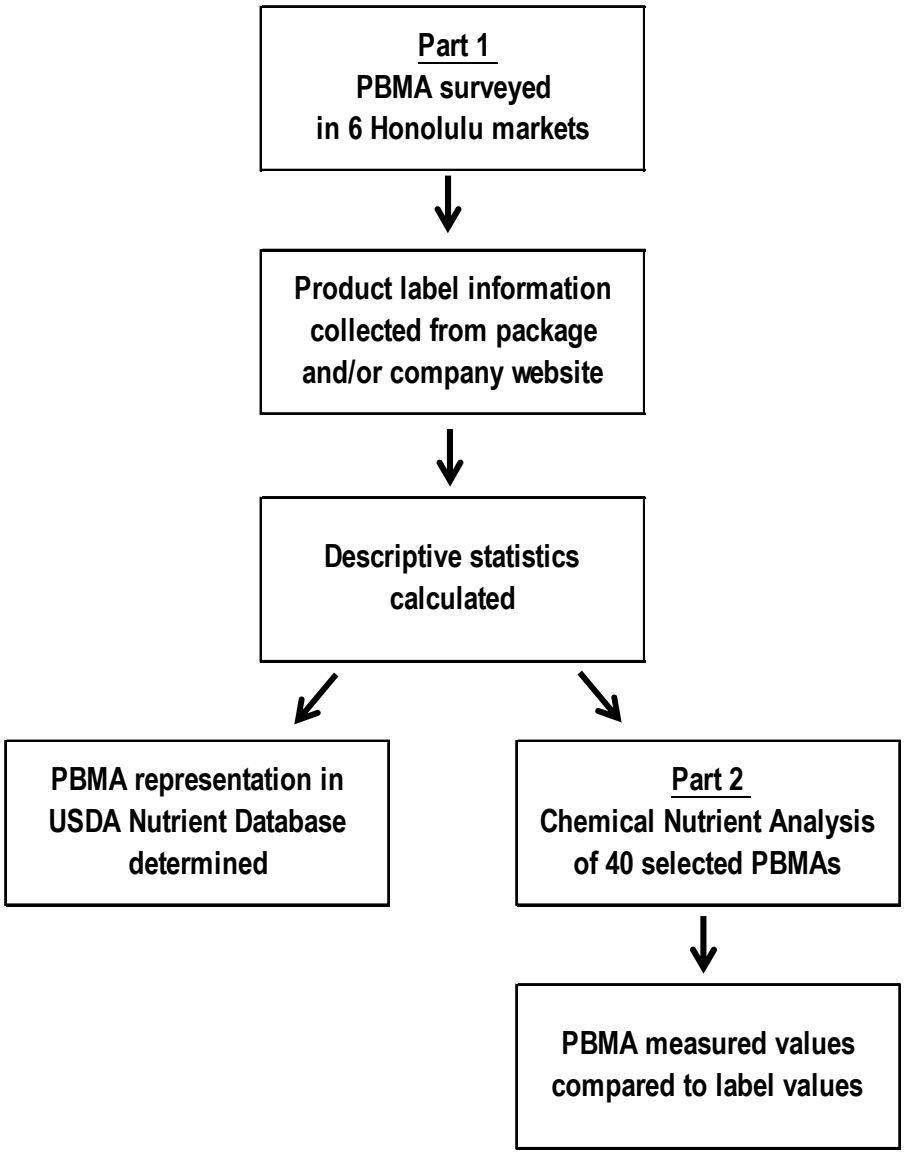

Figure 2.1. General study design to identify availability and label quality of plant-based meat-alternatives.

local and national health food stores and chain-name supermarkets on O'ahu. Stores in the Honolulu area were chosen for their size and proximity to the university, with the expectation that these would provide the greatest availability of PBMA (**Table 2.1**).

Table 2.1. Market types surveyed in Honolulu Hawaii on March 4, 2010.

Stores	Supermarket	Health Food Market	Local Market	National Market
Down to Earth		x	x	
Foodland	x		x	
Kokua		x	x	
Safeway	x			x
Times	x		x	
Whole Foods		x		x

Data collected on each PBMA food item included the product name, brand, food manufacturer, food form (i.e., sausage, patty, tofu etc.), Nutrition Facts panel information, ingredient list, and the stores in which it was available. Product Nutrition Facts and ingredient lists were obtained from product packages or manufacturers' websites. To determine PBMA product representation in the USDA National Nutrient Database for Standard Reference, version 24 (USDA 2011), brand name searches of the database were conducted.

Product Food-Form Categories

A product's food form category was determined by the form identified on the package label. If there was no form reference on the label, the product was categorized based on its visual appearance and definitions of food form in *Food Lover's Companion* (Herbst 2001) or *Merriam-Webster Online Dictionary* (Merriam Webster Incorp. 2012) . See **Glossary**.

Product Ingredients

The first ingredient of each PBMA product was recorded as the predominant ingredient. If the first ingredient was water, the second ingredient was recorded as the predominant ingredient. The frequency distribution of predominant PBMA ingredients was computed using the tabulate function of JMP Pro 9.0.2. To determine the availability

of PBMA products free of allergen ingredients, egg, dairy, wheat, soy and nut derivatives were identified from product ingredient labels.

Product Nutrient Composition from Food Labels

Values for serving size, energy, protein, carbohydrate, fiber, fat, iron and calcium were recorded for each product based on product label information. If the label provided additional nutrient value information, the key nutrients provided by animal meat were also recorded (zinc, thiamin, riboflavin, niacin, pyridoxine and cobalamin). Product fortification and enrichment were noted.

PART 2 - EVALUATION OF THE RELIABILITY OF NUTRIENT INFORMATION PRESENTED ON LABELS OF PLANT-BASED MEAT ALTERNATIVE PRODUCTS

Representative PBMA Sub-sample Selection for Chemical Analysis

From the 245 PBMA products identified in the supermarket label survey, a representative sub-sample of 40 products was selected for macronutrient and mineral chemical analysis. Out of 17 PBMA food product forms identified in the survey, this sub-sample selection process focused on three traditional and three non-traditional PBMA product food forms: tofu, tempeh and seitan (traditional), and hotdogs, patties and sausages (non-traditional). Within these six food forms (n = 150), products included for possible selection were limited to those distributed nationwide (i.e. strictly locally produced and distributed products were excluded from selection).

Products within each of the six chosen food forms were numerically ranked based on the summed score of four values:

A) 1 point per gram of protein per serving,

B) 1 point per gram of protein per 100 grams of product,

C) 5 points for each national chain-store that sold the product (Whole Foods or Safeway).

D) 2 points for each local store that sold the product (i.e. Down to Earth, Foodland, Kokua Market, and Times Market).

For example, a vegetarian hotdog with 16 grams of protein per serving, 21 grams of protein per 100 grams of product, available for purchase in Whole Foods market and Safeway (national chain-stores) and Down to Earth market (a local store chain) would have a tallied final score of 49 (16 + 21 + 5 + 5 + 2). The greater the tallied score of a PBMA product, the higher the ranking, and the greater the possibility it would be selected for chemical nutrient analysis.

After numeric ranking of products within each of the six food forms, a sub-sample selection process was designed to represent each food form proportionately. While this process gave importance to products that were top-ranking, it also ensured inclusion of products representing a variety of food manufacturers. To do this, half of the products identified within each of the six food forms were chosen from the very top-ranked products regardless of manufacturer and the remaining half were selected consecutively from the remaining top-ranking product manufacturers, not including products from manufacturers previously selected.

Chemical Analysis of Products

A single package of the 40 selected products was purchased. Each package contained one to 4 units. The complete content of the package was homogenized. Tofu products were drained of any water, if present, before homogenization. Product label information was documented, and products were photographed in and out of its packaging. Product weights were recorded and then compared with weight information provided on the packaging. The product chemical nutrient analysis procedure is summarized in **Figure 2.2**.

Triplicate samples of each product were analyzed for moisture and fat and duplicate samples were analyzed for total dietary fiber at the University of Hawai'i Mānoa Human Nutrition Laboratory. Triplicate samples were analyzed for protein

(nitrogen x 6.25) and selected minerals (Na, Ca, Fe, Mg, P, K, and Zn) at the Louisiana State University (LSU) AgCenter Soil Testing and Plant Analysis Laboratory using the LSU protocol (LSU 2010).

In preparation for analysis, samples were homogenized and then freeze-dried 30 hours in a pilot scale freeze-dryer (Virtis SOL, SP Industries). Using freeze-dried samples, fat was analyzed in triplicate with a Soxhlet extractor and ether solvent (Modified AOAC Official Method 2003.05) and minerals were analyzed in triplicate using ICP-OES Optical Emission Spectroscopy. Total dietary fiber (TDF), soluble dietary fiber (SDF), and insoluble dietary fiber (IDF) were quantified from moisture-free, lipid-free PBMA samples using AOAC method 991.43. Protein was calculated from nitrogen x 6.25. Total carbohydrate was determined by difference. Energy was calculated using Atwater factors, 4/4/9 calories per gram of protein, total carbohydrate and total fat respectively, minus insoluble fiber. All nutrient analysis followed AOAC International guidelines 18th ed. (AOAC International 2006) For detailed lab procedures refer to **Appendix A - C**.

Comparison of Analytical Nutrient Values to Food Label Values and USDA Data

To evaluate the accuracy of nutrition label information, Nutrition Labeling and Education Act (NLEA) standards 21 CFR 101.9 (g) 4,5,6 and 7 were used (U.S. Food and Drug Administration.) NLEA established allowable limits for labeling errors based on the regulations in **Table 2.2.**

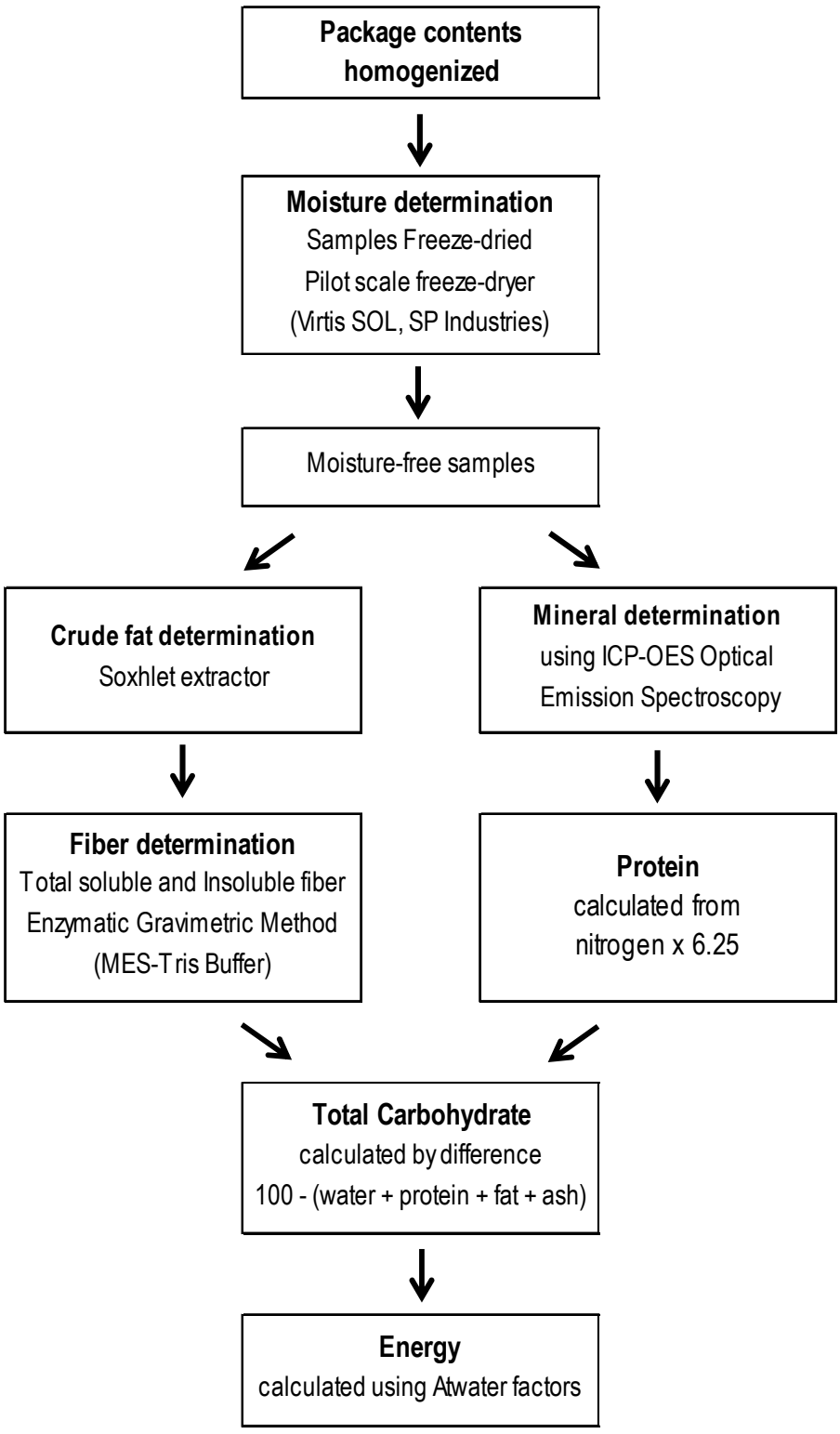

Figure 2.2. Work flow of analytical laboratory procedures following AOAC international guidelines.

Table 2.2. Code of Federal Regulations for Class I, Class II and Third Group nutrient categories.		
Nutrient Categories	**Regulation**	**Nutrient Types**
Class I (added) (21 CFR 101.9(g)(3))	Nutrient must be present at 100% or more of the declared label value	Vitamins, minerals, protein, dietary fiber, or potassium
Class II (naturally occurring) (21 CFR 101.9(g)(3))	Nutrient must be present at 80% or more of value declared on label.	Vitamins, minerals, protein, total carbohydrate, dietary fiber, other carbohydrate, polyunsaturated and monounsaturated fat, or potassium
Third Group (21 CFR 101.9(g)(5))	Nutrient must be present at 120% or less of value declared on label	Calories, sugars, total fat, saturated fat, cholesterol, and sodium

Source: Guidance for Industry: Nutrition Labeling Manual - A Guide for Developing and Using Databases http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/FoodLabelingNutrition/ucm063113.htm 1998 edition, July 2003 update.

Nutrient values on food labels also are rounded based on NLEA rounding rules (Bender et al. 1998). See **Appendix D** for additional details on these food labeling regulations.

To compare analytical nutrient values of PBMA products with nutrient values presented on food labels, analytical values of nutrients expressed in percent Daily Value (%DV) were converted to this form, but were not rounded using U.S. food labeling rounding rules before comparison. This was decided to more accurately evaluate comparison of analytical values with label values.

The USDA National Nutrient Database for Standard Reference (SR 24) provides data for five of our analyzed products. Means of the analyzed nutrient values for each of these products were compared to the USDA values.

Statistical Analysis

Descriptive statistics (frequencies, means, standard deviations, ranges and proportions) correlations and t-tests were performed using GraphPad InStats (version 3.06). Means of our analytical nutrient values were compared with product label values and USDA database values using Spearman's correlation. P values less than 0.05 were considered significant.

CHAPTER III: RESULTS

PART 1 - NUTRIENT AND INGREDIENT COMPOSITION OF PLANT-BASED MEAT-ALTERNATIVE PRODUCTS

Market Survey of PBMA

In all six markets surveyed, a combined total of 245 different PBMA products from 38 brands and 31 different manufacturers were identified (**Table 3.1**). See **Appendix E** for the complete product list. From these 245 products, 17 different food forms were identified and grouped as traditional or non-traditional PBMA (**Table 3.2**). Natto, seitan, tempeh and tofu were classified as traditional PBMA forms (n = 63);

Table 3.1. Manufacturers and number of plant-based meat alternative products identified in six Honolulu markets.[a]

Manufacturer	Number of products	Manufacturer	Number of products
Aloha Tofu Factory	5	Kellogg NA Co.	34
Amy's Kitchen Inc	6	Lightlife Foods	34
Boca Food Co.	11	Lucerne Foods Inc.- Safeway Brand	27
Dominex LC	2	Morinaga Nutritional Foods Inc	5
Dr Praeger's Sensible Foods	6	Mrs Cheng's Soybean Products	2
El Burrito Mexican Food Product Inc.	1	Nate's	5
Field Roast Grain Meat Co.	8	Nijiya	1
Follow Your Heart	1	Pulmuone Wildwood Inc	7
Food for Life Baking Co.	3	Quong Hop Co.	6
FoodTech International, Inc.	6	Quorn Foods Ltd	12
Garden Protein International	9	Sunshine Burgers & Speciality Foods, LLC	6
Hains Celestial Group	24	Turtle Island Foods Inc.	15
Hawai'i Taro Co., Inc.	3	VegeUSA, LLC	12
Health is Wealth Products Inc.	3	Vitasoy USA	6
House Foods America Corp.	11	Whole Foods Market IP, LP	2
Kanai Tofu Factory	2		

[a]Survey was conducted in 3 supermarkets and 3 health food stores on March 4, 2010

bacon, cutlets and filets, deli cold cuts, ground, hotdog, meat balls, 'mixed,' nuggets, patties, roast, sausage, strips and 'other' were grouped as non-traditional PBMA (n = 182). Products labeled 'cutlet' and 'filet' had similar appearances, and were categorized together. PBMA in the 'mixed' category were products that contained a PBMA product as an ingredient in a ready-to-eat food, such as a taquito or chili made with PBMA ground 'beef.' The 'other' food form category was included to accommodate a PBMA shrimp product and tofu noodle product that did not fit in existing food form categories.

Table 3.2. Plant-based meat alternative(PBMA) food forms identified in six Honolulu markets.[a]

Product Food Forms	n	% of Traditional PBMA (n = 63)	% of Non-traditional PBMA (n = 182)	% of Total Traditional and Non-traditional PBMA (n = 245)
Traditional PBMA				
natto	2	3.2%		0.8%
seitan	2	3.2%		0.8%
tempeh	11	17.5%		4.5%
tofu	48	76.2%		19.6%
Non-traditional PBMA				
bacon	3		1.6%	1.2%
cutlet and filets	24		13.2%	9.8%
deli cold cuts	12		6.6%	4.9%
ground	12		6.6%	4.9%
hotdog	11		6.0%	4.5%
meat balls	7		3.8%	2.9%
mixed	6		3.3%	2.4%
nuggets	18		9.9%	7.3%
patties	59		32.4%	24.1%
roast	6		3.3%	2.4%
sausage	17		9.3%	6.9%
strips	5		2.7%	2.0%
other	2		1.1%	0.8%

[a]Survey was conducted in 3 supermarkets and 3 health food stores on March 4, 2010

Retail Market Sources of PBMA

Of the total 245 products, tofu (n = 48) and patties (n = 60) were the most common traditional and non-traditional forms and made up 20% and 24% of all identified PBMA, respectively. While most forms of PBMA were available in both health food stores and mainstream supermarkets, the variety of forms and of products within forms was much greater in national chain stores. National chain stores, Whole Foods Market and Safeway, carried ~ 60% and ~ 33% of total products identified respectively. Among local stores, health food stores carried more varieties of PBMA forms and products within forms than local super markets. A majority of PBMA in local supermarkets (70%) were in the form of tofu and patties. PBMA in the form of seitan, tempeh and the non-traditional roast form were only available in health food store locations.

Main Ingredients in PBMA

The predominant ingredients found in both traditional and non-traditional PBMA were water, soy and wheat. When the ingredient water is not considered, of the 63 traditional PBMA products, more than 95% were soy-based. Of the 182 non-traditional PBMA, almost 60 % had soy as a first ingredient, followed by wheat (~16%) and then smaller amounts of a variety of other ingredients. Other main ingredients of specific products included vegetables, Mycoprotein (a proprietary ingredient made from Fusarium venenatum fungus), and sunflower seeds.

Among products with soy or wheat as the predominant ingredient, there were some noted differences between traditional and non-traditional products. The type of soy used in traditional products utilized most of the whole soybean in the final product, while non-traditional products were predominantly made from soy isolates and concentrates (i.e. soy with some of the non-protein constituents removed). Traditional products were made of either soy or wheat rather than a combination of the two like some of the non-traditional PBMA that included both soy and wheat. TVP, (textured vegetable protein), was the primary ingredient in 15% of non-traditional PBMA. Based on surveyed PBMA ingredient labels, the sub-ingredients of TVP are soy isolate or soy concentrate along

with wheat gluten or wheat protein as secondary components. See **Table 3.3** for details on predominant PBMA ingredients. Typical traditional products contained a maximum

Table 3.3. Predominant ingredients[a] of 245 traditional and non-traditional plant-based meat alternatives (PBMA) identified in six Honolulu markets.

Ingredients	% of Traditional PBMA (n = 63)	% of Non-traditional PBMA (n = 182)
Soy	**96.8%**	**58.8%**
soy protein concentrate		17.6%
TVP[b]		14.8%
soy protein isolate		9.3%
soy protein		7.7%
soy fiber		6.6%
soybean	96.8%	2.2%
soy flour		0.5%
Wheat	**3.2%**	**15.9%**
wheat gluten	3.2%	9.3%
wheat protein		4.9%
bulgur wheat		1.1%
wheat fiber		0.5%
Other	**0%**	**25.3%**
vegetables[c]		9.3%
Mycoprotein[d]		6.6%
sunflower seed		3.3%
brown rice		2.7%
beans[e]		1.6%
egg white		1.1%
curdlan gum		0.5%

[a]The first ingredient listed on package label. If first ingredient was water, then second ingredient on list was used.

[b]Textured Vegetable Protein. The main ingredients of TVP are soy isolate or concentrate followed typically by wheat gluten or wheat protein.

[c]vegetables = carrot, corn, eggplant, mushroom, onion, spinach, taro leaf.

[d]product based on a fungus called Fusarium venenatum

[e]beans = blackbean, garbanzo bean, kidney bean.

of 4 ingredients, up to 15 for seasoned tofu/tempeh products. Non-traditional PBMA contained a maximum of 39 ingredients as it was common for these products to be prepared with seasonings and 18.7% (n = 34) were fortified with one or more B vitamins and/or selected minerals such as iron and zinc (**Table 3.4**).

Table 3.4. Percent of plant-based meat alternative products (PBMA) which were fortified.[a]

Product Food Forms	n	# of fortified products	% of Traditional PBMA (n = 63)	% of Non-traditional PBMA (n = 182)	% of Total Traditional and Non-traditional PBMA (n = 245)
Traditional PBMA					
natto	2	0	0.0%		0.0%
seitan	2	0	0.0%		0.0%
tempeh	11	0	0.3%		0.1%
tofu	48	1	1.2%		0.3%
Total traditional PBMA	**63**	**1**	**1.6%**		
Non-Traditional PBMA					
bacon	3	2		1.1%	0.8%
cutlet and filets	24	1		0.5%	0.4%
deli cold cuts	12	5		2.7%	2.0%
ground	12	5		2.7%	2.0%
hotdog	11	6		3.3%	2.4%
meat balls	7	0		0.0%	0.0%
mixed	6	0		0.0%	0.0%
nuggets	18	2		1.1%	0.8%
patties	59	8		4.4%	3.3%
roast	6	0		0.0%	0.0%
sausage	17	3		1.6%	1.2%
strips	5	2		1.1%	0.8%
other	2	0		0.0%	0.0%
Total non-traditional PBMA	**182**	**34**		**18.7%**	**14.3%**

[a]Survey was conducted in 3 supermarkets and 3 health food stores on March 4, 2010

Nutrient Composition of PBMA

Energy and Macronutrient Values from Food Labels

Tables 3.5 (traditional PBMA) and **Table 3.6** (non-traditional PBMA) provide a summary of the product nutrient data obtained from food labels for energy and macronutrients values of the surveyed PBMA grouped by food forms. Results show a wide range of PBMA product label serving sizes, and values for energy, protein, and other macronutrients among food form categories and within some food form categories. Among food form categories, serving size values ranged from a low of 10 g for a 'bacon strip' product to a high of 284 g for a 'mixed' product. Label energy values ranged from 20 kcals/serving for a 'bacon strip' product, to 340 kcals per serving for a 'roast' product. Label protein values ranged from zero g per serving for a product in the 'other' category (a shrimp analog product) up to 42 g per serving for a product in the roast food form category. Similarly other macronutrient label values among surveyed PBMA products showed wide variations.

The food form categories 'tofu' and 'mixed' products had wide ranges of values within each category. For example, within the tofu category, there were substantial ranges in serving sizes (83.2 ± 16.9 g/serving), energy (83.3 ± 42.5 kcals/serving) and protein content (9.52 ± 5.87 g/serving). Due to these variations, tofu products were further separated into 'firm', 'soft', 'fried' and 'seasoned.' The 'soft' tofu group included regular soft tofu, as well as silken extra firm, firm and soft tofu. This separation allowed for greater nutrient similarity within each form of tofu, with the exception of products in the 'fried tofu' category that had serving sizes ranging from 14 to 170 g. The mean protein content of 'seasoned' tofu products (19.6 ± 5.32 g/serving) was almost 15 grams more per 85 g serving than tofu products grouped as 'soft' (5.0 ± 0.85 g/serving). Although firmness was not indicated on the package label of the 'seasoned' tofu products (all from the same manufacturer), they were notably denser than products labeled as soft tofu. It is likely that differences in moisture content are responsible for the marked difference in protein content per serving.

Another food form category that showed a wide range in label values were PBMA products in the 'mixed' category. These included vegetarian taquitos, vegetable proteins combined with beans, and a turkey-like product with cranberry stuffing. Thus, the

Table 3.5. Summary of 63 macronutrient nutrient label values for traditional plant-based meat alternative food forms (amount per serving).

Name (form)	n	Serving size (g)	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Fiber (g)	Protein (g) per 100 kcal
natto (mean ±SD)	2	62.5 ± 31.8	110.0 ± 42.4	9.5 ± 3.5	5.0 ± 2.8	5.5 ± 0.7	3.5 ± 0.7	8.7 ± 0.1
range		40 - 85	80 - 140	7 - 12	3 - 7	5 - 6	3 - 4	8.6 - 8.7
seitan (mean ±SD)	2	112.5 ± 38.9	125.0 ± 21.2	22 ± 2.8	2 ± na[d]	6.0 ± 2.8	1.5 ± 0.7	17.7 ± 0.7
range		85 - 140	110 - 140	20 - 24	2 - 2	4- 8	1 - 2	17.1 - 18.2
tempeh (mean ±SD)	11	93.5 ± 20.2	186.4 ± 49.0	16 ± 4.7	7.1 ± 2.9	14.6 ± 3.7	7.4 ± 3.4	8.6 ± 1.0
range		57 - 113	100 - 240	8 - 22	3 -11	9 - 20	3 - 12	6.5 - 10.0
tofu TOTAL (mean ±SD)	48	83.2 ± 16.9	86.3 ± 42.5	9.5 ± 5.9	3.9 ± 2.3	33 ± 3.5	1.2 ± 0.9	10.8 ± 1.9
range		14 - 170	30 - 170	4 - 25	0.5 - 13	0 - 15	0 - 3	8.0 - 16.7
tofu, firm[a] (mean ±SD)	23	82.7 ± 3.0	76.1 ± 17.7	8.0 ± 2.4	3.8 ± 0.8	2.0 ± 1.2	1.1 ± 0.7	10.4 ± 1.1
range		79 - 85	50 - 130	5 - 15	2 - 5	0 - 5	0 - 3	8.6 - 14.0
tofu, fried (mean ±SD)	4	78.0 ± 66.0	102.5 ± 49.9	9.3 ± 4.1	6.8 ± 4.3	2.3 ± 3.3	1.8 ± 1.3	9.1 ± 1.1
range		14 - 170	50 - 170	4 - 14	4 - 13	0 - 7	0 - 3	8.0 - 10.0
tofu, soft[b] (mean ±SD)	12	84.6 ± 2.6	46.7 ± 8.3	5.0 ± 0.9	2.1 ± 0.8	1.7 ± 0.7	0.7 ± 0.9	10.9 ± 2.2
range		79 - 91	30 - 60	4 - 6	0.5 - 3	1 - 3	0 - 3	8.9 - 16.7
tofu, seasoned[c] (mean ±SD)	9	85 ± 0	157.8 ± 13.9	19.6 ± 5.3	5.6 ± 3.0	9.0 ± 4.1	2.0 ± 0.7	12.3 ± 2.7
range		85 - 85	130 - 170	13 - 25	3.5 - 12	3 - 15	1 - 3	8.1 - 14.7

[a]tofu products labeled as firm, medium firm or extra firm

[b]tofu products labeled as soft or silken

[c]tofu products that were packaged with condiments.

[d]not applicable

Table 3.6. Summary of 182 macronutrient nutrient label values for non-traditional plant-based meat alternative food forms (amount per serving).

Name (form)	n	Serving size (g)	Energy (kcal)	Protein (g)	Fat (g)	Carbohydrate (g)	Fiber (g)	Protein (g) per 100 kcal
bacon strips[a] (mean ±SD)	3	14.0 ± 3.5	46.7 ± 23.1	2.0 ± na[c]	3.3 ± 2.0	1.3 ± 1.2	0.7 ± 0.6	5.6 ± 3.9
range		10 - 16	20 - 60	2 - 2	1 - 4.5	0 - 2	0 - 1	3.3 - 10.0
cutlets + filets (mean ±SD)	24	84.9 ± 19.9	159.4 ± 57.2	12.3 ± 4.2	6.0 ± 4.6	15.3 ± 8.6	2.9 ± 1.1	8.8 ± 4.8
range		51 - 142	80 - 280	3 - 21	0.5 - 17	4 - 35	1 - 6	3.0 - 17.5
deli cold cuts (mean ±SD)	12	53.2 ± 9.0	91.7 ± 16.4	13.0 ± 2.0	2.3 ± 1.2	5.2 ± 1.9	1.7 ± 1.6	14.6 ± 3.0
range		30 - 62	50 - 110	9 - 16	0 - 4	2 - 8	0 - 4	10.0 - 18.8
ground (mean ±SD)	12	59.4 ± 9.2	78.3 ± 27.9	10.4 ± 2.7	1.4 ± 2.1	7.6 ± 3.2	2.3 ± 1.2	14.1 ± 4.8
range		55 - 85	60 - 160	6 - 14	0 - 7.5	4 - 13.5	0 - 5	8.1 - 23.3
hotdog (mean ±SD)	11	51.4 ± 14.0	75.5 ± 24.5	10.1 ± 2.9	2.5 ± 1.8	3.1 ± 2.1	1.2 ± 1.2	14.1 ± 3.9
range		35 - 76	45 - 110	7 - 16	0 - 6	1 - 8	0 - 3	10.0 - 20.0
meat balls (mean ±SD)	7	64.3 ± 20.7	108.6 ± 33.4	9.7 ± 3.6	4.4 ± 2.4	8.4 ± 5.8	3.1 ± 1.9	9.6 ± 3.8
range		43 - 85	90 - 180	5 - 16	1.5 - 9	4 - 21	1 - 6	2.8 - 14.4
mixed[b] (mean ±SD)	6	144.3 ± 92.1	143.3 ± 82.4	11.2 ± 7.9	3.6 ± 2.7	17.0 ± 14.3	3.7 ± 4.2	7.7 ± 3.9
range		45 - 284	50 - 260	3 - 19	0 - 7	6 - 44	1 - 12	3.3 - 12.0
nuggets (mean ±SD)	18	83.9 ± 14.3	160.8 ± 35.2	12.8 ± 3.6	6.6 ± 3.3	13.7 ± 5.6	3.1 ± 1.0	8.5 ± 3.4
range		71.0 - 123	80 - 210	6 - 20	1 - 15	5 - 23	2 - 6	4.0 - 15.4
patties (mean ±SD)	59	72.7 ± 15.0	130.7 ± 46.6	10.3 ± 4.6	4.5 ± 3.2	13.4 ± 7.0	3.4 ± 1.7	8.6 ± 4.3
range		38 - 120	70 - 250	3 - 26	0.5 - 13	2 - 30	0 - 9	2.5 - 21.3
roast (mean ±SD)	6	116.0 ± 26.7	240.0 ± 91.0	27.8 ± 10.8	9.3 ± 6.6	11.5 ± 4.1	4.1 ± 1.4	12.0 ± 2.8
range		85 - 147	90 - 340	14 - 42	1.5 - 21	6 - 16	2.5 - 6	8.8 - 15.6
sausage (mean ±SD)	17	77.2 ± 20.9	164.1 ± 69.9	17.1 ± 7.5	7.2 ± 4.1	8.5 ± 2.9	3.4 ± 2.4	10.5 ± 1.4
range		45 - 100	60 - 270	7 - 29	0 - 13	3 - 12	1 - 8	7.5 - 12.7
strips (mean ±SD)	5	93.6 ± 19.2	122.0 ± 40.2	18.6 ± 4.5	1.6 ± 1.8	9.0 ± 6.7	2.6 ± 1.8	15.8 ± 2.6
range		85 - 128	80 - 170	14 - 23	0 - 3.5	6 - 21	1 - 5	11.2 - 17.5
other (mean ±SD)	2	99.0 ± 19.8	100.0 ± 113.1	0.5 ± 0.7	5.3 ± 6.7	4.5 ± 2.1	2.5 ± 0.7	2.5 ± 3.5
range		85 -113	20 -180	0 - 1	0.5 - 10	3 - 6	2 - 3	0 - 5.0

[a]Canadian bacon was grouped with pattes

[b]Products which contain PBMA as part of a multi-food group product.

[c]Not applicable

serving size and nutrient content variability is primarily due to the heterogeneity of the forms of the products. (For energy and macronutrient label data obtained from individual products see **Appendix F.**)

Energy and Macronutrients Values per 100 grams of Product

Overall, due to substantial variations in serving sizes, it is difficult to compare the macronutrient content among and within PBMA food forms. Consequently, macronutrient label values also are expressed per 100 g amounts (**Appendix G-1and G-2**). Comparing mean values for energy and macronutrients among food forms at 100 g continued to show wide value ranges particularly for energy, protein, fiber and fat.

Energy per 100 g

Traditional and non-traditional PBMA forms varied for energy values per 100 g amounts from a mean of 55.4 ± 11.0 kcals (soft tofu) to 210 ±141 kcals (fried tofu); 130 ± 35.3 kcals (strips) to 317± 101 kcals (bacon strips) respectively. Traditional tofu continued to have the widest range of energy values within a food form.

Protein per 100 g

Among the various food forms, non-traditional deli cold cuts and roasts had the greatest protein values per 100 g at a mean of 24.7 ± 2.74 g and 23.3 ± 5.16 g respectively. Traditional seitan and seasoned tofu, averaging 21.3 ± 9.85 g protein /100 g, and 23 ± 6.25 g protein /100 g respectively, were comparable to non-traditional deli cold cuts, roasts, sausage and strips food forms with mean protein values between 20 to 25 g per 100 g. In contrast, 100 g amounts of traditional soft tofu products and non-traditional 'other' products contained means of 5.93 ± 1.11 g protein and 0.45 ± 0.64 g protein respectively.

Fiber and Fat per 100 g

Other nutrient values noted with a wide range of mean values among food forms were those of fiber and fat. Among traditional and non-traditional products,

traditional PBMA had both the lowest and highest PBMA fiber values per 100 g with soft tofu at 0.79 ± 1.04 g compared to 7.54 ± 2.25 g for tempeh. For fat values per 100 g, seitan and strips were lowest at a mean of 1.89 ± 0.71 g and 1.80 ± 2.12 g respectively and fried tofu and bacon strips were highest at 15.6 ± 12.2 g and 22.1 ± 10.5 g respectively.

Protein Nutrient Density

Among PBMA food forms, seitan is the most protein dense product, averaging 17.7 ± 9.86 g per 100 kcal (5.6 kcal per g of protein). Non-traditional products in the form of strips contained 15.8 ± 5.56 g/100 kcal, deli cold cuts, 14.6 ± 2.96 g /100 kcals, ground (14.1 ± 4.82 g/100 kcal and hotdogs 14.1 ± 3.88 g/100 kcals, were also comparatively high in protein relative to energy content. Traditional and non-traditional PBMA food forms with comparatively low protein density were tempeh (8.56 ± 0.93 g/100 kcals), natto (8.66 ± 0.13g /100 kcal), 'other' (2.50 ± 3.54 g/100 kcals), and bacon strips (5.56 ± 3.85 g/100 kcals) (**Table 3.5 and 3.6**).

Micronutrient Values from Food Labels

Based on food label nutrient information, PBMA products frequently provide significant amounts of sodium and iron, key nutrients commonly available in meat products. Some PBMA products also contain significant amounts of calcium. **Tables 3.7** and **3.8** provide information about the content of these nutrients in traditional and non-traditional PBMA products based on the product labeled amounts per serving size. These data also are available in **Appendix H-1 and H-2**, expressed per 100 g amounts of each food.

The sodium content indicated on traditional PBMA food products ranged from zero to 770 mg per serving. Most soy products contain little natural sodium. Traditional food forms with the greatest sodium content (due to added salt) included seitan (620 ± 212 mg; range 470 to 770 mg), 'seasoned' tofu (386 ± 199 mg; range 155 to 700 mg), and tempeh (49.1 ± 139 mg; range 0 to 470 mg).

The sodium content indicated on non-traditional PBMA food products ranged from zero to 820 mg per serving. Non-traditional food forms with the greatest sodium

Table 3.7. Summary of 63 micronutrient nutrient label values for traditional plant-based meat alternative food forms (amount per serving).

Name (form)	n	Serving size (g)	Sodium (mg)	Iron %DV	Calcium % DV
natto (mean ±SD)	2	62.5 ± 31.8	15.0 ± 21.2	9.0 ± 1.4	5.0 ± 1.4
range		40 - 85	0 - 30	8 - 10	4 - 6
seitan (mean ±SD)	2	112 ± 38.9	620.0 ± 212.1	7.0 ± 1.4	3.0 ± 1.4
range		85 - 140	470 - 770	6 - 8	2 - 4
tempeh (mean ±SD)	11	93.5 ± 20.2	49.1 ± 139.7	14.5 ± 5.2	8.6 ± 2.9
range		57 - 113	0 - 470	8 - 20	4 - 15
tofu TOTAL (mean ±SD)	48	83.2 ± 16.9	87.4 ± 167.6	7.0 ± 4.0	9.6 ± 8.7
range		14 - 170	0 - 700	0 - 16	0 - 50
tofu, firm[a] (mean ±SD)	23	82.7 ± 3.0	16.1 ± 17.1	6.4 ± 2.3	10.1 ± 5.8
range		79 - 85	0 - 55	0 - 10	0 - 30
tofu, fried (mean ±SD)	4	78.0 ± 66.0	12.5 ± 6.5	6.5 ± 3.4	24.5 ± 19.7
range		14 - 170	5 - 20	2 - 10	8 - 50
tofu, soft[b] (mean ±SD)	12	84.6 ± 2.6	25.0 ± 22.5	4.8 ± 1.3	4.2 ± 2.9
range		79 - 91	0 - 70	4 - 8	2 - 10
tofu, seasoned[c] (mean ±SD)	9	85.0 ± 0	386.1 ± 199.5	11.4 ± 6.5	8.7 ± 6.1
range		85 - 85	155 - 700	0 - 16	0 - 20

[a]tofu products labeled as firm, medium firm or extra firm

[b]tofu products labeled as soft or silken

[c]tofu products that were packaged with condiments.

content included roasts (552 ± 106 mg; range 420 to 710 mg), strips (502 ± 58.1 mg; range 410 to 570 mg), and sausage (499 ± 169 mg; range 270 to 840 mg).

Based on product label nutrient information, the iron content of traditional PBMAs ranged from zero to 20% of the Daily Value (DV; 100% DV for iron = 18 mg). Among the traditional food forms, tempeh contained the greatest amount of iron per labeled serving size (14.5 ± 5.18 % DV; range 8 to 20 % DV). 'Soft' tofu had the lowest iron content (4.83 ± 1.34 % DB; range 4 to 8 % DV). Some types of tofu indicated zero iron in the product. Since their base ingredient, soybeans, is moderately high in iron, these values likely represent under reporting of this nutrient.

The labeled iron content of non-traditional PBMAs ranged from zero to 40% DV per serving. The food form with the greatest amount of iron per serving was strips (20.0 ±

Table 3.8. Summary of 182 micronutrient nutrient label values for non-traditional plant-based meat alternative food forms (amount per serving).

Name (form)	n	Serving size (g)	Sodium (mg)	Iron %DV	Calcium % DV
bacon strips[a] (mean ±SD)	3	14.0 ± 3.5	196.7 ± 49.3	1.3 ± 1.2	0 ± 0
range		10 - 16	140 - 230	0 - 2	0 - 0
cutlets + filets (mean ±SD)	24	84.9 ± 19.9	484.6 ± 126.8	10.3 ± 9.1	6.8 ± 5.1
range		51 - 142	250 - 690	0 - 40	0 - 20
deli cold cuts (mean ±SD)	12	53.2 ± 9.0	365.0 ± 75.9	11.5 ± 7.6	2.2 ± 1.0
range		30 - 62	240 - 480	2 - 20	0 - 4
ground (mean ±SD)	12	59.4 ± 9.2	295.0 ± 64.5	9.9 ± 5.6	4.2 ± 2.5
range		55 - 85	170 - 380	0 - 20	0 - 8
hotdog (mean ±SD)	11	51.4 ± 14.0	355.5 ± 123.8	8.6 ± 5.3	1.8 ± 1.4
range		35 - 76	160 - 560	2 - 20	0 - 4
meat balls (mean ±SD)	7	64.3 ± 20.7	362.9 ± 90.5	8.5 ± 5.0	9.4 ± 9.2
range		43 - 85	230 - 480	0 - 15	0 - 25
mixed[b] (mean ±SD)	6	144.3 ± 92.1	435.0 ± 274.2	13.5 ± 14.3	7.3 ± 5.3
range		45 - 284	170 - 820	0 - 35	4 -15
nuggets (mean ±SD)	18	83.9 ± 14.3	447.6 ± 79.0	10.2 ± 9.7	5.6 ± 5.9
range		71 - 123	230 - 600	2 - 40	0 - 20
patties (mean ±SD)	59	72.7 ± 15.0	373.5 ± 112.1	8.7 ± 4.6	4.3 ± 3.1
range		38 - 120	200 - 700	1 - 25	0 - 15
roast (mean ±SD)	6	116.0 ± 26.7	551.7 ± 106.1	9.5 ± 3.6	9.2 ± 8.4
range		85 - 147	420 - 710	4 - 15	3 - 20
sausage (mean ±SD)	17	77.2 ± 20.9	498.8 ± 169.4	9.7 ± 6.7	2.9 ± 1.7
range		45 - 100	270 - 840	2 - 25	0 - 6
strips (mean ±SD)	5	93.6 ± 19.2	502.0 ± 58.1	20.0 ± 9.4	6.4 ± 2.6
range		85 - 128	410 - 570	10 - 30	4 - 10
other (mean ±SD)	2	99.0 ± 19.8	297.5 ± 399.5	8.5 ± 9.2	7.0 ± 4.2
range		85 -113	15 - 580	2 - 15	4 - 10

[a]Canadian bacon was grouped with pattes

[b]Products which contain PBMA as part of a multi-food group product

9.35 % DV; range 10 to 30 % DV); the form with the least iron was bacon strips (1.33 ±1.15 % DV; range 0 to 2 % DV). Some of the individual products (in the cutlets and fillets and nuggets forms) indicated that they contained 40% DV for iron.

As a food group, the protein foods are not typically considered to be good sources of calcium. However, some of the PBMA products contain significant amounts of

calcium. Among the traditional PBMA products, some types of tofu indicate that they contain from zero to as much as 50% DV for calcium.

Other key nutrients often highlighted as key nutrients in the protein foods group include thiamin, riboflavin, niacin, pyridoxine, alpha-tocopherol, zinc, and magnesium. Limited data were available for these micronutrient values since they are not required on product labels unless they have been added through fortification. Of the 245 products, 14 % (n = 35) products provided these values. These values were provided more commonly for non-traditional PBMA (n = 34) as compared to traditional PBMA (n = 1). See **Appendix I** for micronutrient data obtained from individual product labels.

Allergen Ingredients in PBMA

Over all, PBMA included products free of common allergens such as soy, wheat, egg, dairy derivatives, or nuts. Soy-free and wheat-free options were much more limited compared to egg-free and dairy-free products (**Table 3.9**).

Soy

Since soy was the main ingredient in 97% of traditional and ~ 60% of non-traditional PBMA surveyed, there were limited products that excluded this ingredient. Among the traditional food forms, only seitan was completely soy-free. Among non-traditional forms, soy-free products were composed primarily of wheat gluten, mycoprotein (trademark ingredient of Quorn products) or sunflower seeds (signature ingredient of Organic Sunshine products). Products containing mycoprotein and sunflower seeds as primary ingredients commonly are marketed by their manufacturer specifically as soy-free.

Wheat

Since most traditional PBMA products are soy-based, most are wheat-free. A much lower percent of non-traditional products were wheat-free. Among traditional PBMA products, natto, and most tofu and tempeh products did not have wheat. Some pre-flavored tofu and tempeh products contained wheat in the added ingredients.

Table 3.9. Percent of traditional and non-traditional plant-based meat alternatives free of common allergens.

Food Forms	Soy-free (%)	Wheat-free (%)	Soy-free and Wheat-free (%)	Dairy-free (%)	Egg-free (%)	Dairy-free and Egg-free (%)	Tree Nut-free (%)	Peanut-free (%)
Traditional (n=63)	3	97	0	100	100	100	100	100
Non-traditional (n=182)	21	23	9	82	74	66	97	100
Both traditional and non-traditional (n=245)	17	40	7	87	80	75	98	100

Among the 23% (n = 42) of non-traditional products that did not contain wheat, predominant ingredients were soy, and again, mycoprotein, sunflower seeds, and additional ingredients in the 'other group.' The few products that were free of both soy and wheat were based on mycoprotein, sunflower seeds or other ingredients in the 'other' group as their main ingredient.

Egg and Dairy

In contrast to the availability of soy-free and wheat-free products, there were many products that did not contain dairy ingredients (87 %), egg (80 %) or neither of the two (75 %). No traditional forms of PBMA contained dairy or egg. Non-traditional forms that did not contain dairy and or egg were primarily composed of soy and or wheat.

Nuts

None of the 245 PBMA products surveyed contained peanut and 98% were free of tree nuts. Walnuts were included as an ingredient in 5 patty products.

PART 2 - EVALUATION OF THE RELIABILITY OF NUTRIENT INFORMATION PRESENTED ON LABELS OF PLANT-BASED MEAT ALTERNATIVE PRODUCTS

PBMA Selected for Chemical Nutrient Analysis

Forty products from the six popular traditional and non-traditional forms were chosen for chemical nutrient analysis using the selection scoring criteria described in the Methods. The 40 products represented a total of 22 different manufacturers (**Figure 2.1**). The scoring system was overridden for two fairly unique products that were judged by the investigators to be important to include: one traditional product, natto (fermented soy bean) and a mock chicken cutlet product. The natto was chosen because of its nutritional qualities. The mock chicken cutlet was chosen based on its package label indicating that the product had the "authentic taste, texture and nutrition of premium lean meat."

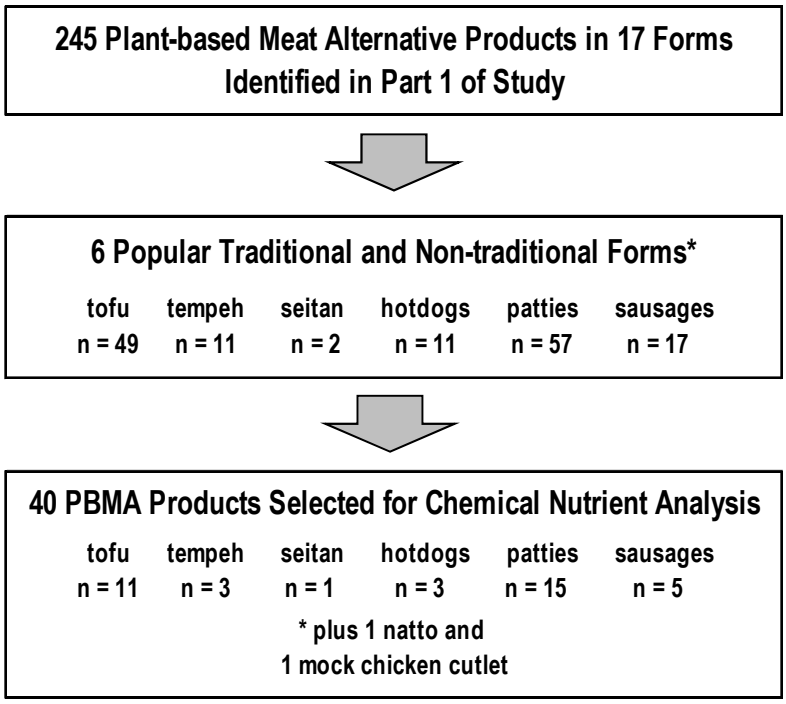

Figure 3.1. Process to select 40 products from 6 popular plant-based meat alternative (PBMA) forms for chemical nutrient analysis.

Analyzed Nutrient Composition of 40 PBMA

Moisture, Energy and Macronutrient Analytical Values

Tables 3.10 (traditional PBMA) and **3.11** (non-traditional PBMA) provide the energy, and macronutrient data of individual products selected for chemical analysis. As with stated label values, analytical results confirm a wide range for energy, protein and other macronutrients per serving for both the traditional and non-traditional products. Energy per serving ranged from 28 kcals for a 'soft' tofu and 75 kcals for a patty to 216 kcals for a tempeh product and 282 kcals for a sausage product. Protein values per serving ranged from 2.8 g for a 'fried' tofu and 4.7 g for a patty to 23.4 g for a tempeh and 28.5 g for a sausage product. Calculations for protein nutrient density showed a 'soft' tofu, a seitan and a hotdog product calculated between 18 and 19 g protein per 100 kcals (5.2 to 5.5 kcal per g protein). Lower protein density products were a fried tofu at 8.2 g per 100 kcal (12.2 kcal/g protein) and a patty at 3.5 g per 100 kcal (28.6 kcal/g protein).

Micronutrient Analytical Values

Tables 3.12 (traditional) and **3.13** (non-traditional) show 40 PBMA analyzed values of four selected minerals typically provided in meat products (sodium, iron and zinc), as well as calcium. Analytical values for these micronutrients also confirm a wide range of values among products. Measured sodium content per serving ranged from 1 mg in a natto product and 272 mg in a patty product to 425 mg and 808 mg in a seasoned tofu and sausage product respectively.

Iron values per serving ranged from 0.33 mg (2% DV) for a fried tofu product and 0.48 mg (2.6% DV) for a patty to 3.26 mg (18 % DV) for a tempeh product and 7.36 mg (41% DV) for a hot dog product. Of the 40 analyzed traditional and non-traditional products, 18 products contained $\geq$10% DV for iron per serving and two products (a patty and hotdog) contained $\geq$ 20% DV per serving. (100% Daily Value for iron is 18 mg). The two products containing greater than 20% DV indicated fortification on package labels.

Zinc values ranged from 0.25 mg (1% DV) fried tofu and 0.47 mg (3% DV) for a patty to 1.91 mg (11% DV) for a tempeh and 3.85 mg (21% DV) for a patty. Among 40 analyzed PBMA, two products (a tempeh and patty product) contained $\leq$10% DV for zinc and two other products (a zinc fortified patty and hotdog) contained $\leq$20% DV (100% DV for zinc is 15 mg).

Table 3.10. Analytical macronutrient values per serving for 40 traditional plant-based meat alternative products (mean±SD).

	Serv Wt (g)	% Moisture	Kcalories[a]	Protein (g)	Total Fat (g)	CHO (g)[b]	Fiber (g)	PRO (g) per 100kcal
TRADITIONAL								
Natto								
Natto_1	40	58.78 ± 0.42	75	6.82 ± 0.01	4.28 ± 0.08	4.60	3.32 ± 0.24	8.88
Seitan								
Seitan2	85	64.46 ± 0.89	114	21.70 ± 0.07	1.07 ± 0.03	6.65	2.89 ± 0.44	18.44
Tempeh								
Tempeh_4	85	56.61 ± 0.06	175	15.59 ± 0.02	11.07 ± 1.21	9.76	6.43 ± 0.09	8.74
Tempeh_6	113	57.19 ± 24.20	212	23.44 ± 0.08	11.72 ± 0.16	12.24	10.04 ± 1.09	10.85
Tempeh_10	76	55.84 ± 0.04	156	15.82 ± 0.10	8.75 ± 0.07	8.10	5.05 ± 0.84	9.91
Tofu - Firm, Medium Firm and Extra Firm								
Tofu-Firm_1	79	83.78 ± 0.45	57	8.36 ± 0.02	2.70 ± 0.67	1.65	1.15 ± 0.13	14.12
Tofu-Firm_5	79	81.56 ± 0.45	76	8.07 ± 0.04	4.44 ± 0.06	1.68	1.09 ± 0.01	10.45
Tofu-Firm_7	79	80.77 ± 0.31	81	8.52 ± 0.01	4.78 ± 0.04	1.46	0.72 ± 0.13	10.35
Tofu-Firm_8	79	75.23 ± 0.44	102	11.32 ± 0.01	6.07 ± 0.10	1.58	1.45 ± 0.03	10.84
Tofu-Firm_11	85	74.09 ± 0.42	119	12.12 ± 0.03	7.61 ± 0.29	1.79	1.72 ± 0.11	10.03
Tofu-Firm_22	85	71.61 ± 0.19	123	12.75 ± 0.05	7.14 ± 0.09	3.38	1.91 ± 0.06	10.09
Tofu - Fried								
Tofu - Fried_3	14	58.93 ± 0.19	33	2.75 ± 0.05	2.41 ± 0.02	0.45	0.39 ± 0.01	8.15
Tofu - Silken and Regular Soft								
Tofu - Silken/ Soft_3	84	91.10 ± 0.10	27	5.30 ± 0.01	0.18 ± 0.01	1.72	0.75 ± 0.12	18.77
Tofu - Seasoned (packaged with condiments)								
Tofu - Seasoned_1	85	57.41 ± 0.25	174	14.37 ± 0.06	8.64 ± 0.34	11.92	3.48 ± 0.51	8.02
Tofu - Seasoned_2	85	66.22 ± 0.93	151	16.09 ± 0.08	9.62 ± 0.57	2.23	1.60 ± 0.10	10.37
Tofu - Seasoned_9	85	67.13 ± 0.54	138	14.04 ± 0.02	7.66 ± 0.16	4.89	2.19 ± 0.29	9.81

[a]Energy calculated using Atwater factors 4-9-4 Protein, fat, carbohydrate minus fiber

[b]Carbohydrate values calculated by difference

Table 3.11. Analytical macronutrient values per serving for 40 non-traditional plant-based meat alternative products (mean±SD).

	Serv Wt (g)	% Moisture	Kcalories[a]	Protein (g)	Total Fat (g)	CHO (g)[b]	Fiber (g)	PRO (g) per 100kcal
NON-TRADITIONAL								
Cutlet/Filet								
Cutlet/Filet_21	98	68.39 ± 0.15	124	19.24 ± 0.07	3.22 ± 0.02	7.74	3.99 ± 0.42	15.13
Hotdog								
Hotdog_2	45	53.90 ± 0.04	86	11.55 ± 0.01	3.03 ± 0.02	5.48	2.96 ± 0.63	13.00
Hotdog_6	76	66.07 ± 0.60	103	15.44 ± 0.04	2.03 ± 0.09	7.35	2.05 ± 0.47	14.50
Hotdog_7	76	71.55 ± 0.23	74	14.57 ± 0.03	0.51 ± 0.05	5.20	2.82 ± 0.14	18.30
Patties								
Patties_1	71	61.02 ± 0.10	116	13.85 ± 0.08	5.48 ± 0.20	7.29	5.21 ± 0.20	11.48
Patties_13	78	65.39 ± 0.08	120	4.75 ± 0.04	6.07 ± 0.39	15.35	4.78 ± 0.25	3.86
Patties_16	74	54.65 ± 0.01	173	10.45 ± 0.10	10.56 ± 0.15	11.82	3.73 ± 0.47	5.93
Patties_24	75	40.94 ± 0.41	241	8.74 ± 0.01	16.47 ± 0.30	17.88	4.49 ± 0.05	3.56
Patties_25	71	65.90 ± 0.44	92	9.83 ± 0.02	0.82 ± 0.09	12.95	2.32 ± 0.59	10.43
Patties_27	114	56.10 ± 0.35	243	24.65 ± 0.12	12.43 ± 0.03	11.79	4.89 ± 1.05	9.94
Patties_30	71	56.61 ± 0.29	147	16.91 ± 0.11	7.72 ± 0.42	5.24	3.44 ± 0.58	11.18
Patties_33	75	55.65 ± 0.03	155	9.07 ± 0.06	7.15 ± 0.20	16.32	3.83 ± 0.66	5.75
Patties_35	57	66.32 ± 0.50	72	10.05 ± 0.03	1.96 ± 0.06	6.31	3.65 ± 0.59	13.26
Patties_38	71	51.07 ± 0.45	146	17.00 ± 0.06	6.29 ± 0.15	10.39	6.03 ± 0.36	11.32
Patties_42	71	62.13 ± 0.19	85	15.48 ± 0.01	0.81 ± 0.13	9.49	6.31 ± 0.23	17.27
Patties_44	113	55.20 ± 0.08	191	20.34 ± 0.09	3.51 ± 0.39	25.28	7.74 ± 1.29	10.33
Patties_46	71	69.15 ± 0.07	72	10.93 ± 0.03	1.75 ± 0.07	8.12	5.65 ± 0.40	14.32
Patties_51	71	52.58 ± 0.19	131	13.10 ± 0.04	3.55 ± 0.12	16.03	4.94 ± 0.19	9.70
Patties_54	71	60.41 ± 0.33	122	5.32 ± 0.02	4.39 ± 0.12	17.48	2.76 ± 0.27	4.23
Sausages								
Sausages_4	100	44.16 ± 0.09	276	28.49 ± 0.25	14.44 ± 0.11	11.25	4.70 ± 0.28	10.09
Sausages_5	100	44.70 ± 0.04	270	28.68 ± 0.16	13.70 ± 0.11	11.40	4.70 ± 0.48	10.40
Sausages_7	55	63.38 ± 0.07	91	6.85 ± 0.16	5.08 ± 0.11	7.18	3.74 ± 0.03	7.20
Sausages_10	85	63.52 ± 0.04	148	13.32 ± 0.21	7.73 ± 0.21	8.46	2.81 ± 0.54	8.64
Sausages_11	92	46.10 ± 0.03	237	23.33 ± 0.22	11.20 ± 0.07	13.92	4.14 ± 0.10	9.66

[a]Energy calculated using Atwater factors 4-9-4 Protein, fat, carbohydrate minus fiber

[b]Carbohydrate values calculated by difference

Table 3.12. Analytical micronutrient values per serving for 40 traditional plant-based meat alternative products (mean±SD).

	Serv Wt (g)	Sodium(mg)	Calcium (mg)	Calcium % DV	Iron (mg)	Iron% DV	Zinc (mg)	Zinc % DV
TRADITIONAL								
Natto								
Natto_1	40	1 ± 0	36 ± 1	4%	1.13 ± 0.02	6%	0.71 ± 0.01	4%
Seitan								
Seitan2	85	318 ± 5	25 ± 0	2%	1.97 ± 0.02	11%	1.23 ± 0.02	7%
Tempeh								
Tempeh_4	85	1 ± 0	64 ± 1	6%	1.41 ± 0.07	8%	1.40 ± 0.01	8%
Tempeh_6	113	2 ± 0	94 ± 1	9%	3.26 ± 0.03	18%	1.91 ± 0.01	11%
Tempeh_10	76	2 ± 0	76 ± 2	8%	1.57 ± 0.35	9%	1.21 ± 0.02	7%
Tofu - Firm, Medium Firm and Extra Firm								
Tofu-Firm_1	79	22 ± 1	147 ± 9	15%	1.27 ± 0.11	7%	0.52 ± 0.02	3%
Tofu-Firm_5	79	3 ± 0	32 ± 1	3%	1.25 ± 0.04	7%	0.64 ± 0.01	4%
Tofu-Firm_7	79	3 ± 0	34 ± 1	3%	1.34 ± 0.05	7%	0.72 ± 0.01	4%
Tofu-Firm_8	79	1 ± 0	107 ± 5	11%	2.00 ± 0.09	11%	1.17 ± 0.04	6%
Tofu-Firm_11	85	2 ± 0	41 ± 2	4%	2.05 ± 0.13	11%	1.39 ± 0.06	8%
Tofu-Firm_22	85	12 ± 0	218 ± 3	22%	2.55 ± 0.04	14%	1.12 ± 0.02	6%
Tofu - Fried								
Tofu - Fried_3	14	2 ± 0	51 ± 3	5%	0.33 ± 0.03	2%	0.25 ± 0.00	1%
Tofu - Silken and Regular Soft								
Tofu - Silken/ Soft_3	84	64 ± 2	31 ± 1	3%	0.86 ± 0.03	5%	0.28 ± 0.01	2%
Tofu - Seasoned (packaged with condiments)								
Tofu - Seasoned_1	85	236 ± 4	204 ± 4	20%	3.16 ± 0.24	18%	1.25 ± 0.03	7%
Tofu - Seasoned_2	85	306 ± 5	65 ± 1	6%	3.14 ± 0.09	17%	1.73 ± 0.03	10%
Tofu - Seasoned_9	85	425 ± 9	206 ± 5	21%	2.84 ± 0.09	16%	1.24 ± 0.01	7%

Table 3.13. Analytical micronutrient values per serving for 40 non-traditional plant-based meat alternative products (mean±SD)

	Serv Wt (g)	Sodium(mg)	Calcium (mg)	Calcium % DV	Iron (mg)	Iron% DV	Zinc (mg)	Zinc% DV
NON-TRADITIONAL								
Cutlet/Filet								
Cutlet/Filet_21	98	361 ± 113	23 ± 8	2%	1.41 ± 0.80	8%	1.05 ± 0.29	6%
Hotdog								
Hotdog_2	45	286 ± 14	20 ± 1	2%	1.27 ± 0.12	7%	0.55 ± 0.02	3%
Hotdog_6	76	384 ± 2	18 ± 0	2%	7.36 ± 0.07	41%	3.70 ± 0.02	21%
Hotdog_7	76	611 ± 21	22 ± 1	2%	2.02 ± 0.08	11%	0.78 ± 0.03	4%
Patties								
Patties_1	71	314 ± 8	106 ± 1	11%	1.50 ± 0.05	8%	0.79 ± 0.02	4%
Patties_13	78	272 ± 4	43 ± 1	4%	1.20 ± 0.36	7%	0.66 ± 0.03	4%
Patties_16	74	260 ± 4	33 ± 0	3%	1.65 ± 0.01	9%	0.66 ± 0.01	4%
Patties_24	75	314 ± 6	42 ± 1	4%	1.95 ± 0.04	11%	1.68 ± 0.05	9%
Patties_25	71	251 ± 1	15 ± 1	1%	0.83 ± 0.04	5%	0.64 ± 0.01	4%
Patties_27	114	412 ± 5	92 ± 1	9%	4.27 ± 0.49	24%	1.17 ± 0.01	7%
Patties_30	71	387 ± 12	46 ± 1	5%	1.64 ± 0.05	9%	0.68 ± 0.02	4%
Patties_33	75	326 ± 6	31 ± 1	3%	0.48 ± 0.02	3%	2.22 ± 0.01	12%
Patties_35	57	312 ± 3	32 ± 0	3%	2.58 ± 0.23	14%	3.85 ± 0.04	21%
Patties_38	71	378 ± 6	60 ± 1	6%	2.14 ± 0.06	12%	1.11 ± 0.02	6%
Patties_42	71	315 ± 7	79 ± 2	8%	1.68 ± 0.46	9%	0.67 ± 0.02	4%
Patties_44	113	512 ± 17	67 ± 2	7%	2.56 ± 0.21	14%	1.44 ± 0.05	8%
Patties_46	71	463 ± 6	63 ± 1	6%	1.42 ± 0.01	8%	0.47 ± 0.01	3%
Patties_51	71	351 ± 8	43 ± 1	4%	1.82 ± 0.04	10%	0.95 ± 0.02	5%
Patties_54	71	436 ± 12	86 ± 4	9%	0.84 ± 0.08	5%	1.12 ± 0.03	6%
Sausages								
Sausages_4	100	756 ± 18	51 ± 1	5%	3.19 ± 0.05	18%	1.64 ± 0.05	9%
Sausages_5	100	809 ± 13	36 ± 1	4%	2.76 ± 0.06	15%	1.63 ± 0.03	9%
Sausages_7	55	468 ± 4	31 ± 1	3%	0.60 ± 0.02	3%	0.65 ± 0.01	4%
Sausages_10	85	678 ± 13	106 ± 1	11%	1.89 ± 0.05	10%	0.59 ± 0.01	3%
Sausages_11	92	458 ± 16	37 ± 1	4%	2.08 ± 0.06	12%	1.90 ± 0.08	11%

Calcium values per serving for traditional PBMA ranged from 31 mg (3% DV) for a soft tofu to 218 mg (22% DV) for a firm tofu. Non-traditional PBMA calcium values ranged from 18 mg (2% DV) for a hotdog product to 106 mg (11% DV) for a patty product. (100% Daily Value for calcium is 1000 mg).

Traditional products in the tofu food form (n = 11) showed the widest range of calcium content per serving. Tofu product ingredients were noted to include calcium sulfate or calcium chloride, nigari (magnesium chloride), gluconolactone or a combination of any two. Products indicating calcium in the ingredients (n = 3) had analyzed calcium contents ranging from 51 mg to 147 mg. Products indicating magnesium chloride as a coagulant had calcium values that ranged from 32 mg to 217 mg/serving. It was noted that three tofu products indicating coagulation solely with magnesium chloride had the greatest calcium content of all analyzed PBMA products ranging from 204 mg (20% DV) to 217 mg (22% DV) per serving.

Product Label Weight Compared to Measured Weight

When package label weights were compared to actual measured weights of total package contents, 37 of 40 samples had more actual net weight than indicated on labels. Additional gram weight averaged 17.4 ± 14.5 g and ranged from 1.5 to 51.5 g (100.5% to 106% of labeled product weight). Tofu products (drained weight) had the highest average weight excess. One fried tofu product indicated a net weight of 31 g and serving size of 14 g, but the measured weights were 64 g and 28 g respectively. The three products with measured weights less than indicated on the package label averaged 4.2 ± 1.2 g and ranged from 2.8 to 5.0 g. These products were within reasonable weight variations permitted by law while the fried tofu product would be considered misbranded (Code of Federal Regulation 2012).

Validation of Analytical PBMA Values to Identical products Listed in the USDA Nutrient Database for Standard Reference (SR24)

Of the 245 products identified, 15% (n = 38) had brand name nutrient data available in the USDA National Nutrient Database for Standard Reference (RS24) (USDA 2011). Kellogg's® manufactured 31 of the 38 represented products. Morinaga Nutritional Foods® (n = 5) and Vitasoy USA® (n = 2) were two other manufacturers that had PBMA products represented in the database.

Five of the products selected for nutrient analysis in this study had existing nutrient data in the USDA National Nutrient Databank for Standard References (SR24) (USDA 2011). See **Table 3.14**. A comparison of USDA data with the analytical values obtained in this study showed similarities for most sets of all nutrients. Percent moisture, protein total fat, iron, calcium and sodium measured values compared to USDA values were within an acceptable 20% tolerance (Lee et al. 1992). Unlike these nutrient values, grams of fiber for 4 of 5 products differed from USDA values in amounts greater than 20%. Other analysis ranged within expected product variability.

Comparison of 40 PBMA Product Analytical Nutrient Values to Food Label Values

Among the 40 analyzed PBMA products more than 80% (n = 13) of traditional and 75% (n = 18) of non-traditional products had 1 to 4 label values that were not within the NLEA 80% - 120% tolerance limits See **Table 3.15**. These mislabeled products were identified in all forms of traditional and non-traditional PBMA that were analyzed. Nutrients in non-compliance most frequently were fat, iron and calcium.

Table 3.14. Comparison of USDA Nutrient Database[a] to analytical values.[b] Nutrient values are expressed on a per label serving weight (USDA Value or Mean ± SD)[c].

Brand	Product		Serving Size (g)	% Water	Energy - (kcal)[d]	Protein (g)	Total Fat (g)	Total Carbohydrate (g)	Dietary Fiber (g)	Sodium (mg)	Calcium (mg)	Iron (mg)	Magnesium (mg)	Phosphorus (mg)	Potassium (mg)	Zinc (mg)
Garden Burger®	**Garden Vegan® Veggie Patties**	USDA	71	68.3	75	8.88	0.71	12.07	4.3	273	16	0.78	2	111	72	0.78
		Current Study	71	65.9 ±0.4	92	9.83 ±0.02	0.82 ±0.09	12.95	2.4 ±0.7	251 ±2	14.95 ±0.54	0.83 ±0.04	21 ±1	120 ±2	84 ±1	0.64 ±0.01
Garden Burger®	**The Original® Veggie Burgers**	USDA	71	61.9	103	4.54	3.19	17.93	4.6	401	46	1.14	3	113	111	0.78
		Current Study	71	60.4 ±0.3	122	5.32 ±0.02	4.39 ±0.12	17.48	2.8 ±0.3	436 ±12	86 ±4.18	0.84 ±0.08	31 ±1	145 ±4	168 ±3	1.12 ±0.03
Mori-Nu®	**Silken Lite Tofu, Firm**	USDA	84	91.4	31	5.29	0.67	0.92	0	71	30	0.63	8	68	53	0.28
		Current Study	84	91.1 ±0.1	27	5.30 ±0.01	0.18 ±0.01	1.41	0.8 ±0.1	64 ±2	31 ±0.92	0.86 ±0.03	10 ±0	64 ±2	58 ±1	0.28 ±0.01
Morningstar Farms®	**Grillers® 1/4 Pound Burger**	USDA	114	55.6	252	25.98	11.97	10.17	2.9	489	90	5.59	21	141	268	1.25
		Current Study	114	56.1 ±0.4	243	24.65 ±0.12	12.43 ±0.04	11.79	4.2 ±1.0	412 ±5	92 ±0.58	4.26 ±0.49	40 ±0	156 ±2	203 ±2	1.17 ±0.01
Morningstar Farms®	**Grillers Prime® Veggie Burger**	USDA	71	54.3	169	17.04	9.37	4.19	1.8	356	41	1.99	NA	NA	159	0.85
		Current Study	71	56.6 ±0.3	148	16.91 ± 0.11	7.72 ±0.42	5.24	3.4 ±0.6	387 ±11	46 ±1.17	1.64 ±0.05	27 ±1	118 ±4	179 ±5	0.68 ±0.02

[a]USDA National Nutrient Database for Standard Reference, Release 24; database values calculated by manufacturer

[b]Lab Mean values obtained from triplicate samples with the exception of fiber values obtained from duplicate samples

[c]Current Study values were rounded to the same decimal place as USDA database values

[d] Values for energy and total carbohydrate are calculated

Table 3.15. Label values out of NLEA[a] compliance for 40 analyzed traditional and non-traditional plant-based meat alternative.

Label Values	Traditional PBMA[b] (n = 16)		Non-traditional PBMA[b] (n = 24)		Total PBMA[b]	
	n	%	n	%	n	%
Calories	1	6.3%	3	12.5%	4	10.0%
Fat	10	62.5%	8	33.3%	18	45.0%
Protein	1	6.3%	0	0.0%	1	2.5%
CHO[c]	7	43.8%	0	0.0%	7	17.5%
Fiber	1	6.3%	4	16.7%	5	12.5%
Na	0	0.0%	3	12.5%	3	7.5%
Ca	6	37.5%	6	25.0%	12	30.0%
Fe	2	12.5%	8	33.3%	10	25.0%

[a]Nutrition Labeling Education Act

[b]Plant-based meat alternative

[c]Carbohydrate

Macronutrients

Kilocalories and protein label values were relatively consistent with analyzed values for all forty PBMA products (**Figures 3.2, and 3.3**). Correlations between label and measured values were good (r = 0.95, and 0.96 respectively). For kilocalories, a Third Group nutrient, four of 40 products were found in non-compliance. Understated label kilocalorie values with analyzed values >120% of labeled value ranged from -23 kcal to -63 kcal. Only one product was in non-compliance for protein with label value overstating analyzed value by 31% (1 g of protein). Protein is a Class II nutrient; therefore label values must be 80% or more of analytical values or will be considered non-compliant.

Carbohydrates label values were both slightly overstated and understated compared to measured values with a correlation coefficient of 0.90 (**Figure 3.4**). The seven overstated values that were in non-compliance were all traditional products. One tempeh product was found to be overstated by 10 g more than analytical value.

As a Class II nutrient, label carbohydrate values are out on compliance if they are 80% or less of analytical value.

For fat label values, 65% (n = 26) of the values were understated by -0.5 to -9.1 g/serving with ~50% (n = 18) in label non-compliance. The correlation coefficient for the relationship between the labeled and measured fat amounts was 0.83 (**Figure 3.5**). Non-compliant products with label fat grams understated by 3 to 5 g were predominantly tofu and tempeh products. Two patty products with percent error found to be -319% and -604% of analytical value had understated label fat values by -4.8g and -9.1 g respectively. These products were among the 18 products that were in non-compliance of >120% measured value maximum tolerance for Third Group nutrients.

Overall most fiber label values were found to understate the measured values with an overall correlation of r = 0.82. Fiber is a Class II nutrient, so these understated values fall within the acceptable minimum 80% of measured value tolerance. Five of the 40 products had over stated label fiber grams compared to analyzed values ranging from <1 g to 3 g placing them out of compliance with U.S. food labeling law **(Figure 3.6**).

Micronutrients

Measured values for mineral content revealed many under and over stated label values. Label iron value ranged from 4 mg less that to 6 mg more than analytical values, with the correlation between analytical and label values of r = 0.49 (**Figure 3.7**). Label calcium ranged from158 mg less than to 153 mg more than analytical amounts (r = 0.53) (**Figure 3.8**). As class II nutrients 10 and 12 of 40 iron and calcium product label values respectively fell below the minimum 80% of measured values. Sodium ranged from 310 mg less than to 180 mg more than labeled amounts (r = 0.89) (**Figure 3.9**). As a Third group nutrient 3 of 40 products label values did not comply with the 120% maximum of measured values. For details of PBMA label value comparison to analyzed values see **Appendix J, K, L** and **M.**

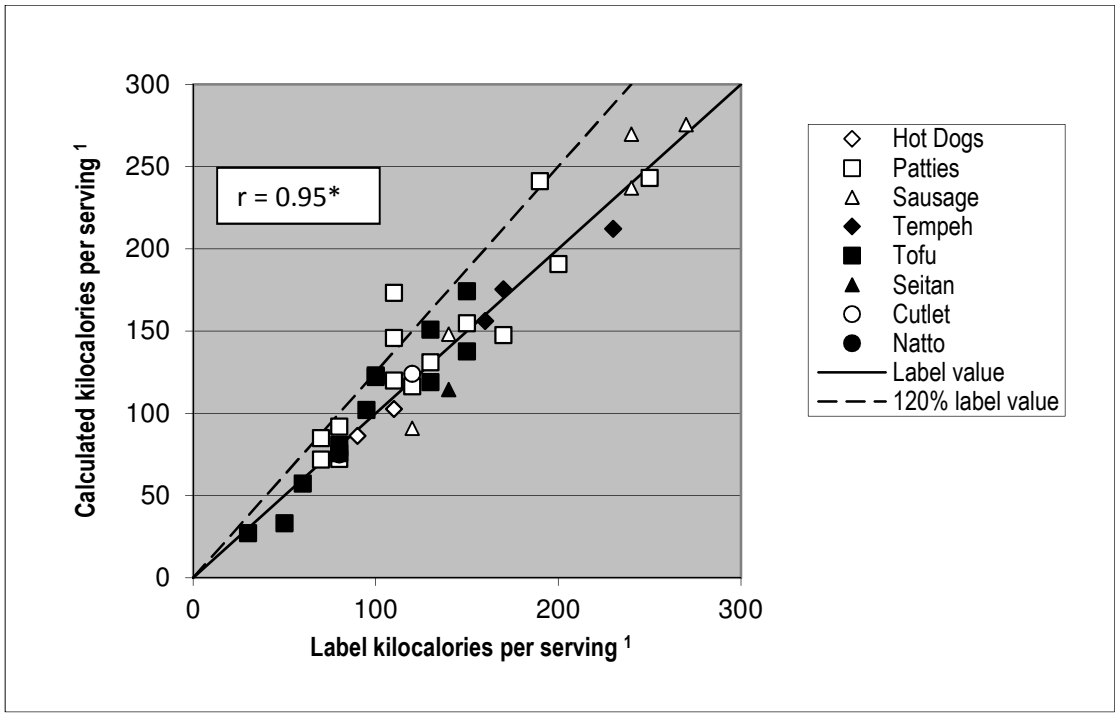

Figure 3.2. Calculated kilocalorie values compared to label values for meat-alternative foods.
[1]Serving size indicated on product package * P< 0.0001

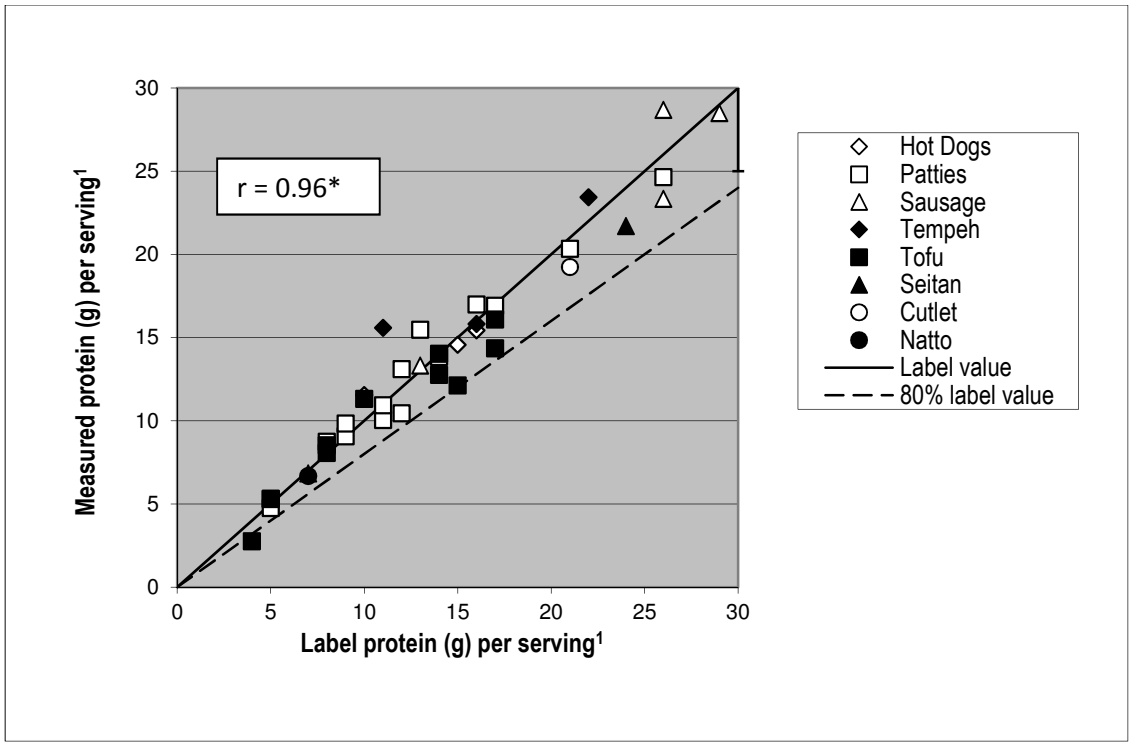

Figure 3.3. Measured protein values compared to label values for meat-alternative foods.
[1]Serving size indicated on product package * P< 0.0001

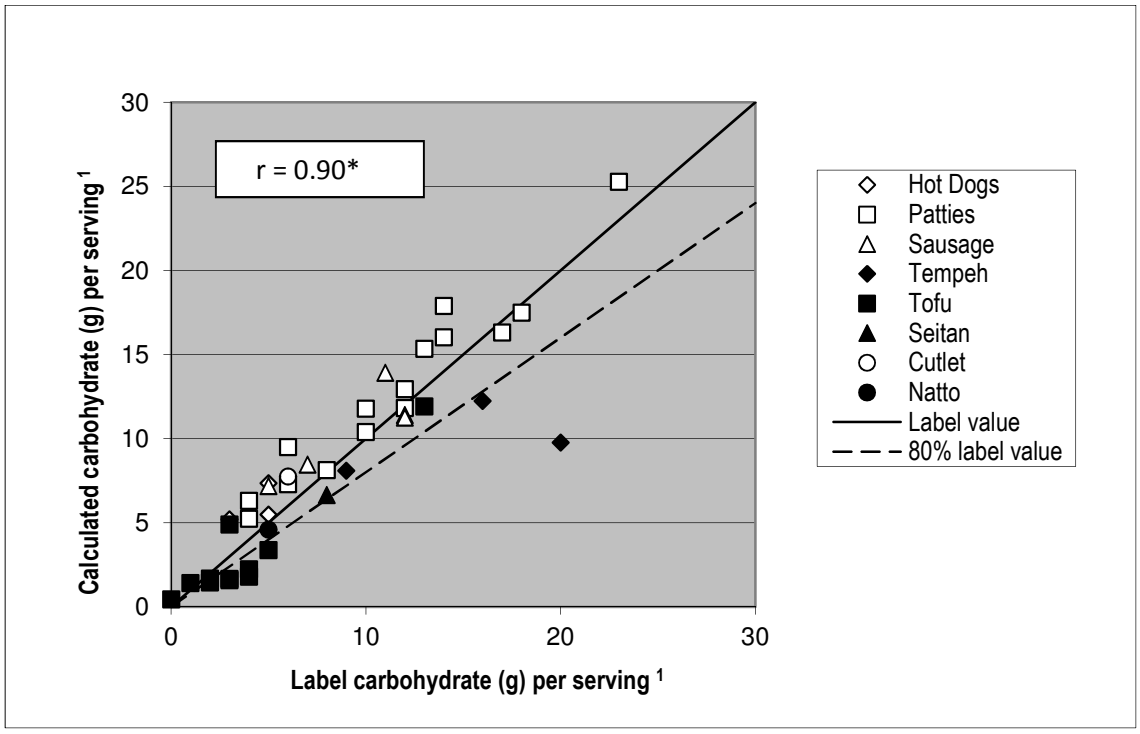

Figure 3.4. Calculated carbohydrate values compared to label values for meat-alternative foods.
[1]Serving size indicated on product package * P< 0.0001

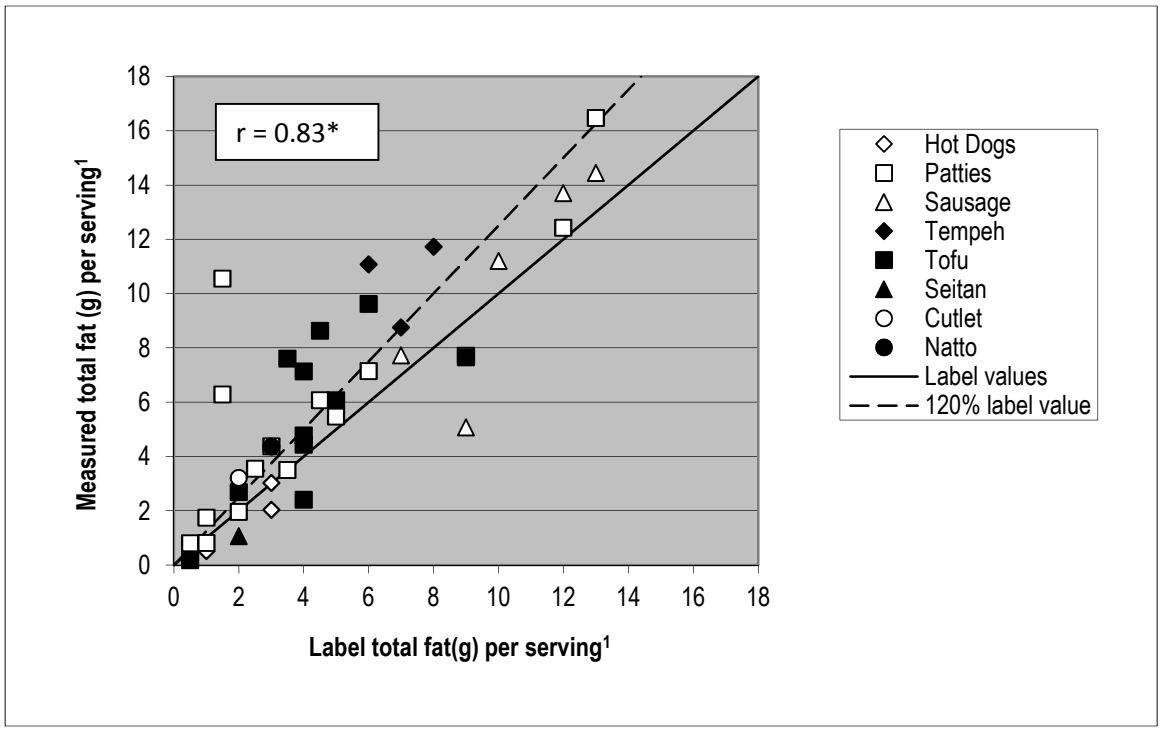

Figure 3.5. Measured total fat values compared to label values for meat-alternative foods.
[1]Serving size indicated on product package * P< 0.0001

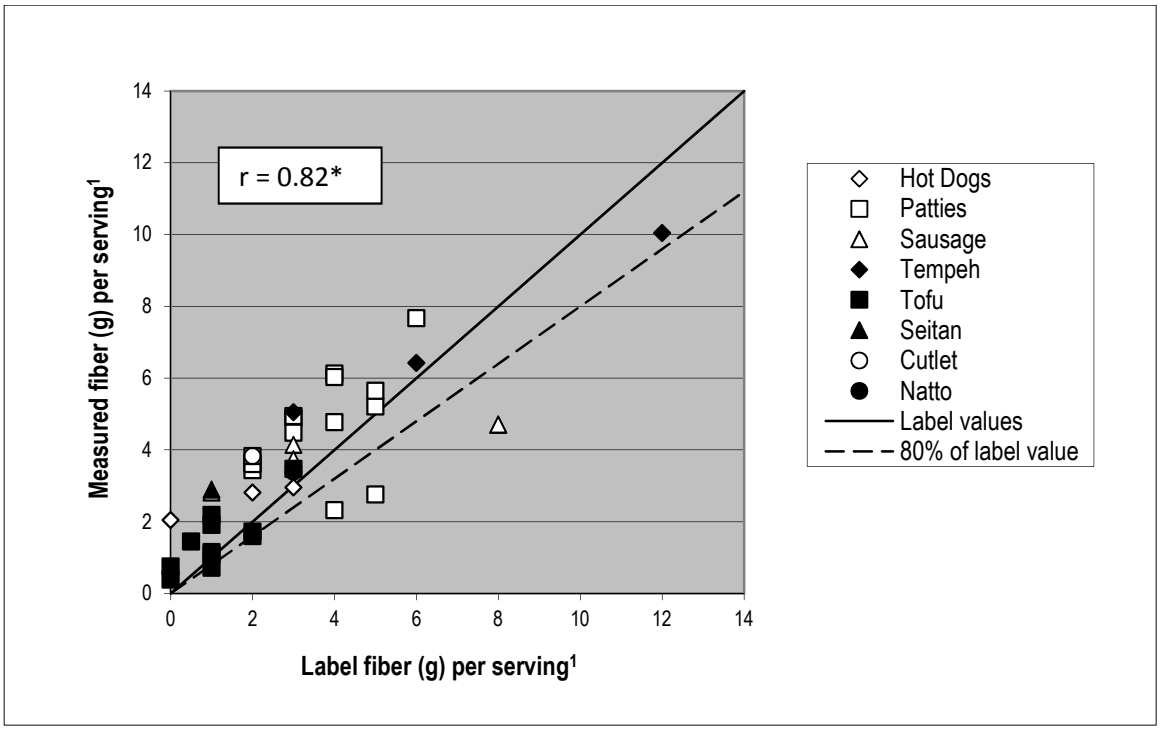

Figure 3.6. Measured total fiber values compared to label values for meat-alternative foods.
[1]Serving size indicated on product package * P< 0.0001

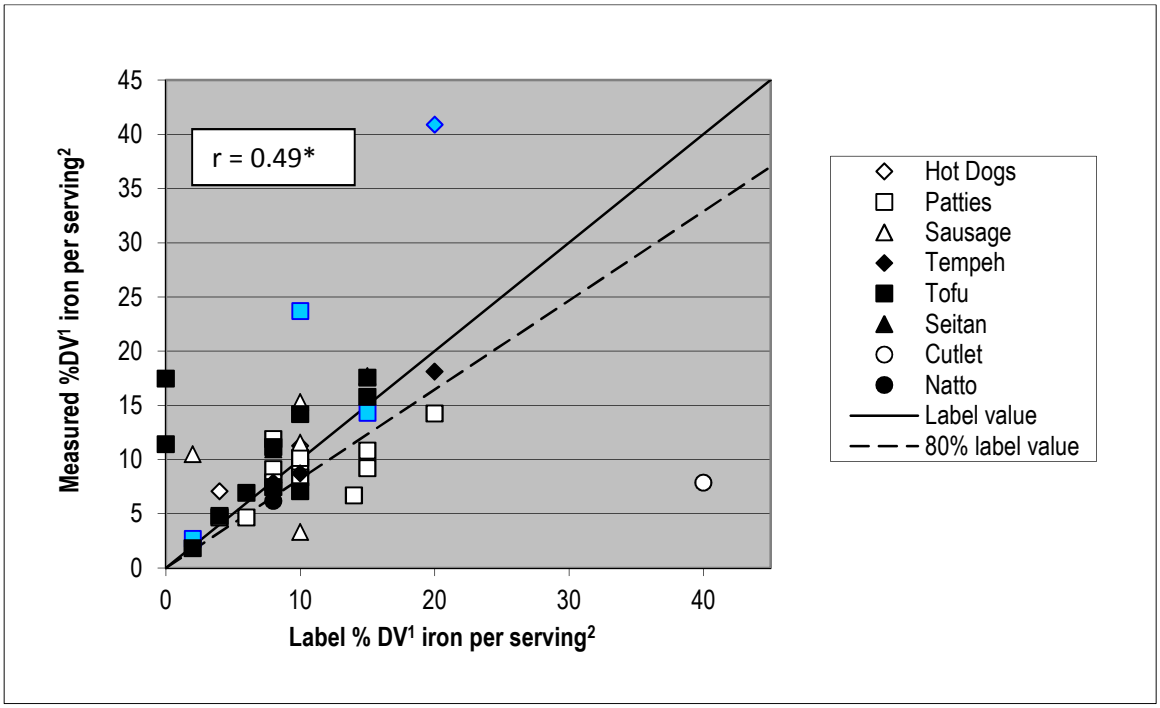

Figure 3.7. Measured iron values compared to label values for meat-alternative foods.
[1]Daily Value [2] Serving size indicated on product package * P< 0.0013 Blue color indicates fortification.

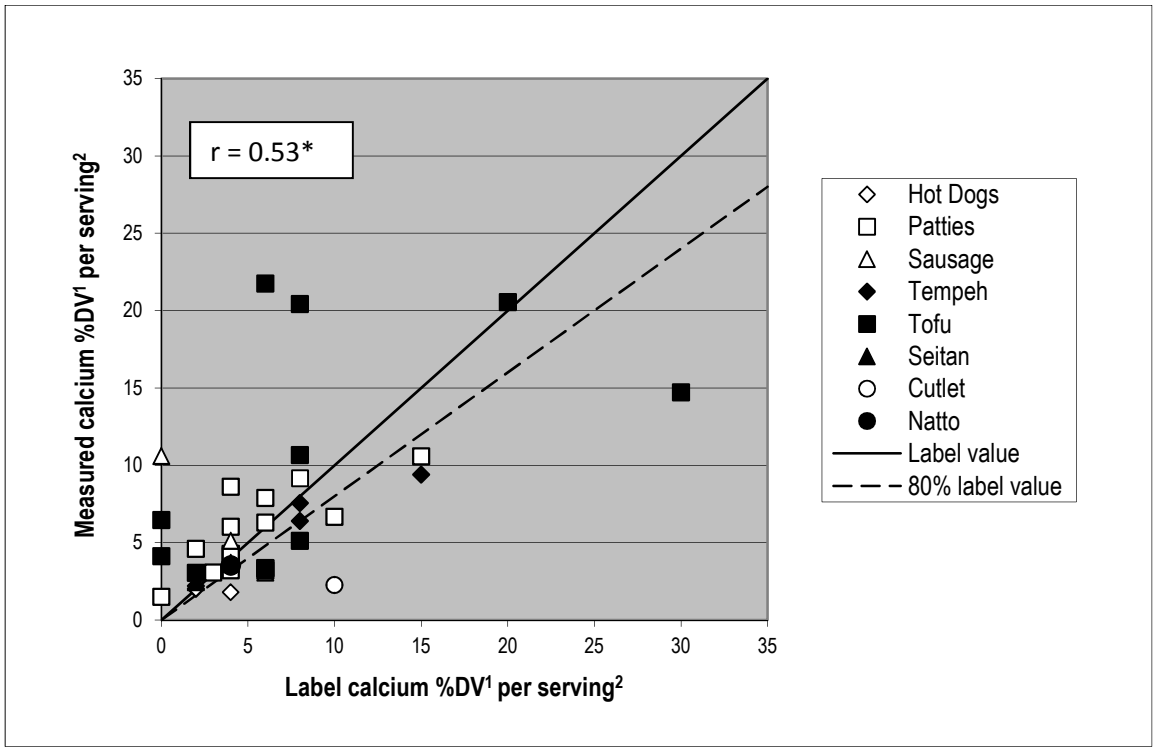

Figure 3.8. Measured calcium values compared to label values for meat-alternative foods
[1]Serving size indicated on product package * P< 0.0001

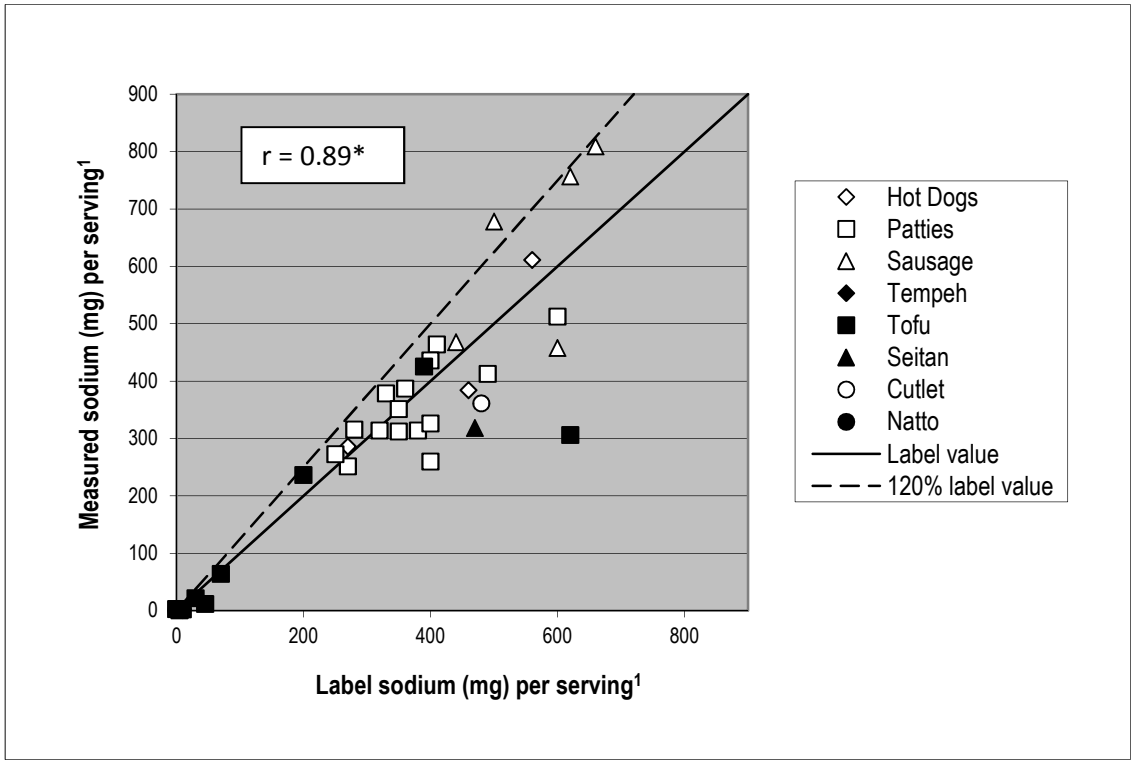

Figure 3.9. Measured sodium values compared to label values for meat-alternative foods.
[1]Serving size indicated on product package * P< 0.0001

CHAPTER IV: DISCUSSION

PBMA Nutrient and Ingredient Composition

Many culinary forms of PBMA products were widely available in the surveyed stores. However, the predominant ingredient of most products was fairly limited, with the major ingredients being soy and wheat. U.S. food labeling regulations 21 CFR 101.12 provide Reference Amounts Commonly Consumed (RACC) to be used for labeling meat products and products that substitute for meats (FDA 2005). Although some PBMA products complied with these reference amounts for their serving sizes, many did not. This can make it difficult for consumers to compare PBMA products nutritionally with meat products or other similar PBMA products.

Also, the terminology used for some PBMA product names may be confusing for consumers from a nutritional perspective. For example, 'tofu' is available in several types that vary in nutrient amounts per serving. This variability is due to differences in processing that include the use of different coagulants (calcium and magnesium salts and gluconolactone) and variations in moisture amounts that vary with product firmness. Also, terminology for tofu product firmness does not appear to be standardized across products or even within some product brands. Due to the resultant nutrient variation in tofu products, it is difficult to recommend tofu as a good source of nutrients that are sometimes high in some tofu products, but low in others.

Label values indicate that some non-traditional PBMA products serve as reasonable substitutes for many of the nutrients commonly found in meat products. However, some are made from ingredients that provide a culinary similarity to meat products with ingredients that do not provide the nutrients commonly provided by the protein foods group. For example, many PBMA products are sold in the form of a burger pattie. Some of these have label values that indicate very high in protein content and others very low content. One PBMA product sold as a vegetarian shrimp type of product is made from curdlan gum as the main ingredient and provides no protein. Consequently, the form of the product does not predict the nutrient content. Consumers need to be

nutritionally aware to appropriately select PBMA products when they are used to substitute for foods in the protein foods group.

Some of the PBMA products that are high in protein can substitute reasonably well for most of the nutrients commonly available in meats. Soy-based foods, for example provide a high quality protein source similar to meat products. Conversely, wheat-based PBMA products can be high in protein and protein density, but the quality of the protein (digestibility and amino acid pattern) is much lower than meat or soy proteins (Schaafsma 2000). Wheat gluten products can be complemented with higher lysine proteins such as legumes, egg or milk to improve dietary protein quality (Young and Pellett 1994). PBMA products that combine soy with gluten ingredients in a ~6 to 1 ratio create a complimentary amino acid blend that compensates the lower lysine level in wheat gluten to meet the preschool age lysine level requirement of FAO/WHO (FAO/WHO/UNU Expert Consultation 1985, Schaafsma 2000).

Some PBMA product labels indicate significant amounts of micronutrients like calcium and iron. Individual tofu product labels specify that many of these products are good sources of calcium providing between 10 to 19% of the DV. Calcium bioavailability from tofu is also considered good with a fractional absorption similar to that of cow milk (Heaney et al. 1991, Weaver et al. 1999, Titchenal and Dobbs 2007). However, calcium label values among tofu products vary widely and the mean calcium value for tofu in this study was below 10% DV. Also, this variation makes general recommendations of tofu as a good calcium source unreliable. Iron label values for several individual PBMA and selected food forms (tempeh, seasoned tofu, cutlets/filets, 'mixed' and strips) indicate good sources of iron, yet issues in the bioavailability of iron in these products is mostly unknown and may be limited by calcium, phytates, polyphenols, and fiber. Murray-Kolb et al.(2003) and Lonnerdal et al.(2009) suggest that iron absorption from soy may be quite high, due to most soy iron being in the form of ferritin, yet the processing of some soy PBMA products may affect micronutrient bioavailability and this impact requires further study (Watzke 1998).

Many PBMA products are composed of common allergenic ingredients such as wheat and soy. This may limit the use of PBMA products for some consumers. This poses more of a problem for consumers of non-traditional PBMAs that often have long

lists of ingredients. Allergies and intolerances appear to be increasing in the American population (Fasano et al. 2003, Branum and Lukacs 2008). Label allergy warnings for wheat were not added to foods labels until January 1, 2006 when the enforcement of the "Food Allergen Labeling and Consumer Protection Act of 2004" began (U.S. Congress 2004). Based on the present survey, about 60% of the 245 products contain wheat. In addition, while many bioactive components in soy may contribute to the hypothesized health benefits, there is controversy over the concern that soy may adversely affect breast cancer patients (Messina and Loprinzi 2001) and thyroid function for a subset of the population (Messina and Redmond 2006) .

Factors Affecting Dietary Fiber Determination in PBMA

Of the five analyzed PBMA products that had existing nutrient data in the USDA Nutrient Database, four had analyzed fiber nutrient values that differed from the USDA value in amounts greater than the typically acceptable 20% tolerance. This high variability is thought to be due to the complexity of fiber determination, particularly for non-traditional PBMA products. Three main factors thought to affect analytical fiber values of a PBMA product sample are 1) environmental variables that can increase or decrease the amounts of fibers in a plant ingredient, 2) fiber heterogeneity of PBMA products and 3) limitations in the fiber determination protocol to recover all varieties of fiber. Fiber content of legume and grain plants can vary due to differences in growing conditions such as climate, soil etc. Non-traditional PBMA are typically composed of not one, but a combination of legumes and grains. Therefore, in addition to fiber variation among similar plants ingredients, the combination of different types of plant ingredients in PBMA increase the possibility of varying types and amounts of each type of fiber among samples of an identical product. Lee et al. (1992) compared fiber values of standardized samples of oat bran from among and within 11 professional laboratories. This single ingredient, known for its fiber heterogeneity, resulted in total dietary fiber that ranged from 12.5 g to 21.8 g/100 g among labs with a mean ± SD of 18.3 g ± 2.2. The USDA database did not provide standard deviation information of fiber value data. This information would have been useful to compare USDA results provided by

manufacturers with the fiber results obtained in the University of Hawai'i Mānoa Human Nutrition Laboratory. Lack of standard deviation information suggests the possibility that values were based on the results of a single analysis.

Varying fiber value results for identical products can also be accounted for by limitations in fiber determination protocols. In this study protocol 991.43a was utilized to determine fiber values. This protocol is an approved method for fiber determination, but it has its limitations. Using this method insoluble fiber including some types of RS fiber and high molecular weight soluble fiber are retained as a measure of fiber content. This retained soluble fiber includes B-glucan, arabinoxylan, psyllium gum, arabinogalactan and to a lesser amount some inulin, polydextrose and resistant maltodextrin. (McCleary et al. 2012). Inulin (chicory root extract), a fiber common in plant ingredients, is not well recovered by this method, requiring another specific protocol to detect its amount in a sample. Combined results from more than one protocol can be used to determine label fiber values. An example of a product that contains inulin and has a label fiber value representing the results of more than one fiber determination protocol is the General Mills® Fiber One granola bar (Hughlett 2010). The use of combined fiber results from more than one protocol might also account for greater fiber values presented for Gardenburger® products in the USDA database as compared to this study's analytical values for the identical products.

While percent differences between this study's analytical values and USDA data were determined were up to ~190 percent, it is to be noted that total fiber values for these four PBMA products were each less than 5 grams. The actual differences in fiber gram weight obtained for identical products were quite small ranging from 1.3 to 1.9 grams.

PBMA Laboratory Fiber Determination Observations

Total dietary fiber determination for this study was conducted at the University of Hawai'i, Mānoa Human Nutrition Laboratory. Laboratory observations noted three analyzed non-traditional PBMA products with ingredient components that did not permit adequate filtration needed per protocol to obtain accurate fiber values. Each of these products had several characteristics in common. All had many ingredients, ranging in

number from 17 to 27. All three products were composed of both soy protein and wheat gluten and contained some form of binding agent. It was suspected that vegetable gum found in two of the products and methylcellulose present as an ingredient in of one product could have been contributors to these fiber analysis difficulties. Modified vegetable gum, xanthan gum and methylcellulose are polysaccharides that are often included as thickeners or water binding agents in food and are identified as ingredients used for this purpose in PBMAs (Asgar et al. 2010)

PBMA Label Values Compared to Analytical Values

Chemical analysis of 40 PBMA products revealed more than 75% of products having one to four label values that were in non-compliance. This was about three times the amount of product label non-compliance identified between the years 2000 and 2006 by the FDA (GAO 2008).

PBMA label values found in non-compliance most often were fat, calcium and iron. These nutrients were similar to those in label reliability studies done by Lobanco et al. (2009), Fernandez et al. (2011), and Lai et al. (2009).

Similar to results from Lobanco et al, fat was the label value most often in non-compliance and most frequently understated compared to analytical values. As lower fat values on nutrition facts panels have been found to produce a more favorable product attitude and purchase intention (Garretson and Burton 2000), the trend of fat under-estimation of these PBMA products is to be noted.

Unpredictable over and under stated calcium values, particularly for some tofu products, were unpredictably under or overstated on labels compared to measured values. Most unexpected were high analytical calcium values for tofu indicating coagulation with magnesium chloride. Similar findings were also noted in a previous study (Fernandez et al. 2011) comparing analyzed and label calcium values of a Hawai'i brand of tofu also indicating coagulation exclusively with magnesium chloride. The nutrient labels of these tofu products not only understate calcium content, but also fail to include calcium as part of the ingredients. For individuals seeking to increase or limit dietary calcium, this type

of nutrient value and ingredient mislabeling makes it impossible to use package information dependably to make the best product choice.

Comparable to findings of Lai et al., PBMA iron label values were both over and understated compared to analytical values. It was noted that PBMA product labels that were unreliable for iron content were both products that contained naturally occurring iron as well as products that indicated fortification. Also among two different iron-fortified PBMA products of the same brand, one was measured at 95% of label value while the other was 204% of label value.

Differences between measured and stated label values for calcium and iron could be due to a couple of reasons: 1) variations related to product production including uneven mixing of predominant or nutrient fortified ingredients and 2) label values conservatively presented by food company to accommodate potential variation in nutrient content of food products and to assure that the product labels have a high probability of passing an FDA compliance evaluation (Bender et al. 1998).

It is to be noted here that the NLEA 80% - 120% guidelines for determining label non-compliance has its shortcomings. Label values deemed non-compliant based on this system could represent an actual quantitative difference between label and analytical values that is quite small. This can occur with products that have label values indicating limited content of a nutrient. For example a label value of 1 g, could be non-compliant with a difference of an analytical value of less than 1 gram. Therefore, while well over half of label values of traditional and non-traditional PMBA were identified as non-compliant, quantitative differences between label and analyzed values for most products were not of biological significance.

Limitations

There were limitations to this research. This study used convenience sampling to obtain data of PBMA available in the market. Due to the variety of stores included in the study and the large number of products identified though, it is thought that the sample obtained represented products that would generally be available in the market. Another limitation is only one package of each product was used to determine analytical values of

each compared nutrient. Although products were analyzed in triplicate (duplicate for fiber values), the protocols set by the USDA requires a composite of 12 products (Bender et al. 1998) Future analysis of these products using a composite of several product samples within a lot is warranted. Additional limitations include the lack of a protein quality assessment (digestibility and amino acid profile), as well as an assessment of the bioavailability of iron and calcium provided by these products.

Conclusion

PBMA are available in many forms similar to meat products, but these forms do not predict nutrient content. Among product with similar appearances, soy-based PBMA can provide high protein quality, some fortified with vitamin and mineral typically obtained from meat. These higher quality protein PBMA may be healthful options for vegetarians and appropriate for those with renal deficiencies (Bernstein 2007) and individuals seeking plant-based, protein dense options for weight loss (Layman et al. 2003).

Because PBMA products may be substituted for more traditional sources of protein in U.S. diets, which are typically good sources of minerals such as iron and zinc, it is important to be aware of the impact of PBMA on mineral balance. While most PBMA contain iron, its bioavailability may vary due to the presence of inhibitors or enhancers in the lumen. Unless fortified, PBMA products may not be a good source of zinc and this essential nutrient must be obtained from other foods or from supplements in the diet. Although calcium in not a nutrient typically provided by meat, PBMA, particularly selected tofu products may be a good source, but variations in calcium content among products makes it difficult to recommend as a reliable source.

Analysis of 40 PBMA products indicates that label values for protein and energy were fairly reliable while micronutrient values for iron, calcium and sodium were often over and understated. Due to similarity of product forms and wide range of nutrient content among forms accurate nutrition labels for these product are essential for individuals consuming these products to meet nutrient needs. Obtaining adequate calories

and nutrients from wide variety of foods will increase the likelihood of meeting essential nutrient requirements.

Implications

As public health messages and other societal influences continue to encourage a shift to the consumption of plant-based proteins, the nutritional impact of PBMA food products may become more significant. With the recognition of nutrition's importance to health, food label information is a fundamental tool for making informed food decisions. Unreliable nutrition fact panels create challenges for those making food purchasing decisions and for professionals assessing nutrient intake. Additionally, the accuracy of food labels has the potential to positively or negatively impact clinical and epidemiological research, as well as nutrition and public health policy. For these reasons, those responsible for food label information should be encouraged to provide nutrient information that is as accurate as possible.

"Knowledge of the chemical composition of foods is the first essential in dietary treatment of disease or in any quantitative study of human nutrition" ***McCance and Widdowson 1940***

APPENDICES

Appendix A. Moisture Determination

MOISTURE DETERMINATION

SUPPLIES and EQUIPMENT: (All equipment must be stainless, glass, or plastic)
Teflon Weighing boats
Sharpie permanent marking pen
Food processor (Cuisinart Classic Pro with stainless blades)
Stainless Steel Spatulas
Graduated cylinder
De-ionized water
Analytical Balance (3 decimal point precision)
Pilot scale freeze-dryer (Virtis SOL, SP Industries)
Cafeteria trays
Plastic saran wrap
Walk in Freezer (T = <20 C)
Ziploc plastic bags (Quart size)
Desiccator

PROCEDURES:

1. Label weighing boats with sharpie permanent pen
2. Record weighing boat weight using analytical balance to 3 decimal places.
3. Homogenization of samples in food processor
    a. Tofu – drain excess water for 15 minutes before homogenizing
    b. If needed, add measured amounts of water to samples that are difficult to homogenize. Record total grams of water added. Subtract this value from final moisture calculation.
4. Divide sample into weighing boats.
    a. Spread homogenized sample with even thickness across the bottom of weighing boat.
    b. Maximum thickness of sample is below the height of the sides of the weighing boat.
5. Record weight of weighing boat + sample.
6. Place samples on cafeteria trays. Cover trays with plastic wrap.
7. Put trays in walk in freezer for minimum 24 hour.
8. Load frozen samples in freeze dryer.
9. Set program for appropriate cycle (30 hours)
10. When freeze drying cycle is complete remove samples from machine one at a time and record weight.
11. Transfer sample from weighing boat to labeled Ziploc bag. Seal and store in desiccator for other analyses.

Appendix A. (continued) Moisture Determination

Calculations

Fresh Sample Weight = [Weigh boat (g) + Fresh Sample (g)] – Initial Weighing boat (g)

Dry Sample Weight = [Weigh boat (g) + Dry Sample (g)] – Initial Weighing boat (g)

$$\% \text{ DM} = \frac{\text{Dry Sample (g)}}{\text{Fresh Sample (g)}} \times 100$$

% Moisture = 100 - %DM

Average % DM (of duplicates) = (Sample #1 %DM + Sample #2 %DM) / 2

$$\% \text{ Error DM (of duplicates)} = \frac{\text{Biggest Value} - \text{Smallest Value}}{\text{Smallest Value}} \times 100$$

Appendix B. Crude Fat Determination

CRUDE FAT DETERMINATION
Modified AOAC Official Method 2003.05

EQUIPMENT AND REAGENTS:

Balance (analytical to 3 decimal places)
Fume hood
Soxhlet apparatus (holds approx. 30 samples in triplicates).
Two Desiccators
Medium porosity Filter Paper 12-18 cm filter paper (No. 5 Fisher Scientific 09-801E P5)
Carbon Pencil #2
Crucibles (three for each sample)
Wax pencil
Weigh paper
Tweezers
Freeze-dried samples (stored in Desiccator)
Gloves

Reagents:
Ethyl ether or petroleum ether - Boiling point 40 - 60 degrees

PROCEDURES:

Laboratory gloves were worn at all times
All samples should be weighed accurately to 3 decimal places.
NOTE: If samples are not previously prepared - Grind freeze-dried samples using a coffee grinder to reduce particle size to homogenous "powder size" particle consistency. (U.S. standard size mesh 25)

A. Filter paper preparation

1. Using a #2 pencil, label filter paper at the top edge. Label three filter papers for each sample. (ex. 1A, 1B, 1C through xA, xB, xC)
2. Pre-fold filter paper into "envelopes"
3. Place filter paper in vacuum oven at 60 - 70 degree C for 5 hours.

a. To test for dryness, remove 2 to 3 filter papers from oven and place in desiccators for 20 - 30 minutes to cool to room temperature. Weigh filter paper and return to oven for 2 hours.

b. Repeat [a] with the same # filter papers until weights indicate dryness. Return to desiccator.

B. Prepare crucibles and sample

1. Use a wax pencil to write ID number on acid washed dried crucible or 50 mL glass beaker. Plan on one crucible for each sample.
2. Place approximately 15 to 20 grams of sample in each crucible, recording container ID# and corresponding sample ID #. Place samples in vacuum oven at 60 - 70 degree C overnight.

a. To test for dryness, remove 2 to 3 crucibles (with sample) from oven and place in desiccators for cooling to room temperature. Weigh crucible and return to oven for 4 hours.

b. Repeat [a] with the same # containers until weights indicate dryness. Return to desiccator.

c. Place crucibles (samples) in desiccator, cool for 30 - 40 minutes to room temperature prior to weighing.

NOTE: Crucibles with samples should be in a desiccator separate from filter paper desiccator.

C. Weigh filter paper and samples

1. Weigh all filter papers individually first using tweezers and Remove filter paper from desiccator one at a time using a tweezers. Return filter paper to desiccator.

NOTE: a. Take care not to let filter paper touch oily sealer on the desiccator rim while removing.

b. Verify that filter paper doesn't touch glass sides of scale when weighing.

2. Place previously weighed # paper on analytical balance and tare.

Remove one crucible at a time from desiccator and measure 2.5 to 3 grams of sample onto weighed pre-folded filter paper. Record weight and fold filter paper sample tightly to assure no sample is lost.

a. Return folded filter papers to desiccator.

D. Ether extraction

1. Place folded filter paper samples into Soxhlet apparatus located under fume hood.

a. Extract for 16 hours with ether.

NOTE: Verify that ether is clear in final "wash cycle"

2. After draining the solvent, let filter paper stand in the fume hood over night to remove the residual solvent.

3. Move filter papers to vacuum oven and dry at 60-70 C^o overnight.

4. Cool filter paper samples in a desiccator until they reach room temperature and record weigh samples.

E. Calculations

The loss in weight of the filter paper sample after soxhlet ether extraction measures its crude fat content.

% crude fat = (loss in weight of dried sample) x 100 / (weight of dry sample)

$$\% \text{ Error EE (of duplicates)} = \frac{\text{Biggest Value - Smallest Value}}{\text{Smallest Value}} \times 100$$

Ether extracts fatty acids, glycerides, phospholipids, sterols, some lipoproteins and many pigments. Not all of these are useful as sources of metabolizable energy.

Appendix C. Insoluble, Soluble and Total Dietary Fiber Determination

PART I - INSOLUBLE, SOLUBLE AND TOTAL DIETARY FIBER DETERMINATION
Based on AOAC Method 991.4

EQUIPMENT AND REAGENTS:

Beakers - 200mL (tall), 600mL
Filter Paper – Whatman No. 40 Ashless 150mm Cat No1440 150
Vacuum system
Shaking water baths 60 ^{o} and 98^{o}
Analytical Balance
Oven
Desiccator
pH meter
Pipettes
Buchner Funnel
Filtration flasks
Dispensers
Magnetic stirrers and stir bars
Aluminum foil

Reagents:
Deionized water
Ethanol solutions 78% and 85%
Acetone
Heat stable α-amylase solution
Protease
Amyloglucosidase solution
MES
TRIS
MES/TRIS buffer solution -0.05M MES, 0.05M TRIS pH8.2 at 24^{o}C
Hydrochloric acid solution – 0.561N

PROCEDURES:

1. Blanks
With each assay, run two blanks along with samples to measure any contribution from reagents to residue.

NOTE: Using the tall 200mL beakers 7 samples (in duplicate) and 2 blanks can be run for each assay (total of 16 beakers)

2. Samples
a. Weigh duplicate 1.000±0.005 g samples accurately into 200 mL tall-form beakers.

b. Add 40 mL MES-TRIS blend buffer solution (pH 8.2) to each beaker. Add magnetic stirring bar to each beaker. Stir on magnetic stirrer until sample is completely dispersed in solution. (This prevents lump formation, which would make sample inaccessible to enzymes.)

3. Incubation with heat-stable α-amylase

a. Add 50 µL heat-stable α-amylase solution, while stirring at low speed.
b. Cover each beaker with aluminum foil squares.
c. Place covered samples in shaking water bath at 95-100°C, and incubate for 35 min with continuous agitation. Start timing once all beakers are in hot water bath.

NOTE: Water level in bath should not be above level of liquid in beakers. This will reduce chances of sample tipping over when placed in water bath. Use the plastic space filler to hold beakers upright in wire basket during agitation.

4. Cool

a. Remove all sample beakers from hot water bath and cool to 60°C.

NOTE: Cooling samples to 60°C can be done by placing samples in 60°C water bath.

b. Remove foil covers.
c. Scrape any ring around beaker and gels in bottom of beaker with spatula, if necessary.
d. Rinse side wall of beaker and spatula with 10 mL distilled water by using pipettor.

5. Incubation with protease

a. Add 100 µL protease solution to each sample.
b. Re-cover with aluminum foil.
c. Incubate in shaking water bath at 60±1°C, with continuous agitation for 30 min. Start timing when temperature of water bath reaches 60°C.

6. pH check

a. Remove sample beakers from shaking water bath.
b. Remove covers.
c. Dispense 3 - 4 mL of 0.561 **N** HCl solution into sample while stirring.
d. Check pH, which should be 4.1- 4.8. Adjust pH, if necessary, with additional 5 % NaOH solution or 5 % HCl solution

7. Incubation with amyloglucosidase

a. Add 200 µL amyloglucosidase solution while stirring on magnetic stirrer.
b. Replace aluminum cover.
c. Incubate in shaking water bath at 60°C for 30 min, with constant agitation. Start timing when temperature of water bath reaches 60°C.

Appendix C. (continued) Insoluble, Soluble and Total Dietary Fiber Determination

8. Filtration preparation for insoluble and soluble dietary fiber (previous day)
a. For each sample and blank, label four, No. 40, ashless, 150mm filter papers with corresponding identification. Two filter papers will be for IDF residue, and two will be for SDF residue.
b. Place filter paper in 100°C oven for 4 hours.
c. Remove from oven and place filter paper in desiccator to cool to room temperature before weighing (~30 minutes).
d. Record weight of filter paper to the nearest 0.1 mg.

A. INSOLUBLE DIETARY FIBER (IDF)
a. Place labeled filter paper in Buchner funnel. Wet filter paper with 15mL distilled water and situate paper in center of funnel.
b. Attach vacuum to filtration flask in hood. Place funnel in filtration flask and apply suction to draw filter paper evenly onto perforated funnel surface.

9. Filter enzyme mixture from Step 7 through corresponding labeled filter paper into a filtration flask using a light vacuum.

NOTE: Prevent filtrate from entering suction hose by reducing vacuum suction and/or by hanging a piece of tinfoil inside filtration flask in front of opening.

10. Wash residue on filter paper in Buchner funnel twice with 10 mL distilled water preheated to 70°C.

NOTE: a. Use preheated, distilled water to first rinse beaker. Then use water in beaker to wash residue on filter paper.
b. Save filtrate and water washings collected in filtration flask for determination of SDF. Transfer this solution from 2 liter filtration flask to a pre-weighed 600 mL tall-form beaker.
c. While transferring solution to beaker keep "arm" of filtration flask up to prevent accidental loss of filtrate.

(For SDF determination, go to Step 11 of SDF procedure.)

11. Wash residue on filter paper in funnel twice with 10 mL of:
a. 95 % EtOH
b. Acetone

NOTE: Be sure to empty filtration flask of previously collected filtrate and water wash before doing these final EtOH and Acetone rinses.

12. Remove filter paper from funnel and dry filter paper containing residue overnight in 100°C oven.

13. Cool filter paper to room temperature in desiccator (~ 1 hr). Weigh filter paper containing dietary fiber residue to nearest 0.1 mg.
To obtain residue weight, subtract initial filter paper weight.

14. Protein and ash determination.
One residue from each type of fiber is analyzed for protein, and the second residue of the duplicate is analyzed for ash.
a. Perform protein analysis on residue using Kjeldahl method. (See Part II of protocol)
b. Perform ash analysis. (See Part III of protocol)

B. SOLUBLE DIETARY FIBER
1-10. Follow Steps 1-10 of IDF method.

11. Weigh combined solution of filtrate and water washings in pre-weighed 600ml beaker from Step 10 of IDF procedure.

12. Precipitation of SDF
a. Add 4 volumes 95 % EtOH preheated to 60°C.
b. Allow the precipitate to form at room temperature for 60 minutes.

13. Filtration setup
a. Use SDF filter paper labeled and weighed in step 8
b. Place labeled filter paper in large perforated funnel.
c. Wet filter paper using 15 mL of 78 % EtOH from wash bottle. Situate filter paper in center of funnel.
d. Place funnel in filtration flask and apply suction to draw filter paper evenly onto perforated funnel surface.

14. Filtration
a. Filter precipitated enzyme digest from SDF Step 12 through corresponding labeled filter paper.
b. Using a wash bottle with 78 % EtOH and a rubber spatula, quantitatively transfer all remaining particles to filter paper.

15. Wash
Using a vacuum, wash residue successively with two 15 mL portions of the following:
a. 78 % EtOH
b. 95 % EtOH
c. Acetone

16. Dry filter paper containing residue overnight in 100°C oven.

17. Proceed with Steps 13 to 14 of IDF method.

Appendix C. (continued) Insoluble, Soluble and Total Dietary Fiber Determination

Calculations

Blank (B, mg) determination:

$$\mathbf{B = [(BR_1 + BR_2)/2] - P_B - A_B}$$

BR_1 and BR_2 = residue weights (mg) for duplicate samples.
P and A = weights (mg) of protein and ash, respectively determined on the first and second blank residues.

Dietary Fiber (DF, g/100g) determination:

$$\mathbf{DF = [(R_1 + R_2)/2] - P - A - B /[(M_1 + M_2)/2] \times 100}$$

R_1 and R_2 = residue weights (mg) for duplicate samples
P and A = weights (mg) of protein and ash respectively determined on first and second residues
B= blank weight (mg)
M_1 and M_2 = weights (mg) for samples.

Total dietary fiber determination: summing IDF and SDF

Source:
Lee, S., Prosky, L., DeVries, J. Determination of Total, Soluble and Insoluble Dietary fiber in foods- Enzymatic Method, MES-TRIS Buffer: Collaborative Study *J AOAC* 1992;75(3):395-416

Appendix C. (continued) Insoluble, Soluble and Total Dietary Fiber Determination

PART II - PROTEIN DETERMINATION OF INSOLUBLE, SOLUBLE AND TOTAL FIBER
Based on AOAC Method 984.13

EQUIPMENT AND REAGENTS:

Digestion unit
Digestion tubes
Heat resistant gloves
Fiber filtrate filter papers (samples)
Dispenser
Distillation unit
Distillation flasks
Beakers (for titration)
Rubber stoppers (size 7)
Boiling beads
Magnetic stirrers
Titration apparatus
Gloves
High temperature marking pen

Reagents:
Blue Kel Pak
Sulfuric acid (H_2SO_4)
Boric acid
Blue indicator
Distilled water
Zinc pieces
Sodium Hydroxide
Distilled water

PROCEDURES:

Preparation of digestion tubes:

1. Number digestion tubes and place digestion tubes in digester with support rack.
2. Fold and place fiber residue filter paper in each digestion tube recording corresponding sample ID #.
3. Add 3-4 boiling beads to digestion tube
4. Add 1 blue Kel-Pak
5. Add (25 ml) of Sulfuric Acid (H_2SO_4) in to each digestion tube from dispenser pump.

NOTE:
a. Use a 25mL graduated cylinder to verify that pump is calibrated to dispense exactly 25 mL
b. Beware- Sulfuric Acid leaves holes in clothes and burns skin

6. **Wait one hour before turning on digester unit**.

Digestion

7. Set digestion tubes on digester supported by rack.
8. Plug in power unit
9. Turn on power switch (2 switches combined)
10. Press [P] to program (should be @ Step 1)
11. Press [L]; set temperature @ **400**; Press [L]
12. Set ramp time @ **115**=1hr 15 min; Press [L]
13. Set time @ **115**=1 hr 15 min; Press [L]
14. Set temperature @ **410**; Press [L] (should be @ Step 2)
15. Set ramp time @ **15**=15 min; Press [L]
16. Set time @ **45**=45 min; Press [L]
17. Keep Pressing [L] From Step 3 to Step 9 (should be set at **O** for temp, ramp, time)
18. Put digester cover over digestion tubes; turn on water valve located on left side of hood; Press [R]; Press [L]

NOTE: Finish time is dependent on the clarity of the green solution. Once mixture is a green color, boil for an additional 30-40 minutes. Turn off power switch if digester doesn't automatically turn off.

19. Remove digester cover with heat resistant gloves and set in water bucket full of **warm water** to cool and clean. Water bucket should remain within hood.
20. Remove digestion tubes from the boiler and leave to cool on orange rack.
21. When cool to the touch, add **300 ml** distilled water to the digestion tube in intervals of **100 ml** at a time to transfer the mixture to the distillation flask (run water down the sides, swirl, and rinse to ensure all digested mixture is removed from the sides of digestion tubes)
22. Add a size 7 rubber stopper to each distillation flask and set on the rack

NOTE: Turn off water valve and unplug power unit of digester.

Distillation

1. Prepare 20 titration beakers with ID number, **100 ml** Boric Acid and **8** drops of blue indicator
2. Prepare distillation unit by turning on main gas valve and water valve of unit.
3. Place one titration beaker under each of the 6 burners.
4. Prepare 6 beakers with **300 ml** distilled water and set aside.
5. Check each distillation flasks – swirl to make sure there is no crystallization in the mixture
6. Turn on gas knob and light burner.

NOTE: Be careful of body parts, hair and clothes *Stop, Drop and Roll!!!

7. Add **3-4** zinc pieces to the distillation flasks
8. Add **80 ml** Sodium Hydroxide to the distillation flask (run down the side of the flask to ensure layering and not mixing)
9. Connect the head stopper of the distillation unit to the round bottomed distillation flasks (one at a time) swirling mixture over flame until contents turn blue. Set in holder.
10. Let distillation flask boil until **300 ml** of solution is distilled into the titration beakers
11. After reaching 300 ml, rinse distillation unit tubing with distilled water by removing titration beaker and replacing it with the previously prepared beaker of 300mL distilled water. Turn off the heat.
12. Let distillation flask sit until the distilled water in beaker is sucked up into the system, back flushing into the distillation flask above.
13. Remove distillation flask, empty mixture in sink saving zinc and boiling beads Wash flask and invert on rack to dry.
14. Dry and separate zinc pieces and boiling beads for reuse.

NOTE: Turn off water and gas valve of distillation condenser.

Titration

1. Drop a magnetic stirrer into the titration flask.
2. Titrate solution with H_2SO_4 until solution turns from blue-green/aqua to blue.
3. Record start and stop titration values. Subtract to obtain mL of titrated H_2SO_4.
4. Subtract titration value of blank from titration value of sample.

Calculations:

One equivalent of HCl reacts quantitatively with one equivalent of N as ammonium borates.
Normality of acid X .014 = grams N equivalent to 1 mL of acid
Grams N/mL acid X 6.25 = grams protein/mL acid (protein factor)

$$\% \text{ Protein} = \frac{(\text{mL } H_2SO_4 - \text{mL Blank}) \times \text{protein factor}}{\text{Sample Weight}} \times 100$$

Gram N = (mL H_2SO_4 – mL Blank) X gram N / mL Acid

% Nitrogen = Gram N / Sample Weight

$$\% \text{ Error} = \frac{\text{Biggest Value} - \text{Smallest Value}}{\text{Smallest Value}} \times 100$$

$(Na_2CO_3)N=.0963$

$$\text{Normality} = \frac{\text{g Na2CO3} \times 1000}{\text{ml Acid} \times 52.99}$$

Appendix C. (continued) Insoluble, Soluble and Total Dietary Fiber Determination

PART III - ASH DETERMINATION OF INSOLUBLE, SOLUBLE AND TOTAL FIBER

EQUIPMENT:

Muffle Furnace
Oven
Crucibles (acid washed)
Desiccator
Analytical Balance
Gloves
High temperature marker

PROCEDURES:

1. Label one acid washed crucible for each sample with heat indestructible marker.
2. Place crucibles in oven over night at 100 °C.
3. Remove crucibles from oven and cool in desiccator to room temperature
4. Record weight of crucible using analytical balance.
5. Place previously weighed fiber residue filter paper in crucible.
   Record crucible number and corresponding filter paper ID#
6. Place crucible samples in muffle furnace for 10 hr at 650°C.
   (The ash should be white or light gray, free from any carbon particles.)
7. After the muffle furnace has cooled significantly (but still hot) put the crucibles with ash into a desiccator. Weigh when crucibles have reached room temperature.
8. Weigh to nearest 0.1 mg.
9. Subtract crucible weight to determine ash.
10. Clean and acid wash crucibles

Calculations

$$\% \text{ Ash} = \frac{(\text{Crucible + ash}) - (\text{Crucible wt.})}{(\text{Crucible + unashed sample}) - (\text{Crucible wt.})} \times 100$$

Appendix D. FDA food labeling rounding rules

Nutrient	Increment Rounding	Insignificant Amount
Calories	< 5 cal - express as 0 ≤ 50 cal - express to nearest 5 cal increment > 50 cal - express to nearest 10 cal increment	< 5 cal
Total Fat	< .5 g - express as 0 < 5 g - express to nearest .5g increment ≥ 5 g - express to nearest 1 g increment	< .5 g
Sodium	< 5 mg - express as 0 5 - 140 mg - express to nearest 5 mg increment > 140 mg - express to nearest 10 mg increment	< 5 mg
Total Carbohydrate Dietary Fiber	< .5 g - express as 0 < 1 g - express as "Contains less than 1 g" or "less than 1 g" ≥ 1 g - express to nearest 1 g increment	< 1 g
Protein	< .5 g - express as 0 < 1 g - express as "Contains less than 1 g" or "less than 1 g" or to 1 g if .5 g to < 1 g ≥ 1 g - express to nearest 1 g increment	< 1 g
Minerals (express as % DV)	< 2% of RDI may be expressed as: (1) 2% DV if actual amount is 1% or more (2) 0 (3) an asterisk that refers to statement "Contains less than 2% of the Daily Value of this (these) nutrient(s)" (4) for calcium, iron: statement "Not a significant source of _____ (listing the vitamins and minerals omitted)" ≤ 10% of RDI - express to nearest 2% DV increment > 10% - 50% of RDI - express to nearest 5% DV increment > 50% of RDI - express to nearest 10% DV increment	< 2% RDI

Source:

Guidance for Industry: Nutrition Labeling Manual - A Guide for Developing and Using Data Bases

http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/FoodLabelingNutrition/ucm063113.htm

1998 edition July 2003 update

Appendix E-1. Traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
TRADITIONAL								
Natto								
Natto_1	Nijiya	Nijiya	Organic Natto	V				L*
Natto_2	Aloha Tofu Factory	Aloha Tofu	Prepared Cultured Soybean Natto	V				
Seitan								
Seitan1	Hains Celestial Group	Westsoy	Chicken Style Seitan	V				
Seitan2	Hains Celestial Group	Westsoy	Seitan Strips	V				L*
Tempeh								
Tempeh_1	Lightlife Foods	Lightlife	Fakin Bacon Organic Smoky Tempeh Strips	V				
Tempeh_2	Hains Celestial Group	Westsoy	Five Grain Tempeh	V				
Tempeh_3	Lightlife Foods	Lightlife	Garden Veggies Original Tempeh	V				
Tempeh_4	Turtle Island Foods Inc.	Turtle Island Foods Inc	Organic Five Grain Home Style Tempeh	V				L
Tempeh_5	Lightlife Foods	Lightlife	Organic Flax Tempeh	V				
Tempeh_6	Lightlife Foods	Lightlife	Organic Soy Tempeh	V				L
Tempeh_7	Turtle Island Foods Inc.	Turtle Island Foods Inc	Organic Soy Tempeh	V				
Tempeh_8	Lightlife Foods	Lightlife	Organic Three Grain Tempeh	V				
Tempeh_9	Lightlife Foods	Lightlife	Organic Wild Rice Tempeh	V				
Tempeh_10	Hains Celestial Group	Westsoy	Original Tempeh	V				L
Tempeh_11	Turtle Island Foods Inc.	Turtle Island Foods Inc	Spicy Veggie Tempeh	V				
Tofu - Firm, Medium Firm and Extra Firm								
Tofu-Firm_1	Vitasoy USA	Azumaya	Extra Firm Lite Tofu (68% Less Fat)	V	F	B12		L
Tofu-Firm_2	House Foods America Corp.	House Foods	Extra Firm Organic Tofu	V				
Tofu-Firm_3	Vitasoy USA	Nasoya	Extra Firm Organic Tofu	V			U	
Tofu-Firm_4	Pulmuone Wildwood Inc	Wildwood Organics	Extra Firm Sprout Tofu	V				
Tofu-Firm_5	Whole Foods Market IP, LP	365 Organic - Whole Foods	Extra Firm Tofu	V				L
Tofu-Firm_6	House Foods America Corp.	House Foods	Extra Firm Tofu	V				
Tofu-Firm_7	Lucerne Foods Inc.- Safeway Brand	O Organic - Safeway brand	Extra Firm Tofu	V				L

Appendix E-1. (continued) Traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Tofu-Firm_8	Hains Celestial Group	Westsoy	Extra Firm Tofu	V				L
Tofu-Firm_9	Kanai Tofu Factory	Kanai Tofu Factory	Firm Soybean Curd Tofu	V				
Tofu-Firm_10	Mrs Cheng's Soybean Products	Mrs Cheng's Soybean Products	Firm Nigari Tofu	V				
Tofu-Firm_11	Quong Hop Co.	Soy Deli	Firm Nigari Tofu	V				L
Tofu-Firm_12	House Foods America Corp.	House Foods	Firm Organic Tofu	V				
Tofu-Firm_13	Vitasoy USA	Nasoya	Firm Organic Tofu	V			U	
Tofu-Firm_14	Aloha Tofu Factory	Aloha Tofu	Firm Soybean Curd Cake Tofu	V				
Tofu-Firm_15	Whole Foods Market IP, LP	365 Organic - Whole Foods	Firm Tofu	V				
Tofu-Firm_16	Vitasoy USA	Azumaya	Firm Tofu	V				
Tofu-Firm_17	House Foods America Corp.	House Foods	Firm Tofu	V				
Tofu-Firm_18	Lucerne Foods Inc.- Safeway Brand	O Organic - Safeway brand	Firm Tofu	V				
Tofu-Firm_19	Hains Celestial Group	Westsoy	Firm Tofu	V				
Tofu-Firm_20	House Foods America Corp.	House Foods	Medium Firm Organic Tofu	V				
Tofu-Firm_21	House Foods America Corp.	House Foods	Medium Firm Tofu	V				
Tofu-Firm_22	Pulmuone Wildwood Inc	Wildwood Organics	Super Firm High Protein Sprout Tofu	V				L
Tofu-Firm_23	Mrs Cheng's Soybean Products	Mrs Cheng's Soybean Products	Super Firm Nigari Tofu	V				
Tofu - Fried								
Tofu - Fried_1	Aloha Tofu Factory	Aloha Tofu	Aborage - Deep-Fried Tofu Pouches	V			U	
Tofu - Fried_2	Aloha Tofu Factory	Aloha Tofu	Deep-Fried Soybean Curd Cake Tofu	V				
Tofu - Fried_3	House Foods America Corp.	House Foods	Oagesan Fried Tofu Pouches	V				L
Tofu - Fried_4	House Foods America Corp.	House Foods	Tofu Cutlets	V				
Tofu - Silken and Regular Soft								
Tofu - Silken/ Soft_1	Morinaga Nutritional Foods Inc	Mori-Nu	Extra Firm Silken Tofu	V			U	
Tofu - Silken/ Soft_2	House Foods America Corp.	House Foods	Extra Soft Sukui Nigari Tofu	V				
Tofu - Silken/ Soft_3	Morinaga Nutritional Foods Inc	Mori-Nu	Firm Silken Lite Tofu	V			U	L
Tofu - Silken/ Soft_4	Morinaga Nutritional Foods Inc	Mori-Nu	Firm Silken Organic Tofu	V			U	
Tofu - Silken/ Soft_5	Morinaga Nutritional Foods Inc	Mori-Nu	Firm Silken Tofu	V			U	

Appendix E-1. (continued) Traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Tofu - Silken/ Soft_6	Pulmuone Wildwood Inc	Wildwood Organics	Silken Sprout Tofu	V				
Tofu - Silken/ Soft_7	Vitasoy USA	Azumaya	Silken Tofu	V				
Tofu - Silken/ Soft_8	Vitasoy USA	Nasoya	Soft Organic Tofu	V				
Tofu - Silken/ Soft_9	Morinaga Nutritional Foods Inc	Mori-Nu	Soft Silken Tofu	V			U	
Tofu - Silken/ Soft_10	House Foods America Corp.	House Foods	Soft Silken Tofu	V				
Tofu - Silken/ Soft_11	Aloha Tofu Factory	Aloha Tofu	Soft Soybean Curd Cake Tofu	V				
Tofu - Silken/ Soft_12	Kanai Tofu Factory	Kanai Tofu Factory	Soft Tofu	V				
Tofu - Seasoned (packaged with condiments)								
Tofu - Seasoned_1	Pulmuone Wildwood Inc	Wildwood Organics	Aloha Baked Sprout Tofu	V				L
Tofu - Seasoned_2	Quong Hop Co.	Soy Deli	Organic Baked Savory Flavor Tofu	V				L
Tofu - Seasoned_3	Quong Hop Co.	Soy Deli	Organic Baked Five Spice Tofu	V				
Tofu - Seasoned_4	Quong Hop Co.	Soy Deli	Organic Baked Hickory Tofu	V				
Tofu - Seasoned_5	Quong Hop Co.	Soy Deli	Organic Baked Honey Sesame Tofu	V				
Tofu - Seasoned_6	Quong Hop Co.	Soy Deli	Organic Baked Teriyaki Tofu	V				
Tofu - Seasoned_7	Pulmuone Wildwood Inc	Wildwood Organics	Pineapple Teriyaki Sprouted Tofu	V				
Tofu - Seasoned_8	Pulmuone Wildwood Inc	Wildwood Organics	Royal Thai Baked Sprout Tofu	V				
Tofu - Seasoned_9	Pulmuone Wildwood Inc	Wildwood Organics	Savory Baked Sprout Tofu	V				L

[a]Product ID corresponds with products in Appendix F1 and G1

Appendix E-2. Non-traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
NON-TRADITIONAL								
Bacon								
Bacon_1	Lightlife Foods	Lightlife	Smart Bacon - Bacon Style Strips	V				
Bacon_2	Kellogg NA Co.	Loma Linda Worthington	Stripples		F	B12	U	
Bacon_3	Kellogg NA Co.	Morning Star Farms	Veggie Breakfast Bacon Strips		F	B12	U	
Cutlet/Filet								
Cutlet/Filet_1	Dominex LC	Dominex	Breaded Italian Style Eggplant Cutlets	V				
Cutlet/Filet_2	Health is Wealth Products Inc.	Health is Wealth	Chicken-Free Buffalo Wings	V				
Cutlet/Filet_3	FoodTech International, Inc.	Veggie Patch	Chick'n Cutlets					
Cutlet/Filet_4	VegeUSA, LLC	Vegetarian Plus	Citrus Sparerib Cutlets	V				
Cutlet/Filet_5	Garden Protein International	Gardein garden products	Classic Style Buffalo Wings	V				
Cutlet/Filet_6	Quorn Foods Ltd	Quorn	Cranberry & Goat Cheese Chik'n Cutlet					
Cutlet/Filet_7	Quorn Foods Ltd	Quorn	Garlic & Herb Chik'n Cutlet					
Cutlet/Filet_8	Quorn Foods Ltd	Quorn	Gruyere Chik'n Cutlet					
Cutlet/Filet_9	Kellogg NA Co.	Morning Star Farms	Hickory BBQ Riblets	V			U	
Cutlet/Filet_10	Garden Protein International	Gardein garden products	Lightly Seasoned Chick'n Scallopini	V				
Cutlet/Filet_11	Kellogg NA Co.	Morning Star Farms	Meat-free Buffalo Wings		F	B12	U	
Cutlet/Filet_12	Garden Protein International	Gardein garden products	Meat-free Chik'n Filets	V				
Cutlet/Filet_13	Quorn Foods Ltd	Quorn	Meatless and Soy-free Southwestern Chik'n Wing					
Cutlet/Filet_14	FoodTech International, Inc.	Veggie Patch	Meat-less Buffalo Wings					
Cutlet/Filet_15	Quorn Foods Ltd	Quorn	Naked Chik'n Cutlets					
Cutlet/Filet_16	Kellogg NA Co.	Morning Star Farms	Original Chik'n Tenders				U	
Cutlet/Filet_17	Garden Protein International	Gardein garden products	Seven Grain Crispy Tender	V				
Cutlet/Filet_18	Lightlife Foods	Lightlife	Smart Cutlets - Original					

Appendix E-2.(continued) Non-traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Cutlet/Filet_19	Lightlife Foods	Lightlife	Smart Tenders - Savory Chick'n - Veggie Protein Tenders					
Cutlet/Filet_20	Lightlife Foods	Lightlife	Smart Wings - Veggie Protein Wings					
Cutlet/Filet_21	Garden Protein International	Gardein garden products	Tuscan Breasts	V				L
Cutlet/Filet_22	VegeUSA, LLC	Vegetarian Plus	Vegan Fish Fillets					
Cutlet/Filet_23	VegeUSA, LLC	Vegetarian Plus	Vegetarian Chicken Steaks					
Cutlet/Filet_24	VegeUSA, LLC	Vegetarian Plus	Vegetarian Ginger Chicken					
Deli Cold Cuts								
Deli_1	Turtle Island Foods Inc.	Tofurky	Cranberry & Stuffing Tofurky Deli Slices	V				
Deli_2	Turtle Island Foods Inc.	Tofurky	Hickory Smoked Tofurky Deli Slices	V				
Deli_3	Turtle Island Foods Inc.	Tofurky	Italian Tofurky Deli Slices	V				
Deli_4	Hains Celestial Group	Yves Veggie Cuisine	Meatless Bologna	V	F	B12		
Deli_5	Hains Celestial Group	Yves Veggie Cuisine	Meatless Deli Turkey	V	F	B12		
Deli_6	Hains Celestial Group	Yves Veggie Cuisine	Meatless Ham	V	F	B12		
Deli_7	Hains Celestial Group	Yves Veggie Cuisine	Meatless Pepperoni	V	F	B12		
Deli_8	Hains Celestial Group	Yves Veggie Cuisine	Meatless Salami	V	F	B12		
Deli_9	Turtle Island Foods Inc.	Tofurky	Oven Roast Tofurky Deli Slices	V				
Deli_10	Turtle Island Foods Inc.	Tofurky	Peppered Tofurky Deli Slices	V				
Deli_11	Turtle Island Foods Inc.	Turtle Island Foods Inc	Philly-Style Steak Deli Slices	V				
Deli_12	Lightlife Foods	Lightlife	Smart Deli - Pepperoni Style Veggie Protein Slices	V				
Ground								
Ground_1	Hains Celestial Group	Yves Veggie Cuisine	Asian Ground Round Lettuce Wraps Original	V	F	B12		
Ground_2	Lightlife Foods	Lightlife	Gimme Lean Ground Beef	V				
Ground_3	Boca Food Co.	Boca Burger	Ground Crumbles	V				
Ground_4	Kellogg NA Co.	Morning Star Farms	Meal Starter Griller Recipe Crumble		F	B12	U	

Appendix E-2.(continued) Non-traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Ground_5	Quorn Foods Ltd	Quorn	Meatless And Soy-Free Grounds					
Ground_6	Hains Celestial Group	Yves Veggie Cuisine	Meatless GroundRound Original	V	F	B12		
Ground_7	Hains Celestial Group	Yves Veggie Cuisine	Meatless Taco Stuffers Original	V	F	B12		
Ground_8	Hains Celestial Group	Yves Veggie Cuisine	Meatless Turkey Ground	V	F	B12		
Ground_9	Lightlife Foods	Lightlife	Smart BBQ - Shredded Veggie Protein In BBQ Sauce	V				
Ground_10	Lightlife Foods	Lightlife	Smart Ground - Mexican Seasoned Veggie Protein Crumble	V				
Ground_11	Lightlife Foods	Lightlife	Smart Ground - Original Veggie Protein Crumble	V				
Ground_12	VegeUSA, LLC	Vegetarian Plus	Tuna Rolls	V				
Hotdog								
Hotdog_1	Kellogg NA Co.	Loma Linda Worthington	Big Franks	V	F	B12	U	
Hotdog_2	Turtle Island Foods Inc.	Tofurky	Chipotle Franks	V				L
Hotdog_3	Hains Celestial Group	Yves Veggie Cuisine	Good Dog	V	F	B12		
Hotdog_4	Hains Celestial Group	Yves Veggie Cuisine	Hot Dog	V	F	B12		
Hotdog_5	Kellogg NA Co.	Loma Linda Worthington	Linkett Protein Links	V	F	B12	U	
Hotdog_6	Hains Celestial Group	Yves Veggie Cuisine	Meatless Jumbo Dog	V	F	B12		L
Hotdog_7	Lightlife Foods	Lightlife	Smart Dog - Jumbo Veggie Protein Links	V	F	B12		L
Hotdog_8	Lightlife Foods	Lightlife	Smart Dog - Veggie Protein Links	V				
Hotdog_9	Lightlife Foods	Lightlife	Smart Links -Breakfast Sausage Style Veggie Protein Links	V				
Hotdog_10	Hains Celestial Group	Yves Veggie Cuisine	Tofu Dogs	V	F	B12		
Hotdog_11	Lightlife Foods	Lightlife	Tofu Pups	V				
Meatballs								
Meatballs_1	Nate's	Nate's	Classic Meatless Meatballs	V				
Meatballs_2	Dominex LC	Dominex	Eggplant Vegetarian Meatballs					

Appendix E-2.(continued) Non-traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Meatballs_3	FoodTech International, Inc.	Veggie Patch	Falafel Chickpea Balls					
Meatballs_4	Quorn Foods Ltd	Quorn	Meatless Meatballs					
Meatballs_5	FoodTech International, Inc.	Veggie Patch	Meatless Meatballs					
Meatballs_6	Nate's	Nate's	Savory Mushroom Meatballs	V				
Meatballs_7	Nate's	Nate's	Zesty Italian Meatless Meatballs	V				
Mixed								
Mixed_1	Nate's	Nate's	Beef StyleTaquitos	V				
Mixed_2	Nate's	Nate's	Chicken Style Taquitos					
Mixed_3	Garden Protein International	Gardein garden products	Meat- free Santa Fe good stuff	V				
Mixed_4	Lightlife Foods	Lightlife	Smart Chili - Veggie Protein Chili With Beans	V				
Mixed_5	Lightlife Foods	Lightlife	Smart Stuffers - Turk'y With Cranberry Stuffing - Breaded Stuffed Veggie Protein					
Mixed_6	Lightlife Foods	Lightlife	Smart Tex Mex - Veggie Protein With Beans In A Southwestern Sauce	V				
Nuggets								
Nuggets_1	Garden Protein International	Gardein garden products	Barbeque Skewers	V				
Nuggets_2	VegeUSA, LLC	Vegetarian Plus	Black Pepper Chicken Tenders	V				
Nuggets_3	Dr Praeger's Sensible Foods	Dr Praeger's Sensible Foods	Buffalo Chickenless Nuggets					
Nuggets_4	Health is Wealth Products Inc.	Health is Wealth	Chicken-Free Nuggets	V				
Nuggets_5	Dr Praeger's Sensible Foods	Dr Praeger's Sensible Foods	Chickenless Nuggets					
Nuggets_6	FoodTech International, Inc.	Veggie Patch	Chick'n Nuggets					
Nuggets_7	Kellogg NA Co.	Morning Star Farms	Chik'n Nuggets		F	B12	U	
Nuggets_8	Quorn Foods Ltd	Quorn	Chik'n Nuggets					
Nuggets_9	Hains Celestial Group	Yves Veggie Cuisine	Lemon Herb Chicken Skewers		F	B12		
Nuggets_10	Quorn Foods Ltd	Quorn	Meatless And Soy-Free Chik'n Tenders					

Appendix E-2.(continued) Non-traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Nuggets_11	Boca Food Co.	Boca Burger	Original Chick'n Nuggets	V				
Nuggets_12	Boca Food Co.	Boca Burger	Original Chik'n Nuggets Made With Natural Ingredients	V				
Nuggets_13	Garden Protein International	Gardein garden products	Seasoned Bites	V				
Nuggets_14	FoodTech International, Inc.	Veggie Patch	Spinach Nuggets					
Nuggets_15	VegeUSA, LLC	Vegetarian Plus	Vegan Black Pepper Steaks	V				
Nuggets_16	VegeUSA, LLC	Vegetarian Plus	Vegan Kung Pau Chicken	V				
Nuggets_17	VegeUSA, LLC	Vegetarian Plus	Vegan Orange Chicken In Tangy Orange Sauce	V				
Nuggets_18	VegeUSA, LLC	Vegetarian Plus	Vegetarian Chicken Drumsticks					
Other								
Other_1	House Foods America Corp.	House Foods	Tofu Shirataki - Spaghetti Noodles Shaped Noodle Substitute	V				
Other_2	VegeUSA, LLC	Vegetarian Plus	Vegan Shrimp	V				
Patties								
Patties_1	Boca Food Co.	Boca Burger	All American Flame Grilled Meatless Burger					L
Patties_2	Amy's Kitchen Inc	Amy's Kitchen	All American Veggie Burger	V				
Patties_3	Boca Food Co.	Boca Burger	All American w/ Non Gmo Soy					
Patties_4	Hawai'i Taro Co., Inc.	Maui Taro Burger	Asian Ginger Maui Taro Burger	V				
Patties_5	Kellogg NA Co.	Morning Star Farms	Asian Veggie Patties				U	
Patties_6	Sunshine Burgers & Speciality Foods, LLC	Organic Sunshine Burger	Barbeque Veggie Burger	V				
Patties_7	Amy's Kitchen Inc	Amy's Kitchen	Bistro Burger	V				
Patties_8	Kellogg NA Co.	Garden Burger	Black Bean Chipotle Veggie Burger	V			U	
Patties_9	Sunshine Burgers & Speciality Foods, LLC	Organic Sunshine Patties	Breakfast Burger	V				
Patties_10	Kellogg NA Co.	Morning Star Farms	Breakfast Patties Made With Organic Soy				U	
Patties_11	Kellogg NA Co.	Garden Burger	California Burgers	V			U	

Appendix E-2.(continued) Non-traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Patties_12	Amy's Kitchen Inc	Amy's Kitchen	California Veggie Burgers	V				
Patties_13	Dr Praeger's Sensible Foods	Dr Praeger's Sensible Foods	California Veggie Burgers	V				L
Patties_14	Amy's Kitchen Inc	Amy's Kitchen	Cheddar Veggie Burger					
Patties_15	Follow Your Heart	Follow Your Heart	Chicken-Free Chicken Pattie	V				
Patties_16	Health is Wealth Products Inc.	Health is Wealth	Chicken-Free Patties	V				L
Patties_17	Dr Praeger's Sensible Foods	Dr Praeger's Sensible Foods	Chickenless Patties					
Patties_18	Kellogg NA Co.	Morning Star Farms	Chik Patties Original		F	B12	U	
Patties_19	Kellogg NA Co.	Morning Star Farms	Chipotle Black Bean Burger	V				
Patties_20	Food for Life Baking Co.	Food for Life Bakery	Cluckphrey Chic-A-Roos	V				
Patties_21	Food for Life Baking Co.	Food for Life Bakery	Cluckphrey Patties	V				
Patties_22	Sunshine Burgers & Speciality Foods, LLC	Organic Sunshine Patties	Falafel Burger	V				
Patties_23	Sunshine Burgers & Speciality Foods, LLC	Organic Sunshine Burger	Garden Herbs Burger	V				L
Patties_24	Kellogg NA Co.	Garden Burger	Garden Vegan Veggie Patties	V			U	L
Patties_25	Kellogg NA Co.	Morning Star Farms	Garden Veggie Patties				U	
Patties_26	Kellogg NA Co.	Morning Star Farms	Grillers 1/4 Pounder		F	B12	U	L
Patties_27	Kellogg NA Co.	Morning Star Farms	Grillers California Turk'y Burger					
Patties_28	Kellogg NA Co.	Morning Star Farms	Grillers Original		F	B12	U	
Patties_29	Kellogg NA Co.	Morning Star Farms	Grillers Prime Veggie Burgers				U	L
Patties_30	Hawai'i Taro Co., Inc.	Maui Taro Burger	Hot and Spicy Maui Taro Burger	V			U	
Patties_31	Kellogg NA Co.	Morning Star Farms	Maple Flavored Veggie Sausage Patties		F	B12	U	
Patties_32	Quorn Foods Ltd	Quorn	Meatless And Soy-Free Chik'n Patties					L
Patties_33	Quorn Foods Ltd	Quorn	Meatless and Soy-free Turk'y Burger					
Patties_34	Hains Celestial Group	Yves Veggie Cuisine	Meat-Less Breakfast Patties	V	F	B12		L
Patties_35	Hains Celestial Group	Yves Veggie Cuisine	Meat-Less Canadian Bacon	V	F	B12		
Patties_36	Dr Praeger's Sensible Foods	Dr Praeger's Sensible Foods	Meatless Southwest Burgers					
Patties_37	Food for Life Baking Co.	Food for Life Bakery	Moophrey Burgers	V				L
Patties_38	Sunshine Burgers & Speciality Foods, LLC	Organic Sunshine Burger	Original Burger	V				

Appendix E-2.(continued) Non-traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Patties_39	Boca Food Co.	Boca Burger	Original Chik'n Patties w/ Non Gmo Soy	V				
Patties_40	Boca Food Co.	Boca Burger	Original Vegan 56 Oz Patty	V				
Patties_41	Boca Food Co.	Boca Burger	Original Vegan Meatless Burger	V				L
Patties_42	Kellogg NA Co.	Garden Burger	Portabella Burgers				U	
Patties_43	Amy's Kitchen Inc.	Amy's Kitchen	Quarter Pound Veggie Burger	V				L
Patties_44	Sunshine Burgers & Speciality Foods, LLC	Organic Sunshine Burger	Southwest Burgers	V				
Patties_45	Lucerne Foods Inc.- Safeway Brand	Eating Right - Safeway brand	Soy Protein Burgers	V				L
Patties_46	Kellogg NA Co.	Morning Star Farms	Spicy Black Bean Veggie Burgers				U	
Patties_47	Boca Food Co.	Boca Burger	Spicy Chik'n Patties	V				
Patties_48	Boca Food Co.	Boca Burger	Spicy Chik'n Patties w/ Non GMO Soy	V				
Patties_49	Kellogg NA Co.	Garden Burger	Sun-Dried Tomato Basil Burgers				U	
Patties_50	Amy's Kitchen Inc.	Amy's Kitchen	Texas Veggie Burger	V				L
Patties_51	Dr Praeger's Sensible Foods	Dr Praeger's Sensible Foods	Texmex Veggie Burgers	V				
Patties_52	Hawai'i Taro Co., Inc.	Maui Taro Burger	The Original Maui Taro Burger	V				
Patties_53	Kellogg NA Co.	Garden Burger	The Original Veggie Burgers				U	L
Patties_54	Kellogg NA Co.	Morning Star Farms	Tomato & Basil Pizza Burgers				U	
Patties_55	Boca Food Co.	Boca Burger	Vegan w/ Non GMO Soy Burger	V				
Patties_56	Kellogg NA Co.	Loma Linda Worthington	Vegetarian Burger	V	F	B12	U	
Patties_57	Kellogg NA Co.	Morning Star Farms	Veggie Breakfast Sausage Patties - Original		F	B12	U	
Patties_58	Lucerne Foods Inc.- Safeway Brand	Eating Right - Safeway brand	Veggie Burger					
Patties_59	Kellogg NA Co.	Garden Burger	Veggie Medley Burger	V			U	
Roasts								
Roasts_1	Field Roast Grain Meat Co.	Field Roast	Celebration Roast	V				
Roasts_2	Field Roast Grain Meat Co.	Field Roast	Classic Meatloaf	V				
Roasts_3	Quorn Foods Ltd	Quorn	Meatless and Soy-free Turk'y Roast					
Roasts_4	Turtle Island Foods Inc.	Turtle Island Foods Inc	Tofurky Roast	V				

Appendix E-2.(continued) Non-traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Roasts_5	Turtle Island Foods Inc.	Turtle Island Foods Inc	Tofurky Vegetarian Feast Roast	V				
Roasts_6	VegeUSA, LLC	Vegetarian Plus	Vegan Half Chicken	V				
Sausages								
Sausages_1	Turtle Island Foods Inc.	Tofurky	Beer Brats	V				
Sausages_2	Lightlife Foods	Lightlife	Gimme Lean Sausage	V				
Sausages_3	Field Roast Grain Meat Co.	Field Roast	Italian Sausage	V				
Sausages_4	Turtle Island Foods Inc.	Tofurky	Italian Sausage w/ Sundried Tomatoes and Basil	V				L
Sausages_5	Turtle Island Foods Inc.	Tofurky	Kielbasa Polish Style Sausage	V				L
Sausages_6	Field Roast Grain Meat Co.	Field Roast	Lentil Sage Sausage	V				
Sausages_7	El Burrito Mexican Food Product Inc.	El Burrito Mexican Food Product Inc	Meatless Soy Chorizo	V				L
Sausages_8	Field Roast Grain Meat Co.	Field Roast	Mexican Chipotle Sausage	V				
Sausages_9	Lightlife Foods	Lightlife	Smart Sausage - Chorizo Style Veggie Protein Sausages					
Sausages_10	Lightlife Foods	Lightlife	Smart Sausage - Italian Style Veggie Protein Sausages					L
Sausages_11	Field Roast Grain Meat Co.	Field Roast	Smoked Apple Sage Sausage	V				L
Sausages_12	Field Roast Grain Meat Co.	Field Roast	Smoked Tomato Sausage	V				
Sausages_13	Hains Celestial Group	Yves Veggie Cuisine	Veggie Brat Classic	V	F	B12		
Sausages_14	Hains Celestial Group	Yves Veggie Cuisine	Veggie Brats Zesty Italian	V	F	B12		
Sausages_15	Kellogg NA Co.	Morning Star Farms	Veggie Breakfast Sausage Links		F	B12	U	
Sausages_16	Kellogg NA Co.	Morning Star Farms	Veggie Italian Style Sausage				U	
Sausages_17	Field Roast Grain Meat Co.	Field Roast	Wild Mushroom Sausage	V				
Strips								
Strips_1	Kellogg NA Co.	Morning Star Farms	Chik'n Strips Made With Natural Ingredients	V	F	B12		

Appendix E-2.(continued) Non-traditional plant-based meat alternative products identified in six Honolulu markets, product information and indication of existance of USDA data and lab analysis.

Product ID[a]	Manufacturer	Brand	Product Name	Vegan	Fortified	B12	USDA	Lab
Strips_2	Kellogg NA Co.	Morning Star Farms	Meal Starters Chik'n Strips	V	F	B12	U	
Strips_3	Garden Protein International	Gardein garden products	Meat-free Barbeque Pulled Shreds	V				
Strips_4	Lightlife Foods	Lightlife	Smart Strips - Chick'n Style Strips - Seasoned Veggie Strips	V				
Strips_5	Lightlife Foods	Lightlife	Smart Strips - Steak Strips - Seasoned Veggie Strips	V				

[a]Product ID corresponds with products in Appendix F2 and G2.

Appendix F-1. Traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
TRADITIONAL																					
Natto																					
Natto_1	40	3	80	30	3	1	0			0	0		5		3	2	7	0	0	4	8
Natto_2	85	1	140	60	7	1	0			0	30		6		4	0	12	0	0	6	10
Seitan																					
Seitan1	140	3.5	110	20	2	0	0			0	770		4		2	1	20	0	0	4	6
Seitan2	85	2.5	140	20	2	0	0	1.5	0.5	0	470		8		1	2	24	0	0	2	8
Tempeh																					
Tempeh_1	57	3	100	25	3	0	0			0	470	135	10		4	2	8	0	4	4	8
Tempeh_2	76	3	150	50	5	0.5	0			0	0		13		3	2	13	0	2	6	20
Tempeh_3	113	2	240	90	10	1.5	0	5	3	0	10	300	17		10	1	19	0	0	10	15
Tempeh_4	85	2.5	170	50	6	1	0			0	10		20		6	0	11	0	0	8	8
Tempeh_5	113	2	230	80	9	1.5	0			0	0	400	16		11	0	20	0	0	10	20
Tempeh_6	113	2	230	70	8	1.5	0			0	10	380	16		12	<1	22	0	0	15	20
Tempeh_7	85	2.5	160	32	3.5	0.5	0			0	10		20		7	0	13	0	0	6	8
Tempeh_8	113	2	240	100	11	2	0			0	10	360	16		9	<1	20	0	0	8	15
Tempeh_9	113	2	230	100	11	2	0			0	10	360	12		11	1	21	6	0	10	20
Tempeh_10	76	3	160	50	7	1	0			0	10		9		3	0	16	0	0	8	10
Tempeh_11	85	2.5	140	40	5		0			0	0	350	12		5	3	13	10	0	10	15
Tofu - Firm, Medium Firm and Extra Firm																					
Tofu-Firm_1	79	5	60	20	2	0	0			0	30		3		<1	0	7	30	0	30	10

Appendix F-1. (continued) Product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Tofu-Firm_2	85	4	70	35	4	1	0			0	10		0		0	0	7	0	0	10	4
Tofu-Firm_3	79	5	80	35	4	0.5	0	2.5	1	0	0		2		<1	0	8	0	0	6	8
Tofu-Firm_4	85	5	80	45	5	1	0			0	5		1		1	0	9	0	0	15	6
Tofu-Firm_5	79	5	80	35	4	0.5	0			0	0		2		1	0	8	0	0	6	6
Tofu-Firm_6	85	4	80	35	4	0.5	0			0	30		1		<1	0	8	0	0	15	8
Tofu-Firm_7	79	5	80	35	4	0.5	0			0	0		2		1	0	8	0	0	6	8
Tofu-Firm_8	79	5	95	45	5	1	0			0	5		3		<1	0	10	0	0	8	8
Tofu-Firm_9	85	5	50	25	3	0				0	15		1		1	0	5	<2	<2	15	8
Tofu-Firm_10	85	6.5	70	45	4	0.5				0	50		2		2	0	7	0	0	4	6
Tofu-Firm_11	85	10	130	60	3.5	0.5	0			0	10		4		2	0	15	2	0	0	0
Tofu-Firm_12	85	4.5	60	35	3.5	0.5	0			0	10		0		0	0	6	0	0	10	2
Tofu-Firm_13	79	5	70	30	3	0	0	2	1	0	0		2		<1	0	7	0	0	10	6
Tofu-Firm_14	85	6	70	35	4	0	0			0	10		2		2	0	6	2	0	10	6
Tofu-Firm_15	79	5	70	30	3	0	0			0	0		2		<1	0	7	0	0	10	6
Tofu-Firm_16	85	5	70	30	3.5	0	0	2	1	0	20		2		<1	0	7	0	0	15	6
Tofu-Firm_17	85	4.5	70	30	3.5	0.5	0			0	30		2		<1	0	8	0	0	15	8
Tofu-Firm_18	79	5	70	30	3	0	0			0	0		2		<1	0	7			10	6
Tofu-Firm_19	79	5	95	45	5	1	0			0	5		3		<1	0	10	0	0	8	8
Tofu-Firm_20	85	4.5	50	30	3.5	0.5	0			0	10		1		0	<1	5	0	0	8	4
Tofu-Firm_21	85	4.5	60	25	3	0	0			0	30		1		<1	0	7	0	0	10	8
Tofu-Firm_22	85	3	100	35	4	1	0			0	45		5		1	0	14	0	0	6	10

Appendix F-1. (continued) Product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Tofu-Firm_23	85	6.5	90	45	5	0.5				0	55		3		3	0	8	0	0	6	6
Tofu - Fried																					
Tofu - Fried_1	57	1	170	120	13	3	0			0	20		0		2	0	14	0	0	50	8
Tofu - Fried_2	170	2	100	35	4	1	0			0	10		7		3	0	10	0	0	30	10
Tofu - Fried_3	14	2	50	35	4	1	0			0	5		0		0	0	4	0	0	8	2
Tofu - Fried_4	71	3.5	90	50	6	1	0			0	15		2		<2	<1	9	0	0	10	6
Tofu - Silken and Regular Soft																					
Tofu - Silken/ Soft_1	84	4	45	15	1.5	0				0	55		2		0		6	0	0	2	4
Tofu - Silken/ Soft_2	85	4	45	20	2	0	0			0	30		2		<0	1	5	0	0	6	6
Tofu - Silken/ Soft_3	84	4	30	5	0.5	0	0			0	70		1				5	0	0	2	4
Tofu - Silken/ Soft_4	84	4	60	25	2.5	0				0	40		2		0		6	0	0	2	4
Tofu - Silken/ Soft_5	84	4	50	20	2.5	0				0	30		2		0		6	0	0	2	4
Tofu - Silken/ Soft_6	85	5	50	25	2.5	0.5	0			0	5		1		1	0	5	0	0	6	4
Tofu - Silken/ Soft_7	91	5	40	20	2	0				0	0	160	1		<1	0	4	0	0	6	4
Tofu - Silken/ Soft_8	79	5	60	30	3	0	0	2	0.5	0	0		1		<1	0	6	0	0	10	6
Tofu - Silken/ Soft_9	84	4	45	20	2.5	0				0	0		2		0		4	0	0	2	4
Tofu - Silken/ Soft_10	85	4.5	50	20	2.5	0	0			0	30		2		<1	0	5	0	0	8	8
Tofu - Silken/ Soft_11	85	6	40	10	1	0	0			0	20		3		3	0	4	2	<2	2	4
Tofu - Silken/ Soft_12	85	5	45	23	3	0				0	20		1		1	0	4	<2	<2	<2	6
Tofu - Seasoned (packaged with condiments)																					
Tofu - Seasoned_1	85	2	150	40	4.5	1	0			0	200		13		3	2	17	0	2	8	15

Appendix F-1. (continued) Product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Tofu - Seasoned_2	85	2.7	130	60	6	0.5				0	620		4		2	0	17	4	0	0	0
Tofu - Seasoned_3	85	2	170	30	3.5	0.5				0	700		10		2	0	25	2	4	12	16
Tofu - Seasoned_4	85	2	170	30	3.5	0.5				0	580		10		2	0	25	2	2	10	14
Tofu - Seasoned_5	85	2	170	30	3.5	0.5				0	310		11		2	4	25	2	2	10	14
Tofu - Seasoned_6	85	2	170	30	3.5	0				0	155		10		2	4	25	2	2	10	14
Tofu - Seasoned_7	85	2	160	100	12	1.5	0			0	230		5		1	3	13	0	0	0	0
Tofu - Seasoned_8	85	2	150	45	5	1	1			0	290	0	15		3	3	15	0	6	8	15
Tofu - Seasoned_9	85	2	150	80	9	1	0			0	390		3		1	<1	14	0	0	20	15

[a]Product ID corresponds with products in Appendix E1 and G1

Appendix F-2. Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
NON-TRADITIONAL																					
Bacon																					
Bacon_1	10	14	20	10	1	0	0	0	0	0	140	40	0		0	0	2	0	0	0	0
Bacon_2	16	9	60	40	4.5	0.5	0	3	1	0	220	15	2		1	0	2	0	0	0	2
Bacon_3	16	9	60	40	4.5	0.5	0	3	1	0	230	15	2		1	0	2	0	0	0	2
Cutlet/Filet																					
Cutlet/Filet_1	85	5	100	20	2	0	0			0	280		18		3	2	3	2	2	0	4
Cutlet/Filet_2	85	4	130	20	2.5	0	0			0	690		18		4	10	13	10	4	10	8
Cutlet/Filet_3	71	4	140	50	6	1	0			0	380		15		3	1	10	2	0	20	6
Cutlet/Filet_4	71	4	210	70	8	2.5	0			0	530		23		3	6	12	0	0	6	10
Cutlet/Filet_5	72	2.5	90	15	2	0	0			0	330		4		1	0	15	0	0	8	20
Cutlet/Filet_6	120	2	280	150	17	5	0	8	4	20	600		25		5	8	12	0	0	10	2
Cutlet/Filet_7	100	2	200	80	9	1	0	2	6	5	570		22		3	4	12	0	0	3	7
Cutlet/Filet_8	110	2	260	135	15	4	0	7	4	20	510		23		3	3	11	0	0	11	0
Cutlet/Filet_9	142	2	220	30	3.5	0	0	1	2	0	620	580	35		6	24	16	0	4	10	15
Cutlet/Filet_10	71	4	90	15	2	0	0			0	330		4		2	0	14	0	0	8	30
Cutlet/Filet_11	85	35	200	70	8	1	0	5	1.5	0	640	410	20		3	2	12	2	0	4	15
Cutlet/Filet_12	100	2	150	60	6	0.5	0			0	490		6		2	0	19	2	0	4	15
Cutlet/Filet_13	85	3.5	180	70	8	1	0	2	5	0	460		21		2	4	10	0	0	2	4
Cutlet/Filet_14	87	3	200	70	8	1	0			0	540		23		3	1	11	6	0	20	8
Cutlet/Filet_15	69	4	80	20	2.5	0.5	0	0.5	1.5	5	420		5		2	0.5	11	0	0	3	2

Appendix F-2. (continued) Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Cutlet/Filet_16	81	3.5	190	60	7	1	0	3.5	2	0	580	200	20		3	1	12	0	0	4	10
Cutlet/Filet_17	51	5	100	35	3.5	0	0			0	250		8		1	0	8	0	0	2	6
Cutlet/Filet_18	85	2	110	5	0.5	0	0	0	0	0	360		8		3	<1	17	0	0	4	8
Cutlet/Filet_19	85	2	110	10	1	0	0	0	0	0	590	490	7		3	3	18	0	0	8	10
Cutlet/Filet_20	85	2	110	30	3	0	0	1.5	1	0	680	310	6		4	<1	13	10	20	4	6
Cutlet/Filet_21	98	2	120	20	2	0	0			0	480		6		2	0	21	0	0	10	40
Cutlet/Filet_22	71	4	145	30	3.5	0.5	0			0	340		23		3	0	5	0	0	3	6
Cutlet/Filet_23	71	4	220	130	14	2.5	0			0	520		9		3	3	13	0	0	6	10
Cutlet/Filet_24	57	5	190	100	11	3	0			0	440		17		3	4	7	0	0	4	4
Deli Cold Cuts																					
Deli_1	52	3	100	25	3	0	0			0	370		8		3	2	11	0	0	2	6
Deli_2	52	3	100	25	3	0	0			0	300		6		3	1	13	0	0	2	6
Deli_3	52	3	110	35	4	1	0			0	360		7		4	2	11	0	0	2	6
Deli_4	62	2.5	80	20	2.5	0	0	0.5	1	0	450	200	2		0	<1	14	0	0	2	20
Deli_5	62	2.5	100	15	1.5	0	0	0.5	1	0	340	230	5		0	<1	16	0	15	2	20
Deli_6	62	2.5	100	20	2	0	0	0.5	1	0	480	220	5		0	<1	15	0	20	2	20
Deli_7	48	2.5	80	10	1	0	0	0	0.5	0	390	150	4		0	<1	14	4	0	4	20
Deli_8	62	2.5	80	0	0	0	0	0	0	0	480	200	4		0	<1	15	4	0	4	20
Deli_9	52	3	100	25	3	0	0			0	300		6		3	1	13	0	0	2	6
Deli_10	52	3	100	25	3	0	0			0	300		6		3	1	13	0	0	2	6
Deli_11	52	3	100	25	3	0	0			0	370		7		3	0	12	0	0	2	6

Appendix F-2. (continued) Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Deli_12	30	4	50	10	1	0	0			0	240	490	2		1	1	9	0	0	0	2
Ground																					
Ground_1	55	6	60	5	0.5	0	0	0	0	0	350	250	8		2	4	7	25	6	4	20
Ground_2	57	7	70	0	0	0	0			0	350	250	10		2	1	7	0	0	6	8
Ground_3	57	6	60	0	0.5	0	0			0	270		6		3	0	13	0	0	6	10
Ground_4	55	6	80	20	2.5	0	0	1.5	0.5	0	230	100	5		3	<1	10	0	0	0	10
Ground_5	85	4	90	20	2	0.5	0	1	0.5	0	170		9		5	0.5	13	0	0	2	4
Ground_6	55	6	60	5	0.5	0	0	0	0.5	0	270	250	5		2	1	10	0	0	4	15
Ground_7	55	6	90	20	2.5	0	0	1	1	0	300	270	5		2	1	11	50	0	6	15
Ground_8	55	6	60	10	1	0	0	0.5	0.5	0	330	230	4		2	0	14	0	0	4	15
Ground_9	58	3	70	0	0	0				0	380	80	13		1	10	6	0	0	4	6
Ground_10	55	6	70	0	0	0	0			0	220	310	7		3	1	9	0	0	6	8
Ground_11	55	6	70	0	0	0	0	0	0	0	310	360	6		3	<1	12	0	0	8	8
Ground_12	71	4	160	70	7.5	2.5	0			0	360		14		0	0	13	0	0	0	0
Hotdog																					
Hotdog_1	51	11	110	60	6	1	0	3.5	1.5	0	220	50	3		2	0	11	0	0	0	4
Hotdog_2	45	5	90	25	3	0	0			0	270		5		3	1	10	2	0	2	4
Hotdog_3	58	9	70	30	3.5	0	0	1	2	0	430		1		0	<1	8	0	0	2	10
Hotdog_4	46	6	50	5	0.5	0	0	0	0	0	400	150	2		0	<1	10	0	0	2	15
Hotdog_5	35	10	70	35	4	0.5	0	2.5	1	0	160	20	1		1	0	7	0	0	0	2
Hotdog_6	76	5	110	25	3	0	0	1	1.5	0	460	240	5		0	2	16	0	0	4	20

Appendix F-2. (continued) Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Hotdog_7	76	5	80	5	1	0	0			0	560	490	3		2	1	15	0	0	2	10
Hotdog_8	42	8	45	0	0	0	0			0	310	270	2		1	1	8	0	0	0	6
Hotdog_9	56	3	100	25	3	0	0	1.5	1	0	500	570	8		3	<1	10	0	0	4	8
Hotdog_10	38	9	45	5	1	0	0	0	0	0	300	120	2		0	0	8	0	0	2	10
Hotdog_11	42	8	60	25	2.5	0.5	0			0	300	180	2		1	0	8	2	0	2	6
Meatballs																					
Meatballs_1	43	8	90	40	4.5	0	0			0	270		5		2	<1	8	0	0	4	6
Meatballs_2	85	5	90	25	2.5	0.5	0			5	450		9		5	3	9	2	2	10	10
Meatballs_3	84	3	180	80	9	1	0			0	380		21		6	3	5	35	10	6	15
Meatballs_4	68	4.5	90	14	1.5	0.5	0	0.5	0.5	5	390		7		1	1	13	0	0	2	0
Meatballs_5	84	3	120	40	4.5	0.5	0			0	480		7		4	1	16	30	2	25	10
Meatballs_6	43	8	100		4.5	0				0	230		6		2	1	8				10
Meatballs_7	43	8	90		4.5	0	0			0	340		4		2	1	9				
Mixed																					
Mixed_1	45		90		4.5						210		9		1		3				0
Mixed_2	45		90		4.5						210		9		1		3				0
Mixed_3	142	2	150	45	5	0	0			0	570		12		3	2	18	4	4	4	25
Mixed_4	284	1	260	5	0.5	0	0			0	820	1230	44		12	12	19	0	6	15	35
Mixed_5	113	2	220	70	7	0.5	0			0	630	310	22		3	2	18	0	2	6	15
Mixed_6	57	3	50	0	0	0	0			0	170	250	6		2	2	6	0	0	4	6

Appendix F-2. (continued) Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Nuggets																					
Nuggets_1	114	2	160	45	5	0	0			0	420		11		3	4	19	2	20	4	15
Nuggets_2	71	4	210	140	15	2.5	0			0	530		7		3	1	11	0	0	4	10
Nuggets_3	71	4	160	60	7	0.5	0			0	460		13		3	4	11	10	4	4	4
Nuggets_4	84	3.5	120	15	2	1	0			0	450		14	12	2	0	14	0	0	0	4
Nuggets_5	71	4	170	70	7	0.5	0			0	230		14		3	2	11	0	0	2	4
Nuggets_6	84	3	190	70	8	1	0			0	480		22		3	1	10	2	0	20	6
Nuggets_7	86	3.5	190	80	9	1.5	0	4.5	2.5	0	600	320	19		4	2	12	0	0	6	10
Nuggets_8	85	3.5	180	70	8	1	0	2	5	0	460		21		2	4	10	0	0	2	4
Nuggets_9	80	2	100	10	1	0	0	0.5	0	0	450	260	7		4	2	15	2	2		40
Nuggets_10	85	4	80	20	2	0.5	0	1	0.5	0	390		9		4	1	10	0	0	4	2
Nuggets_11	87	4	180	60	7	1	0			0	500		17		3	2	14	2	0	4	8
Nuggets_12	87	4	180	60	7	0.5	0			0	500		17		3	2	14	2	0	4	8
Nuggets_13	123	2	130		2.5	0	0	0	0		410		8		2		20				30
Nuggets_14	84	3	150	60	7	1	0			0	390		19		3	1	6	80	20	20	8
Nuggets_15	71	4	170	80	8	2	0			0	400		10		2	3	13	0	4	2	8
Nuggets_16	71	4	205	65	7	2	0			0	497		23		6	4	13	0	0	3	7
Nuggets_17	71	4	140	70	7	2.5	0			0	380		10		3	7	9	2	0	2	6
Nuggets_18	85	3.5	180	90	10	1.5	0			0	510		5		3	0	18	0	0	8	10

Appendix F-2. (continued) Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Other																					
Other_1	113	2	20	5	0.5	0	0			0	15		3		<2	0	1	0	2	10	2
Other_2	85	4	180	90	10	1.5	0			0	580		6		3	0	0	0	0	4	15
Patties																					
Patties_1	71	4	120	45	5	1.5	0	2	1.5	<5	380	370	6		5	0	14	0	0	15	10
Patties_2	71	4	140	30	3.5	0	0			0	390		14		4	2	13	8	6	4	10
Patties_3	71	4	140	45	5	1.5	0			5	500		9		4	1	15	0	0	15	8
Patties_4	96	2	130		1						320		26		3		5				4
Patties_5	67	4	100	35	4	0.5	0	2.5	1	0	490	260	10		2	3	7	20	0	2	4
Patties_6	75	3	250	90	10	1	0			0	250		30		3	3	9	4	0	4	10
Patties_7	71	4	110	30	3	0	0			0	330		15		2	1	5	10	2	2	4
Patties_8	71	4	100	25	3	0	0			0	390	140	16		5	1	5	4	10	2	8
Patties_9	75	3	210	80	9	1	0			0	300		26		5	1	8	0	0	4	10
Patties_10	38	6	80	25	3	0.5	0	1.5	1	0	240	170	4		1	<1	8	0	0	0	6
Patties_11	71	4	140	40	4.5	0	0			0	510		20		3	1	5	25	10	4	4
Patties_12	71	4	150	45	5	0.5	0			0	500		21		4	2	6	20	4	2	8
Patties_13	78	4	110	40	4.5	0	0			0	250		13		4	1	5	50	6	4	14
Patties_14	71	4	160	50	6	1.5	0			5	510		17		3	1	9	15	4	6	6
Patties_15	55	5	80	18	2	0	0			0	245		5		0	1	11	0	2	8	11
Patties_16	74	4	110	15	1.5	0	0			0	400		12	10	2	0	12	0	0	6	15
Patties_17	71	4	160	60	7	0.5	0			0	250		13		3	3	13	0	0	2	4

Appendix F-2. (continued) Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Patties_18	71	4	140	45	5	0.5	0	3.5	1	0	590	280	16		2	1	8	0	0	2	10
Patties_19	120	12	210	60	7	1	0	4	2	0	700	470	24		7	2	17	0	0	10	15
Patties_20	80	3.5	150	43	5	0.5	0			0	450		13		4	0	15	0	0	5	10
Patties_21	71	4	120	35	4	0	0			0	370		11		3	0	12	0	0	4	8
Patties_22	75	3	230	100	11	1	0			0	260		25		6	1	10	0	0	6	15
Patties_23	75	3	190	90	13	1.5	0			0	320		14		3	2	8	90	10	4	15
Patties_24	71	4	80	5	1	0	0			0	270	70	12		4	0	9	0	0	0	4
Patties_25	67	4	110	30	3.5	0.5	0	1.5	0.5	0	350	180	9		3	1	10	4	0	4	4
Patties_26	114	2	250	110	12	2	0	6	2.5	0	490	207	10		3	<1	26	0	0	8	10
Patties_27	64	4	90	45	5	0.5	0	2	1.5	0	390	170	7		5	<1	9	0	0	4	15
Patties_28	64	4	130	50	6	1	0	3	2	0	260		5		2	1	15	0	0	4	10
Patties_29	71	4	170	80	9	1	0	4	4	0	360	160	4		2	0	17	0	0	2	8
Patties_30	96	2	130		1						320		26		3		5				4
Patties_31	38	6	80	25	3	0.5	0	1.5	0.5	0	250	100	5		<1	2	10	0	0	0	8
Patties_32	75	4	150	50	6	0.5	0	1.5	4	0	400		17		2	4	9	0	0	3	2
Patties_33	70	4	90	35	4	0.5	0	1	2.5	5	200		6		2	0	10	0	0	3	1
Patties_34	57	4	80	20	2	0	0	0.5	1	0	350	219	4		2	1	11	2	0	4	15
Patties_35	57	3	80	5	0.5	0	0	0	0	0	400	220	2		0	<1	17	0	0	2	25
Patties_36	71	4	120	30	3.5	0	0			0	260		11		3	2	12	0	0	4	8
Patties_37	71	4	110	10	1.5	0.5	0			0	330		10		4	2	16	2	0	4	8
Patties_38	75	3	190	110	13	1.5	0			0	320		14		3	3	8	90	10	4	10

Appendix F-2. (continued) Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Patties_39	71	4	160	50	6	0	0		3.5	0	430		15		2	1	11	2	0	4	10
Patties_40	99	16	100	5	1	0	0		0	0	520		8		6	1	19	0	0	8	15
Patties_41	71	4	70	5	0.5	0	0	0	0	0	280	340	6		4	0	13	0	0	6	10
Patties_42	71	4	100	25	2.5	1	0			<5	490	105	17		5	<1	4	10	2	4	4
Patties_43	113	4	200	30	3.5	0.5	0			0	600		23		6	5	21	15	8	10	20
Patties_44	75	3	240	110	12	1.5	0			0	240		26		9	2	6	50	0	2	2
Patties_45	71	4	70	10	1	0	0			0	410		8		5	0	11	0	0	6	8
Patties_46	67	4	120	35	4	0.5	0	2	1	0	350	250	13		4	2	11	0	0	6	8
Patties_47	71	4	160	50	6	1	0		1.5	0	560		15		2	1	11	2	0	4	10
Patties_48	71	4	160	50	6	0	0		3	0	560		15		2	1	11	2	0	4	10
Patties_49	71	4	100	25	2.5	0.5	0			<5	270	55	17		4	2	4	4	4	2	4
Patties_50	71	4	130	25	2.5	0	0			0	350		14		3	2	12	15	2	4	10
Patties_51	78	4	110	40	4.5	<0.5	0			0	250		13		5	2	6	50	6	4	14
Patties_52	96	2	130	20	1	0	0			0	320		26		3	1	5	20	0	2	4
Patties_53	71	4	100	30	3	1	0			10	400	110	18		5	<1	5	4	6	4	6
Patties_54	67	4	120	50	6	1.5	0	2.5	1.5	10	280	160	7		3	2	10	4	10	2	6
Patties_55	71	4	100	20	2.5	0	0			0	470		9		4	1	13	0	0	10	8
Patties_56	55	10	70	15	1.5	0	0	1	0	0	250	25	3		1	0	10	0	0	0	8
Patties_57	38	6	80	25	3	0.5	0	2	0.5	0	260	120	3		1	<1	10	0	0	0	8
Patties_58	71	4	100	25	3	1.5	0			5	470		16		3	<1	5	0	0	6	4
Patties_59	71	4	100	25	2.5	0	0	1	1	0	380	125	17		5	1	3	25	20	2	4

Appendix F-2. (continued) Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Roasts																					
Roasts_1	114	4	280	90	10	0.5	0			0	710		16		6	5	31	0	0	4	10
Roasts_2	113	4	340	190	21	7	0			0	420		9		5	0	30	10	0	4	8
Roasts_3	90	5	90	15	1.5	0.5	0	0.5	0.5	10	470		9		5	0.5	14	0	0	3	4
Roasts_4	147	5	250	50	6	0	0			0	510		13		2.5	1	34	0	0	20	10
Roasts_5	147	6	300	60	7	0				0	620		16		3	1	42		0	20	10
Roasts_6	85	4	180	90	10	1.5	0			0	580		6		3	0	16	0	0	4	15
Sausages																					
Sausages_1	100	4	260	120	13	1	0			0	620		12		8	2	27	0	0	4	10
Sausages_2	57	7	60	0	0	0	0	0	0	0	310	440	7		3	<1	7	0	0	4	4
Sausages_3	92	4	240	90	10	1	0			0	570		11		4	2	25	0	8	4	10
Sausages_4	100	4	270	120	13	1.5	0			0	620		12		8	3	29	6	0	4	15
Sausages_5	100	4	240	110	12	1	0			0	660		12		8	2	26	0	0	4	10
Sausages_6	52	3	110	25	3	0	0			0	270		8		3	2	12	0	0	2	6
Sausages_7	55	6	120	80	9	0.5				0	440		5		3	2	9	15	2	6	10
Sausages_8	92	4	250	100	12	1	0			0	520		12		4	8	23	0	0	2	10
Sausages_9	85	4	140	70	8	1	0			0	590	430	5		<1	<1	12	0	0	0	2
Sausages_10	85	4	140	70	7	1	0			0	500	330	7		1	<1	13	0	0	0	2
Sausages_11	92	4	240	90	10	1	0			0	600		11		3	3	26	0	0	4	10
Sausages_12	52	3	110	25	3	0	0			0	340		8		3	2	13	0	0	2	6
Sausages_13	95	4	160	50	5	0	0	1.5	3	0	840	260	9		1	2	19	2	0	4	25

Appendix F-2. (continued) Non-traditional plant-based meat alternative product nutrient composition based on nutrition facts panels. (See Appendix E-1 for product names.)

Product ID[a]	Serving Wt (g)	Serving per Pkg	Calories	Calories from Fat	Total Fat (g)	Saturated Fat (g)	Trans Fat (g)	Poly Fat (g)	Mono Fat (g)	Cholesterol (mg)	Na (mg)	K (mg)	Total Carb (g)	Other Carb (g)	Total Fiber (g)	Sugar (g)	Protein (g)	Vit A % DV	Vit C % DV	Ca % DV	Fe % DV
Sausages_14	95	4	150	45	5	0.5	0			0	680	320	9		2	2	19	2	0	4	25
Sausages_15	45	5	80	25	3	0.5	0	1.5	1	0	300	50	3		2	0	9	0	0	0	10
Sausages_16	64	4	120	50	6	0.5	0	2.5	1	0	350	125	7		1	<1	10	0	0	2	4
Sausages_17	52	3	100	25	3	0	0			0	270		6		2	2	12	0	0	4	6
Strips																					
Strips_1	85	2.5	140	30	3.5	0.5	0	1.5	1.5	0	510	110	6		1	1	23	0	0	4	30
Strips_2	85	2.5	140	30	3.5	0.5	0	1.5	1.5	0	500	110	6		1	1	23	0	0	4	30
Strips_3	128	2	170	10	1	0	0			0	410		21		2	16	19	8	6	6	15
Strips_4	85	2	80	0	0	0	0			0	520	500	6		4	0	14	0	4	10	10
Strips_5	85	2	80	0	0	0	0			0	570	560	6		5	0	14	0	2	8	15

[a]Product ID corresponds with products in Appendix E2 and G2.

Appendix G-1. Summary of 63 macronutrient label values for traditional plant-based meat alternative food forms (amount per 100g).

Name (form)	n	Energy (kcal)	Protein (g)	CHO[d] (g)	Fiber (g)	Fat (g)
natto (mean ± SD)	2	182.4 ± 25.0	15.8 ± 2.4	9.8 ± 3.8	6.1 ± 2.0	7.9 ± 0.5
range		164.7 - 200.0	14.1 - 17.5	7.1 - 12.5	4.7 - 7.5	7.5 - 8.2
seitan (mean ± SD)	2	121.7 ± 60.9	21.3 ± 9.8	6.2 ± 4.6	1.3 ± 0.1	1.9 ± 0.7
range		78.6 -164.7	14.3 - 28.2	2.9 - 9.4	1.2 - 1.4	1.4 - 2.4
tempeh (mean ± SD)	11	197.4 ± 15.4	16.9 ± 2.4	16.0 ± 4.2	7.5 ± 2.2	7.4 ± 1.9
range		164.7 - 212.4	12.9 - 21.1	10.6 - 23.5	3.9 - 10.6	4.1 - 9.7
tofu TOTAL (mean ± SD)	48	110.4 ± 66.5	11.9 ± 7.5	3.8 ± 4.0	1.5 ± 1.1	5.3 ± 4.9
range		35.7 - 357.1	4.4 - 29.4	0 - 17.6	0 - 3.5	0.6 - 28.6
tofu, firm[a] (mean ± SD)	23	92.2 ± 21.6	9.7 ± 2.9	2.4 ± 1.4	1.3 ± 0.8	4.5 ± 1.0
range		58.8 - 152.9	5.9 - 17.6	0 - 5.9	0 - 3.5	2.5 - 6.3
tofu, fried (mean ± SD)	4	210.2 ± 140.5	18.0 ± 10.5	1.7 ± 2.1	2.0 ± 1.5	15.6 ± 12.2
range		58.8 - 357.1	5.9 - 28.6	0 - 4.1	0 - 3.5	2.4 - 28.6
tofu, soft[b] (mean ± SD)	12	55.4 ± 11.0	5.9 ± 1.1	2.0 ± 0.8	0.8 ± 1.0	2.5 ± 0.9
range		35.7 - 75.9	4.4 - 7.6	1.1 - 3.5	0 - 3.5	0.6 - 3.8
tofu, seasoned[c] (mean ± SD)	9	185.6 ± 16.4	23.0 ± 6.3	10.6 ± 4.8	2.4 ± 0.8	6.6 ± 3.5
range		152.9 - 200.0	15.3 - 29.4	3.5 - 17.6	1.2 - 3.5	4.1 - 14.1

[a]Tofu products labeled as firm, medium firm or extra firm.

[b]Tofu products labeled as soft or silken.

[c]Tofu products that were packaged with condiments.

[d]Carbohydrate

Appendix G-2. Summary of 182 macronutrient label values for non-traditional plant-based meat alternative food forms (amount per 100g).

Name (form)	n	Energy (kcal)	Protein (g)	CHO[a] (g)	Fiber (g)	Fat (g)
bacon strips[b]						
(mean ± SD)	3	316.7 ±101.0	15.0 ± 4.3	8.3 ± 7.2	4.2 ± 3.6	22.1 ± 10.5
range		200.0 - 375.0	12.5 - 20.0	0 - 12.5	0 - 6.3	10.0 - 28.1
cutlets and filets						
(mean ± SD)	24	190.5 ± 64.4	14.7 ± 4.6	17.9 ± 9.0	3.4 ± 1.0	7.3 ± 5.4
range		115.9 - 333.3	3.5 -21.4	5.6 - 32.4	1.4 - 5.3	0.6 - 19.7
deli cold cuts (mean ± SD	12	173.9 ± 26.2	24.7 ± 2.7	9.8 ± 3.6	3.3 ± 3.1	4.3 ± 2.2
range		129.0 - 211.5	21.2 - 30.0	3.2 - 15.4	0 - 7.7	0 - 7.7
ground (mean ± SD)	12	130.9 ± 34.5	17.7 ± 4.5	12.7 ± 4.7	3.9 ± 1.8	2.2 ± 3.1
range		105.3 -225.4	10.3 - 25.5	7.3 - 22.4	0 -5.9	0 -10.6
hotdog (mean ± SD)	11	149.3 ± 42.0	19.7± 2.4	6.0 ± 3.7	2.4 ± 2.3	5.1 ±3.9
range		105.3 - 215.7	13.8 - 22.2	1.7 - 14.3	0 - 6.7	0 - 11.8
meat balls (mean ± SD)	7	178.1 ± 49.6	16.1 ± 5.6	12.7 ± 5.7	4.8 ± 1.7	7.5 ± 3.9
range		105.9 - 232.6	6.0 - 20.9	8.3 - 25.0	1.5 - 7.1	2.2 - 10.7
mixed[c] (mean ± SD)	6	146.6 ± 56.9	9.9 ± 3.9	15.7 ± 5.1	2.8 ± 0.9	5.0± 4.5
range		87.7- 200.0	6.7 - 15.9	8.5 - 20.0	2.1 - 4.2	0 - 10.0
nuggets (mean ± SD)	18	197.6 ±57.0	15.2 ± 3.3	16.7 ± 7.4	3.8 ± 1.5	8.3 ± 4.7
range		94.1 - 295.8	7.1 - 21.2	5.9 - 32.4	1.6 - 8.5	1.3 - 21.1
patties (mean ± SD)	59	180.2 ± 52.5	14.5 ± 6.2	18.0 ± 8.1	4.5 ± 2.1	6.3 ± 4.1
range		98.6 - 333.3	4.2 - 29.8	3.5 - 40.0	0 - 12.0	0.7 -17.3
roast (mean ± SD)	6	205.4 ± 68.0	23.3 ± 5.2	9.8 ± 2.5	3.8 ± 1.6	8.3 ± 6.2
range		100.0 - 300.9	15.6 - 28.6	7.1 - 14.0	1.7 - 5.6	1.7 - 18.6
sausage (mean ± SD)	17	207.3 ± 48.3	21.6 ± 5.4	11.0 ± 2.6	4.3 ± 2.4	8.9 ± 4.1
range		105.3 - 271.7	12.3 - 29.0	5.9 - 15.4	1.1 - 8.0	0 - 16.4
strips (mean ± SD)	5	130.1 ± 35.3	20.4 ± 6.2	9.0 ± 4.2	2.9 ± 2.2	1.8 ± 2.1
range		94.1 -164.7	14.8 - 27.1	7.1 - 16.4	1.2 - 5.9	0 - 4.12
other (mean ± SD)	2	114.8 ± 137.2	0.5 ± 0.6	4.9 ± 3.1	2.7 ± 1.2	6.1 ± 8.1
range		17.7 - 211.8	0 - 0.9	2.7 - 7.1	1.8 - 3.5	0.4 - 11.8

[a]Carbohydrate

[b]Canadian bacon was grouped in the patties food form group rather than the bacon strip food form.

[c]Products with PBMA as part of a multi-food group product.

Appendix H-1. Summary of 63 micronutrient nutrient label values for traditional plant-based meat alternative food forms (amount per 100g).

Name (form)	n	Energy (kcal)	Sodium (mg)	Iron %DV	Calcium % DV
natto (mean ±SD)	2	182.4 ± 25.0	17.7 ± 25.0	15.9 ± 5.8	8.6 ± 2.1
range		164.7 - 200.0	0 - 35.0	11.8 - 20.0	7.1 -10.0
seitan (mean ±SD)	2	121.7 ± 60.9	551.5 ± 2.1	6.9 ± 3.6	2.7 ± 0.4
range		78.6 -164.7	550.0 - 553.0	4.3 - 9.4	2.4 - 2.9
tempeh (mean ±SD)	11	197.4 ± 15.4	81.5 ± 246.5	15.5 ± 4.8	9.1 ± 2.0
range		164.7 - 212.4	0 - 825.0	9.4 - 26.3	7.0 - 13.3
tofu TOTAL (mean ±SD)	48	110.4 ± 66.5	106.0 ± 198.3	8.6 ± 4.8	12.7 ± 14.7
range		35.7 - 357.1	0 - 824.0	0 - 18.8	0 - 87.7
tofu, firm[a] (mean ±SD)	23	92.2 ± 21.6	20.0 ± 20.2	7.8 ± 2.9	12.3 ± 7.2
range		58.8 - 152.9	0 - 65.0	0 - 12.7	0 - 38.0
tofu, fried (mean ±SD)	4	210.2 ± 140.5	24.5 ± 14.1	10.7 ± 4.2	44.1 ± 35.0
range		58.8 - 357.1	6.0 - 36.0	5.9 - 14.3	14.1 - 87.7
tofu, soft[b] (mean ±SD)	12	55.4 ± 11.0	29.6 ± 26.7	5.8 ± 1.6	5.0 ± 3.5
range		35.7 - 75.9	0 - 83.0	4.4 - 9.4	2.4 - 12.7
tofu, seasoned[c] (mean ±SD)	9	185.6 ± 16.4	454.3 ± 234.7	13.5 ± 7.7	10.2 ± 7.2
range		152.9 - 200.0	182.0 - 824.0	0 - 18.8	0 - 23.5

[a]Tofu products labeled as firm, medium firm or extra firm

[b]Tofu products labeled as soft or silken

[c]Tofu products that were packaged with condiments.

Appendix H-2. Summary of 182 micronutrient nutrient label values for non-traditional plant-based meat alternative food forms (amount per 100g).

Name (form)	n	Energy (kcal)	Sodium (mg)	Iron %DV	Calcium % DV
bacon strips[a] (mean ±SD)	3	316.7 ±101.0	1404.2 ± 31.5	8.3 ± 7.2	0 ± 0
range		200.0 - 375.0	1375.0 - 1438.0	0 - 12.5	0 - 0
cutlets + filets (mean ±SD)	24	190.5 ± 64.4	580.3 ± 139.5	12.4 ± 10.6	8.1 ± 6.3
range		115.9 - 333.3	329.0 - 812.0	0 - 42.3	0 - 28.2
deli cold cuts (mean ±SD)	12	173.9 ± 26.2	690.1 ± 96.3	20.6 ± 12.4	3.9 ± 2.0
range		129.0 - 211.5	548.0 - 813.0	6.7 - 41.7	0 - 8.3
ground (mean ±SD)	12	130.9 ± 34.5	508.7 ± 127.4	17.7 ± 10.4	7.4 ± 4.6
range		105.3 -225.4	200.0 - 655.0	0 - 36.4	0 - 14.5
hotdog (mean ±SD)	11	149.3 ± 42.0	688.8 ± 150.8	16.4 ± 8.5	3.4 ± 2.4
range		105.3 - 215.7	431.0 - 893.0	5.7 - 32.6	0 - 7.1
meat balls (mean ±SD)	7	178.1 ± 49.6	582.9 ± 106.2	11.3 ± 8.7	8.7 ± 10.4
range		105.9 - 232.6	452.0 - 791.0	0 - 23.3	0 - 29.8
mixed[b] (mean ±SD)	6	146.6 ± 56.9	413.2 ± 105.3	9.0 ± 7.3	3.4 ± 3.0
range		87.7- 200.0	289.0 - 558.0	0 - 17.6	0 - 7.0
nuggets (mean ±SD)	18	197.6 ±57.0	544.4 ± 119.7	11.8 ± 10.7	6.0 ± 6.9
range		94.1 - 295.8	324.0 - 747.0	2 .4- 50.0	0 - 23.8
patties (mean ±SD)	59	180.2 ± 52.5	521.9 ± 141.5	12.4 ± 7.0	5.6 ± 4.2
range		98.6 - 333.3	286.0 - 831.0	1.4 - 43.9	0 - 21.1
roast (mean ±SD)	6	205.4 ± 68.0	494.6 ± 137.6	8.6 ± 4.6	7.0 ± 5.1
range		100.1 - 300.9	347.0 - 682.0	4.4 - 17.6	3.3 - 13.6
sausage (mean ±SD)	17	207.3 ± 48.3	639.4 ± 97.4	12.5 ± 7.1	4.0 ± 2.8
range		105.3 - 271.7	519.0 - 884.0	2.4 - 26.3	0 - 10.9
strips (mean ±SD)	5	130.1 ± 35.3	558.2± 136.7	22.3 ± 12.1	7.1 ± 3.3
range		94.1 -164.7	320.0 - 671.0	11.7 - 35.3	4.7 - 11.8
other (mean ±SD)	2	114.8 ± 137.2	347.9 ± 473.1	9.7 ± 11.2	6.8 ± 2.9
range		17.7 - 211.8	13.0 - 682.0	1.8 - 17.6	4.7 - 8.8

[a]Canadian bacon was grouped with pattes

[b]Products which contain PBMA as part of a multi-food group product.

Appendix I. Micronutrient data for fortified products based on nutrition facts panels.

Product ID[a]	Serving Wt (g)	B1 % DV	B2 % DV	B3 % DV	Pantothenic Acid % DV	B6 % DV	B12 % DV	Vit D % DV	Vit E % DV	Cu % DV	Mg % DV	Zn % DV
TRADITIONAL												
Tofu - Firm, Medium Firm and Extra Firm												
Tofu-Firm_1	79						30	30	30			
NON-TRADITIONAL												
Bacon												
Bacon_2	16	50	2	2		4	4					
Bacon_3	16	50	2	6		4	4					
Cutlet/Filet												
Cutlet/Filet_11	85	30	8	20		10	25					
Deli Cold Cuts												
Deli_4	62	20	8	25	6	16	20				4	20
Deli_5	62	20	10	30	6	15	20				4	20
Deli_6	62	40	10	25	6	15	20				4	20
Deli_7	48	20			10		20				4	20
Deli_8	62	20	8	25	6	15	20				4	20
Ground												
Ground_1	55	30	15	20	20	15	25					30
Ground_4	55	20	6	20		15	50					
Ground_6	55	20	15	25	10	20	25					25
Ground_7	55	35	25	40	6	10	40					30
Ground_8	55	25	8	25	6	15	25					25
Hotdog												
Hotdog_1	51	15	6	10	15	35	40					
Hotdog_3	58	30			4		10				2	10
Hotdog_4	46	15			4		15				2	15
Hotdog_5	35	8	12	4	6	8	15					
Hotdog_6	76	20			6		20				4	20
Hotdog_10	38	30			4		10				2	10
Nuggets												
Nuggets_6	86	25	6	20		10	30					
Nuggets_8	80				8	25	20			4	6	20
Patties												
Patties_19	71	15	6	15		8	20					
Patties_27	114	80	10	20		20	45					
Patties_29	64	120					45					
Patties_32	38	120	6	10		10	35					

Appendix I. (continued) Micronutrient data for fortified products based on nutrition facts panels.

Product ID[a]	Serving Wt (g)	B1 % DV	B2 % DV	B3 % DV	Pantothenic Acid % DV	B6 % DV	B12 % DV	Vit D % DV	Vit E % DV	Cu % DV	Mg % DV	Zn % DV
Patties_35	57	30	20	25	6	10	30					30
Patties_36	57	30			6		20				4	20
Patties_57	55	8	6	8		10	40					
Patties_58	38	120	6	10		15	35					
Sausages												
Sausages_13	95	25			8		30				4	25
Sausages_14	95	25			8		25				6	25
Sausages_15	45	25	10	35		25	50					
Strips												
Strips_1	85	30	15	35	8	20	30				6	30
Strips_2	85	30	15	35	8	20	30				6	30

[a]Product ID corresponds with products in Appendix E an F.

Appendix J. Label values compared to mean analytical macronutrient values per serving for 40 traditional plant-based meat alternative products

Product ID #[a]	Label Kcals	Lab calculated kcal	Label - calculated kcal[b]	Percent error on label[b]	Label Fat (g)	Analyzed fat (g)	Label - Analyzed fat (g)	Percent error on label[c]	Label Protein (g)	Analyzed Protein (g)	Label - Analyzed Protein (g)	Percent error on label	Label CHO (g)	Calculated CHO (g)	Label - Calculated CHO (g)	Percent error on label	Label Fiber (g)	Analyzed Fiber (g)	Label - Analyzed Fiber (g)	Percent error on label
TRADITIONAL																				
Natto																				
Natto_1	80	75	5	6%	3	4.3	-1.3	**-43%**	7	6.7	0.3	5%	5	4.6	0.4	8%	3	3.3	-0.3	-11%
Seitan																				
Seitan2	140	114	26	18%	2	1.1	0.9	46%	24	21.7	2.3	10%	8	6.6	1.4	17%	1	2.9	-1.9	-189%
Tempeh																				
Tempeh_4	170	175	-5	-3%	6	11.1	-5.1	**-85%**	11	15.6	-4.6	-42%	20	9.8	10.2	**51%**	6	6.4	-0.4	-7%
Tempeh_6	230	212	18	8%	8	11.7	-3.7	**-46%**	22	23.4	-1.4	-7%	16	12.2	3.8	**24%**	12	10.0	2.0	16%
Tempeh_10	160	156	4	2%	7	8.8	-1.8	**-25%**	16	15.8	0.2	1%	9	8.1	0.9	10%	3	5.0	-2.0	-68%
Tofu - Firm, Medium Firm and Extra Firm																				
Tofu-Firm_1	60	57	3	4%	2	2.7	-0.7	**-35%**	7	8.4	-1.4	-19%	3	1.7	1.3	**45%**	1	1.2	-0.2	-15%
Tofu-Firm_5	80	76	4	5%	4	4.4	-0.4	-11%	8	8.1	-0.1	-1%	2	1.7	0.3	16%	1	1.1	-0.1	-9%
Tofu-Firm_7	80	81	-1	-1%	4	4.8	-0.8	-20%	8	8.5	-0.5	-7%	2	1.5	0.5	**27%**	1	0.7	0.3	**28%**
Tofu-Firm_8	95	102	-7	-7%	5	6.1	-1.1	**-21%**	10	11.3	-1.3	-13%	3	1.6	1.4	**47%**	0	1.5	-1.4	---[d]
Tofu-Firm_11	130	119	11	9%	3.5	7.6	-4.1	**-117%**	15	12.1	2.9	19%	4	1.8	2.2	**55%**	2	1.7	0.3	14%
Tofu-Firm_22	100	123	-23	**-23%**	4	7.1	-3.1	**-79%**	14	12.8	1.2	9%	5	3.4	1.6	**32%**	1	1.9	-0.9	-91%
Tofu - Fried																				
Tofu - Fried_3	50	33	17	34%	4	2.4	1.6	40%	4	2.8	1.2	**31%**	0	0.4	-0.4	---[d]	0	0.4	-0.4	0%

Appendix J. (continued) Label values compared to mean analytical macronutrient values per serving for 40 traditional plant-based meat alternative products

Product ID #[a]	Label Kcals	Lab calculated kcal	Label - calculated kcal[b]	Percent error on label[b]	Label Fat (g)	Analyzed fat (g)	Label - Analyzed fat (g)	Percent error on label[c]	Label Protein (g)	Analyzed Protein (g)	Label - Analyzed Protein (g)	Percent error on label	Label CHO (g)	Calculated CHO (g)	Label - Calculated CHO (g)	Percent error on label	Label Fiber (g)	Analyzed Fiber (g)	Label - Analyzed Fiber (g)	Percent error on label
Tofu - Silken and Regular Soft																				
Tofu - Silken/ Soft_3	30	28	2	6%	0.5	0.2	0.3	63%	5	5.3	-0.3	-6%	1	2.0	-1.0	-99%	0	0.8	-0.8	---[d]
Tofu - Seasoned (packaged with condiments)																				
Tofu - Seasoned_1	150	179	-29	-19%	4.5	8.6	-4.1	**-92%**	17	14.4	2.6	15%	13	13.2	-0.2	-1%	3	3.5	-0.5	-16%
Tofu - Seasoned_2	130	155	-25	-19%	6.0	9.6	-3.6	**-60%**	17	16.1	0.9	5%	4	3.3	0.7	17%	2	1.6	0.4	20%
Tofu - Seasoned_9	150	143	7	5%	9.0	7.7	1.3	15%	14	14.0	0.0	0%	3	6.2	-3.2	-108%	1	2.2	-1.2	-119%

[a]Product ID corresponds with products in Appendix E-1, F-1, G, and Tables 3.11 and 3.13

[b]A negative number indicates label understated analytical value, a positive number indicates label overstated analytical value

[c]Bold percent error values indicate label value out on NLEA compliance.

[d]Label value stated as 0 and therefore percent error calculation is not possible.

Appendix K. Label values compared to mean analytical macronutrient values per serving for 40 non-traditional plant-based meat alternative products.

Product ID #[a]	Label Kcals	Lab calculated kcal	Label - calculated kcal[b]	Percent error on label[b]	Label Fat (g)	Analyzed fat (g)	Label - Analyzed fat (g)	Percent error on label	Label Protein (g)	Analyzed Protein (g)	Label - Analyzed Protein (g)	Percent error on label	Label CHO (g)	Calculated CHO (g)	Label - Calculated CHO (g)	Percent error on label	Label Fiber (g)	Analyzed Fiber (g)	Label - Analyzed Fiber (g)	Percent error on label
NON-TRADITIONAL																				
Cutlet/Filet																				
Cutlet/Filet_21	120	124	-4	-3%	2	3.2	-1.2	**-61%**	21	19.2	1.8	8%	6	7.7	-1.7	-29%	2	4.0	-2.0	-99%
Hotdog																				
Hotdog_2	90	86	4	4%	3	3.0	0.0	-1%	10	11.6	-1.6	-16%	5	5.5	-0.5	-10%	3	3.0	0.0	1%
Hotdog_6	110	103	7	7%	3	2.0	1.0	32%	16	15.4	0.6	3%	5	7.4	-2.4	-47%	0	2.0	-2.0	---[d]
Hotdog_7	80	74	6	7%	1	0.5	0.5	49%	15	14.6	0.4	3%	3	5.2	-2.2	-73%	2	2.8	-0.8	-41%
Patties																				
Patties_1	120	116	4	3%	5	5.5	-0.5	-10%	14	13.8	0.2	1%	6	7.3	-1.3	-22%	5	5.2	-0.2	-4%
Patties_13	110	120	-10	-9%	5	6.1	-1.6	-35%	5	4.8	0.2	5%	13	15.3	-2.3	-18%	4	4.8	-0.8	-19%
Patties_16	110	173	-63	**-58%**	2	10.6	-9.1	**-604%**	12	10.5	1.5	13%	12	11.8	0.2	1%	2	3.7	-1.7	-87%
Patties_24	190	241	-51	**-27%**	13	16.5	-3.5	**-27%**	8	8.7	-0.7	-9%	14	17.9	-3.9	-28%	3	4.5	-1.5	-50%
Patties_25	80	92	-12	-15%	1	0.8	0.2	18%	9	9.8	-0.8	-9%	12	13.0	-1.0	-8%	4	2.3	1.7	**42%**
Patties_27	250	243	7	3%	12	12.4	-0.4	-4%	26	24.6	1.4	5%	10	11.8	-1.8	-18%	3	4.9	-1.9	-63%
Patties_30	170	147	23	13%	9	7.7	1.3	14%	17	16.9	0.1	1%	4	5.2	-1.2	-31%	2	3.4	-1.4	-72%
Patties_33	150	155	-5	-3%	6	7.2	-1.2	-19%	9	9.1	-0.1	-1%	17	16.3	0.7	4%	2	3.8	-1.8	-92%
Patties_35	80	72	8	10%	2	2.0	0.0	2%	11	10.0	1.0	9%	4	6.3	-2.3	-58%	2	3.7	-1.7	-83%
Patties_38	110	146	-36	**-33%**	2	6.3	-4.8	**-319%**	16	17.0	-1.0	-6%	10	10.4	-0.4	-4%	4	6.0	-2.0	-51%

Appendix K. (continued) Label values compared to mean analytical macronutrient values per serving for 40 non-traditional plant-based meat alternative products.

Product ID #[a]	Label Kcals	Lab calculated kcal	Label - calculated kcal[b]	Percent error on label[b]	Label Fat (g)	Analyzed fat (g)	Label - Analyzed fat (g)	Percent error on label	Label Protein (g)	Analyzed Protein (g)	Label - Analyzed Protein (g)	Percent error on label	Label CHO (g)	Calculated CHO (g)	Label - Calculated CHO (g)	Percent error on label	Label Fiber (g)	Analyzed Fiber (g)	Label - Analyzed Fiber (g)	Percent error on label
Patties_42	70	90	-20	-28%	1	0.8	-0.3	**-62%**	13	15.5	-2.5	-19%	6	10.7	-4.7	-78%	4	6.3	-2.3	-58%
Patties_44	200	197	3	2%	4	3.5	0.0	0%	21	20.3	0.7	3%	23	26.8	-3.8	-16%	6	7.7	-1.7	-29%
Patties_46	70	76	-6	-9%	1	1.8	-0.8	**-75%**	11	10.9	0.1	1%	8	9.2	-1.2	-15%	5	5.7	-0.7	-13%
Patties_51	130	135	-5	-4%	3	3.6	-1.1	**-42%**	12	13.1	-1.1	-9%	14	17.0	-3.0	-22%	3	4.9	-1.9	-65%
Patties_54	100	126	-26	-26%	3	4.4	-1.4	**-46%**	5	5.3	-0.3	-6%	18	18.4	-0.4	-2%	5	2.8	2.2	**45%**
Sausages																				
Sausages_4	270	282	-12	-5%	13	14.4	-1.4	-11%	29	28.5	0.5	2%	12	12.9	-0.9	-8%	8	4.7	3.3	**41%**
Sausages_5	240	276	-36	-15%	12	13.7	-1.7	-14%	26	28.7	-2.7	-10%	12	12.9	-0.9	-8%	8	4.7	3.3	**41%**
Sausages_7	120	95	25	21%	9	5.1	3.9	44%	7	6.8	0.2	2%	5	8.2	-3.2	-64%	3	3.7	-0.7	-25%
Sausages_10	140	154	-14	-10%	7	7.7	-0.7	-10%	13	13.3	-0.3	-2%	7	10.0	-3.0	-42%	1	2.8	-1.8	-181%
Sausages_11	240	242	-2	-1%	10	11.2	-1.2	-12%	26	23.3	2.7	10%	11	15.1	-4.1	-37%	3	4.1	-1.1	-38%

[a]Product ID corresponds with products in Appendix E-2, F-2, G, and Tables 3.12 and 3.14

[b]A negative number indicates label understated analytical value, a positive number indicates label overstated analytical value

[c]Bold percent error values indicate label value out on NLEA compliance.

[d]Label value stated as 0 and therefore percent error calculation is not possible.

Appendix L. Label values compared to mean analytical micronutrient values per serving for 40 traditional plant-based meat alternative products.

Product ID #[a]	Label Calcium % DV	Analyzed %DV calcium/svg	Label Calcium (mg)[d]	Analyzed Calcium (mg)	Label - Analyzed Calcium (mg)[b]	Percent error on label[bc]	Total iron % DV	Analyzed %DV iron/svg	Label Iron (mg)	Analyzed Iron (mg)	Label - Analyzed Iron (mg)	Percent error on label	Label Sodium (mg)	Analyzed Sodium (mg)	Label - Analyzed Sodium (mg)	Percent error on label
TRADITIONAL																
Natto																
Natto_1	4	4	40	36.2	3.8	10%	8	6	1.4	1.1	0.3	**23%**	0	1	-1	---[e]
Seitan																
Seitan2	2	2	20	24.6	-4.6	-23%	8	11	1.4	2.0	-0.5	-36%	470	318	152	32%
Tempeh																
Tempeh_4	8	6	80	64.1	15.9	**20%**	8	8	1.4	1.4	0.0	2%	10	1	9	92%
Tempeh_6	15	9	150	93.9	56.1	**37%**	20	18	3.6	3.3	0.3	9%	10	2	8	81%
Tempeh_10	8	8	80	75.6	4.4	5%	10	9	1.8	1.6	0.2	13%	10	2	8	82%
Tofu - Firm, Medium Firm and Extra Firm																
Tofu-Firm_1	30	15	300	147.2	152.8	**51%**	10	7	1.8	1.3	0.5	**29%**	30	22	8	27%
Tofu-Firm_5	6	3	60	32.0	28.0	**47%**	6	7	1.1	1.2	-0.2	-15%	0	3	-3	---[e]
Tofu-Firm_7	6	3	60	33.7	26.3	**44%**	8	7	1.4	1.3	0.1	7%	0	3	-3	---[e]
Tofu-Firm_8	8	11	80	106.7	-26.7	-33%	8	11	1.4	2.0	-0.6	-39%	5	1	4	87%
Tofu-Firm_11	0	4	0	41.4	-41.4	---[e]	0	11	0.0	2.1	-2.1	---[e]	10	2	8	79%
Tofu-Firm_22	6	22	60	217.6	-157.6	-263%	10	14	1.8	2.6	-0.8	-42%	45	12	33	74%

Appendix L. (continued) Label values compared to mean analytical micronutrient values per serving for 40 traditional plant-based meat alternative products.

Product ID #[a]	Label Calcium % DV	Analyzed %DV calcium/svg	Label Calcium (mg)[d]	Analyzed Calcium (mg)	Label - Analyzed Calcium (mg)[b]	Percent error on label[bc]	Total iron % DV	Analyzed %DV iron/svg	Label Iron (mg)	Analyzed Iron (mg)	Label - Analyzed Iron (mg)	Percent error on label	Label Sodium (mg)	Analyzed Sodium (mg)	Label - Analyzed Sodium (mg)	Percent error on label
Tofu - Fried																
Tofu - Fried_3	8	5	80	51.2	28.8	**36%**	2	2	0.4	0.3	0.0	9%	5	2	3	60%
Tofu - Silken and Regular Soft																
Tofu - Silken/ Soft_3	2	3	20	30.6	-10.6	-53%	4	5	0.7	0.9	0	-20%	70	64	6	9%
Tofu - Seasoned (packaged with condiments)																
Tofu - Seasoned_1	8	20	80	204.3	-124.3	-155%	15	18	2.7	3.2	0	-17%	200	236	-36	-18%
Tofu - Seasoned_2	0	6	0	64.6	-64.6	---[e]	0	17	0.0	3.1	-3	---[e]	620	306	314	51%
Tofu - Seasoned_9	20	21	200	205.6	-5.6	-3%	15	16	2.7	2.8	0	-5%	390	425	-35	-9%

[a]Product ID corresponds with products in Appendix E-1, F-1, G, and Tables 3.11 and 3.13

[b]A negative number indicates label understated analytical value, a positive number indicates label overstated analytical value

[c]Bold percent error values indicate label value out on NLEA compliance.

[d]Mg amount calculated from label percent Daily Value (DV)

[e]Label value stated as 0 and therefore percent error calculation is not possible.

Appendix M. Label values compared to mean analytical micronutrient values per serving for 40 non-traditional plant-based meat alternative products.

Product ID #[a]	Label Calcium % DV	Analyzed %DV calcium/svg	Label Calcium (mg)[d]	Analyzed Calcium (mg)	Label - Analyzed Calcium (mg)[b]	Percent error on label[bc]	Total iron % DV	Analyzed %DV iron/svg	Label Iron (mg)[d]	Analyzed Iron (mg)	Label - Analyzed Iron (mg)	Percent error on label	Label Sodium (mg)	Analyzed Sodium (mg)	Label - Analyzed Sodium (mg)	Percent error on label
NON-TRADITIONAL																
Cutlet/Filet																
Cutlet/Filet_21	10	2	100	22.6	77.4	**77%**	40	8	7.2	1.41	5.79	**80%**	480	361	119	25%
Hotdog																
Hotdog_2	2	2	20	20.1	-0.1	-1%	4	7	0.7	1.27	-0.55	-77%	270	286	-16	-6%
Hotdog_6	4	2	40	18.1	21.9	**55%**	20[f]	41	3.6	7.36	-3.76	-104%	460	384	76	17%
Hotdog_7	2	2	20	22.0	-2.0	-10%	10	11	1.8	2.02	-0.22	-12%	560	611	-51	-9%
Patties																
Patties_1	15	11	150	105.8	44.2	**29%**	10	8	1.8	1.50	0.30	17%	380	314	66	17%
Patties_13	4	4	40	42.8	-2.8	-7%	14	7	2.5	1.20	1.32	**52%**	250	272	-22	-9%
Patties_16	6	3	60	33.4	26.6	**44%**	15	9	2.7	1.65	1.05	**39%**	400	260	140	35%
Patties_24	4	4	40	41.6	-1.6	-4%	15	11	2.7	1.95	0.75	**28%**	320	314	6	2%
Patties_25	0	1	0	14.9	-14.9	---[e]	4	5	0.7	0.83	-0.11	-16%	270	251	19	7%
Patties_27	8	9	80	91.8	-11.8	-15%	10[f]	24	1.8	4.27	-2.47	-137%	490	412	78	16%
Patties_30	2	5	20	46.0	-26.0	-130%	8	9	1.4	1.64	-0.20	-14%	360	387	-27	-7%
Patties_33	3	3	30	30.8	-0.8	-3%	2	3	0.4	0.48	-0.12	-34%	400	326	74	18%
Patties_35	4	3	40	32.3	7.7	19%	15[f]	14	2.7	2.58	0.12	**5%**	350	312	38	11%
Patties_38	4	6	40	60.3	-20.3	-51%	8	12	1.4	2.14	-0.70	-49%	330	378	-48	-15%

Appendix M. (continued) Label values compared to mean analytical micronutrient values per serving for 40 non-traditional plant-based meat alternative products.

Product ID #[a]	Label Calcium % DV	Analyzed %DV calcium/svg	Label Calcium (mg)[d]	Analyzed Calcium (mg)	Label - Analyzed Calcium (mg)[b]	Percent error on label[bc]	Total iron % DV	Analyzed %DV iron/svg	Label Iron (mg)[d]	Analyzed Iron (mg)	Label - Analyzed Iron (mg)	Percent error on label	Label Sodium (mg)	Analyzed Sodium (mg)	Label - Analyzed Sodium (mg)	Percent error on label
Patties_42	6	8	60	78.9	-18.9	-31%	10	9	1.8	1.68	0.12	7%	280	315	-35	-13%
Patties_44	10	7	100	66.7	33.3	**33%**	20	14	3.6	2.56	1.04	**29%**	600	512	88	15%
Patties_46	6	6	60	63.0	-3.0	-5%	8	8	1.4	1.42	0.02	1%	410	463	-53	-13%
Patties_51	4	4	40	42.7	-2.7	-7%	10	10	1.8	1.82	-0.02	-1%	350	351	-1	0%
Patties_54	4	9	40	86.2	-46.2	-116%	6	5	1.1	0.84	0.24	**23%**	400	436	-36	-9%
Sausages																
Sausages_4	4	5	40	51.2	-11.2	-28%	15	18	2.7	3.19	-0.49	-18%	620	756	-136	**-22%**
Sausages_5	4	4	40	36.3	3.7	9%	10	15	1.8	2.76	-0.96	-53%	660	809	-149	**-23%**
Sausages_7	6	3	60	30.7	29.3	**49%**	10	3	1.8	0.60	1.20	**67%**	440	468	-28	-6%
Sausages_10	0	11	0	106.1	-106.1	---[e]	2	10	0.4	1.89	-1.53	-425%	500	678	-178	**-36%**
Sausages_11	4	4	40	37.0	3.0	8%	10	12	1.8	2.08	-0.28	-16%	600	458	142	24%

[a]Product ID corresponds with products in Appendix E-2, F-2, G, K-2, L-2

[b]A negative number indicates label understated analytical value, a positive number indicates label overstated analytical value

[c]Bold percent error values indicate label value out on NLEA compliance.

[d]Mg amount calculated from label percent Daily Value (DV)

[e]Label value stated as 0 and therefore percent error calculation is not possible.

[f]Fortified (Class I nutrient)

GLOSSARY

Alternate Protein Product (APP) - Name used by the USDA Food and Nutrition Services (FNS) to identify products that can be used to satisfy all or part of the meat/meat alternate requirement of the Child Nutrition meal pattern requirements when combined with meat, poultry, or seafood. An APP standard of identity is a.) a protein that is processed so that some of the non-protein constituents of the food have been removed; b.) has the biological quality of at least 80% of casein (milk protein) using the Protein Digestibility Corrected Amino Acid Score (PDCAAS) method and c.) contains at least 18% protein by weight when fully hydrated or formulated. These requirements are found in Appendix A to 7 CFR 210, 220, 225, and 226. Some examples of APPs include soy flours, soy concentrates, soy isolates, whey protein concentrate, whey protein isolate and casein. APPs are not required to be fortified (USDA , USDA Food and Nutrition Services 2000, USDA 2012a) .

Bioavailability - The extent to which an amino acid or other essential nutrient is available for metabolism (Codex Alimentarius 2007).

Codex Alimentarius Commission - Established by FAO and WHO in 1963 develops harmonized international food standards, guidelines and codes of practice to protect the health of the consumers and ensure fair trade practices in the food trade. The Commission also promotes coordination of all food standards work undertaken by international governmental and non-governmental organizations (Codex Alimentarius Commission 2012).

Complementation (of proteins) - The increase in protein nutritional value achieved by mixing two proteins, which have different limiting amino acids, in those proportions which result in the protein quality of the mixture being higher than that of either of the component proteins. Occurs when the first protein has an excess of the amino acid which is limiting in the second protein and vice versa (Codex Alimentarius 2007).

Food Form definitions:

Cutlet - 1.) A thin, tender cut of meat (usually from lamb, pork, or veal) taken from the leg or rib section. 2.) A mixture of finely chopped meat, fish, or poultry that's bound with a sauce or egg mixture and formed into the shape of a cutlet. This type of formed cutlet is often dipped into beaten egg and then breaded before fried (Herbst 2001).

Deli cold cuts - Sliced assorted cold cooked meats (Merriam Webster Incorp. 2012).

Fillet - A boneless piece of meat or fish (Herbst 2001).

Ground (ground beef) – Beef that has been ground or finely chopped (Herbst 2001).

Hotdog - A hot frankfurter served in a long, soft roll and typically topped with various condiments (Merriam Webster Incorp. 2012).

Meatball - A small ball of chopped or ground meat often mixed with bread crumbs and spices (Merriam Webster Incorp. 2012).

Natto – Steamed, fermented and mashed soybeans with a glutinous texture and strong cheese-like flavor (Herbst 2001).

Nugget - a small usually rounded piece of food <chicken *nuggets* (Merriam Webster Incorp. 2012).

Patties - a small flat cake of chopped food <a hamburger *patty*> (Merriam Webster Incorp. 2012).

Roast – A piece of meat that is large enough to serve more than one person. Such a meat is usually cooked by roasting method (Herbst 2001).

Seitan – A protein-rich food made from wheat gluten and used in many vegetarian dishes. Its firm texture is definitely chewy and meat-like, and it is flavored rather neutral (Herbst 2001).

Sausage – A highly seasoned minced meat (as pork) usually stuffed in casings of prepared animal intestine (Merriam Webster Incorp. 2012).

Strip - A long narrow piece of a material (Merriam Webster Incorp. 2012).

Tempeh - A soybean cake made by fermenting cooked soybeans, which formed into a firm, dense, chewy cake with yeasty, nutty flavor. It is often used as a meat-substitute to make food like vegetarian burgers because it readily absorbs flavors and holds its shape when cooked (Herbst 2001).

Tofu - Also known as soybean curd and bean curd, custard-like white tofu is made from curdled soymilk, an iron-rich liquid extracted from ground, cooked soybeans (Herbst 2001).

Non-traditional PBMA- Meat analogs, plant-based meat-alternatives that are designed to mimic meat, poultry and seafood.

Limiting Amino Acid - The essential amino acid of a food protein present in the lowest proportion relative to the amount of that amino acid in the Reference Amino Acid Pattern (Codex Alimentarius 2007).

Plant based Meat Alternative (PBMA) – 1.) A category of meat-like products created from various soybean by-products including TVP (textured vegetable protein), soy protein concentrate and sometimes tempeh (soy bean cake) or tofu (soybean curd). Meat analogs come in a myriad of forms including bits, strips, links, patties and hotdogs. Patties may contain grains or vegetables. They can be prepared as one would prepare meat (grilled, sautéed, broiled) (Herbst 2001). 2.) A product that provides amounts of key nutrients that is similar to meat, chicken or fish. Key nutrients include: protein, iron, zinc, as well as, six B-vitamins: thiamin, riboflavin, niacin, vitamin B6, vitamin B12 and choline.

Protein Digestibility Corrected Amino Acid Score (PDCAAS) - is a method of evaluating the protein quality based on both the amino acid requirements of humans and their ability to digest it. The PDCAAS rating was adopted by the U.S. Food and Drug Administration (FDA) and the Food and Agricultural Organization of the United

Nations/World health Organizations (FAO/WHO) in 1993 as "the preferred 'best'" method to determine protein quality. The formula for calculating the PDCAAS percentage is: (mg of limiting amino acid in 1 g of test protein / mg of same amino acid in 1 g of reference protein) x fecal true digestibility percentage (Schaafsma 2000).

Protein Quality - The extent to which a protein source provides essential amino acids and indispensable nitrogen for meeting human requirements. Protein quality is primarily determined by the level, distribution and bioavailability of the essential amino acids in a protein source (Codex Alimentarius 2007).

Reference Amino Acid Pattern - The levels and distributions of essential amino acids of an ideal protein specified by FAO/WHO/UNU (1985) for meeting the requirements of the 2-5 year old child when consumed at the level of the recommended daily protein intake (Codex Alimentarius 2007).

Soy:

Soy Flour, Defatted or Textured Soy Flour - made entirely from defatted soy meal. This product may also be fortified with various micronutrients and minerals.

Standard of Identity

Soy Flour, Defatted

Item	Requirements Minimum	Maximum
Protein (Nx6.5) As is	50.0%	
Moisture		9.0%
Fat		1.5%
Crude Fiber		3.5%
Ash		7.0%
PDCAAS	0.90	
Carbohydrates (by difference)	20	

(USDA 2007)

Soy Protein Concentrate (SPC) or Textured Soy Protein Concentrate - Shall be made wholly from defatted soy meal with 65% or more protein by weight but less than 90%. This product may also be fortified with various micronutrients and minerals.

Standard of Identity

Soy Protein Concentrates

Item	Requirements Minimum	Maximum
Protein (Nx6.5) As is	65.0%	
Moisture		6.0%
Fat		1.0%
Crude Fiber		4.0%
Ash		6.0%
PDCAAS	0.95	
Carbohydrates (by difference)	20	

(USDA 2007)

Soy protein isolate (SPI) **or textured soy protein isolate -** Made wholly from defatted soy meal. Similar to soy protein concentrate except that additional extraction has removed more of the non-protein fraction, thereby increasing its protein content. This product may also be fortified with various micronutrients and minerals.

Standard of Identity

Soy Protein Isolate

Item	Requirements Minimum	Maximum
Protein (Nx6.5) As is	90.0%	
Moisture		6.0%
Fat		1.0%
Crude Fiber		0.2%
Ash		4.5%
PDCAAS	0.90	
Carbohydrates (by difference)	4	

(USDA 2007)

Soy Protein or Textured Soy Protein (TSP) - Made wholly from either defatted soy meal flakes or soy protein concentrate. This product may also be fortified with various micronutrients and minerals. TSP shall be the caramel colored variety and meet the chemical and physical requirements shown in the following table.

Standard of Identity
Textured Soy Protein

	Requirements	
Item	**Minimum**	**Maximum**
Protein (Nx6.5) As is	50.0%	
Moisture		10.0%
Fat		3.0%
Crude Fiber		4.0%
Ash		6.5%
PDCAAS	0.90	
Carbohydrates (by difference)	20	

(USDA 2007)

Textured vegetable protein (TVP) - 1.) A USDA Food and Nutrition Services (FNS) term defining a textured vegetable protein product produced from vegetable (plant) sources, including, but not limited to soybeans, peanuts, wheat, and corn (USDA).
2) TVP® is also an acronym registered trademark of Archer Daniels Midland Company
http://www.soyfoodsillinois.uiuc.edu/TVPHandout.pdf

Tofu – Nutritionally defined by USDA Food and Nutrition Service for the purpose of school meal programs as "a soy derived food with basic ingredients of whole soybeans, one or more food -grade coagulants (typically a salt or an acid) and water." To be credible as 1 oz. equivalent meat alternative: a.) it must be commercially prepared; b.) a 2.2oz (1/4 cup) serving should contain at least 5 grams of protein to be credible as 1.0 oz equivalent meat alternative 7 CFR 210.2 (USDA 2012b).

Traditional PBMA- processed plant-based proteins that have been used for centuries as non-meat protein forms. Examples are tofu, tempeh, seitan and natto.

Vegetable Protein Product (VPP) – 1) Nomenclature used by the Food and Nutrition Services (FNS) defining a product that can be used to satisfy 30% of the meat/meat alternate requirement of the Child Nutrition meal pattern requirements when combined with meat, poultry, or seafood. It is a vegetable protein that is processed so that some of the non-protein constituents of the food have been removed and fortified with iron and zinc. In 2000 this definition was modified and replaced with a new term "Alternate Protein product" (APP) (USDA Food and Nutrition Services 2000).

2) Codex Standard of Identity nomenclature defining vegetable food products produced by the reduction or removal of certain non-protein constituents (water, oil, starch, other carbohydrates) in a manner to achieve a protein (N × 6.25) content of 40% or more. The protein content is calculated on a dry weight basis excluding added vitamins, minerals (Codex Alimentarius 2007).

Wheat:

Wheat Protein Products (WPP) Codex standard of identity nomenclature defining food products produced by separation of certain non-protein constituents from wheat or wheat flour (i.e. starch, other carbohydrates). Moisture content shall not exceed 10% (m/m). WWP include:

– Vital wheat gluten

The name of the food shall be "vital wheat gluten" or "wheat gluten". It is characterized by its property of high viscoelasticity as hydrated. On a dry weight basis crude protein (N × 6.25) shall be 80% or more.

– Devitalized wheat gluten

The name of the food shall be "devitalized wheat gluten" or "devitalized wheat gluten". It is characterized by its reduced property of viscoelasticity as hydrated due to denaturation. On a dry weight basis crude protein (N × 6.25) shall be 80% or more.

– Solubilized wheat proteins

The name of the food shall be “solubilized wheat protein” or “soluble wheat protein.” It is characterized by their reduced property of viscoelasticity as hydrated due to partial hydrolysis of wheat gluten. On a dry weight basis crude protein (N × 6.25) shall be 60% or more.

No optional ingredients are permitted in vital and devitalized wheat gluten.

For solubilized wheat proteins, the following classes of ingredients may be used:

(a) carbohydrates, including sugars

(b) edible fats and oils

(c) other protein products

(d) amino acids, vitamins and minerals

(e) salt

(f) herbs and spices

(g) enzymes

(Codex Alimentarius 2007)

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