An assessment of nutrition information on front of pack labels and healthiness of Cereals and products in Vanuatu retail market

Ronick Shadrack
rspenly@gmail.com

The Vanuatu Bureau of Standards Laboratory

Krishna K Kotra
University of the South Pacific

Leyanni Livu
The Vanuatu Bureau of Standards Laboratory

Daniel Tari
The Vanuatu Bureau of Standards Laboratory

Hancy Tabi
The Vanuatu Bureau of Standards Laboratory

Research Article

Keywords:

Posted Date: December 19th, 2023

DOI: https://doi.org/10.21203/rs.3.rs-3769452/v1

Additional Declarations: No competing interests reported.

Abstract

Nutrient profiling of front of pack labels is described as the science of ranking foods based on their nutrient content. It is fast becoming the basis for regulating nutrition labels, health claims, and marketing and advertising, especially for child and medicinal products. Survey of imported food nutritional facts is a primary monitoring tool for product quality evaluation prior to facts finding laboratory testing. Vanuatu, a South Pacific Island country depend on imports for its cereals needs, however there has been longstanding concerns over low quality and non-nutrient products with misleading labels. To evaluate this, a survey on nutritional quality on the food labels was conducted on cereals and products sold in retail market in Port Vila to qualitatively assess the nutrient profile. The survey aims to capture the availability of nutrient information on product, most common nutrient information on facts sheets and to qualify food based on the criteria of Food and Drugs Administration of the United States. Front-of pack labels on each cereal product were taken by a tablet device and manually entered into a database. The data was treated in a two-way randomized block design to evaluate presence of each nutrient, most common nutrient, and content of each nutrient on front of pack labels. Results revealed six significant and most common nutrient on cereals and products such as Energy, Protein, Fats, Carbohydrate, Sugar, Sodium and Saturated Fats compared to mineral, vitamins and other factors ($P < 0.05$). Over 70% of cereals and products having sugar, sodium and saturated fats (14.40 ± 15.65 g, 371.67 ± 278.75 mg and 6.61 ± 5.76 g respectively) beyond the FDA maximum limits of 2.5 g, 230 mg and 1 g. In light of these findings, authorities may require including and strengthening food quality monitoring programs to ensure supplies are within safe limits. Further research into developing a healthy food criteria model is recommended.

1. Introduction

In 2021, the global consumption of food reached 2.5 billion metric tons. Bread and cereal products were the largest category of consumption (Statista.com). The consumption of diversified foods leads to a healthy life of a human being, which may also prevent many non-communicable diseases (Blackstone *et al.*,2011 and 2014). Besides, nutrient fact sheets on food products shows some key nutrients that have impacts on the health of consumers. Understanding the nutritional composition of food products is essential for making informed dietary choices which leads to improved and healthy lifestyles.

A healthy and diversified diet is essential for preventing several non-communicable diseases (NCDs), given the increasing evidence of diet-related health burdens and the rising prevalence of NCDs among adults (Popkin, 2006; Oni et al., 2020; Hlaing-Hlaing, 2022). The United States Food and Drug Administration (FDA) has labelled three nutrients that should be less in food which are; Saturated Fat, Sodium, and Added Sugars (Maalouf *et al.*,2017). Eating too much saturated fat and sodium, for example, is associated with an increased risk of developing some health conditions, like cardiovascular disease and high blood pressure (Brown, 2011 and Pallazola 2019). The first salt intake survey conducted in Vanuatu in 2017 revealed that participants ingested more than seven grams of salt daily on average, with 84% above the WHO recommendation (WHO, 2018). Consuming too much added sugars can make it hard to meet important nutrient needs while staying within calorie limits (FDA.gov/food, Blackstone *et al.*,2011 and 2014). For the 272000 residents of Vanuatu, the growth of diabetes is of special concern. Concerns among the health sectors and other interested parties have grown as a result of the rising disease prevalence – from 2.8% in 1998 to 13.1% in 2016 and considerable complication rates (WHO, 2016). Dietary fiber, vitamin D, calcium, iron and potassium are nutrients on the label that are limited. They are identified as nutrients that should be ingested more compared to other nutritional constituents. Eating a diet high in dietary fiber can increase the frequency of bowel movements, lower blood glucose and cholesterol levels, and reduce calorie intake (Morais *et al.*,1999; Gustafson and Rose, 2022). Diets higher in vitamin D, calcium, iron, and potassium can reduce the risk of developing osteoporosis, anemia, and high blood pressure (FDA.gov/food).

The Pacific Is currently ranked as having some of the highest rates of NCD-related incidence, morbidity and mortality in the entire world, mirroring comparable regional trends. Leaders in the Pacific acknowledged the significant and persuasive effects of this burden when they declared NCD’s as a “human, social and economic crisis” in the region in 2011 (Elliott & Taylor, 2021). In Vanuatu, the consequence of poor diets is evident in the high rates of NCDs, which are responsible for an estimated 70% of all deaths (WHO 2013), and malnutrition resulting in obesity, stunting and undernourishment (Martyn *et al.*,2014). The health of urban populations, with their high consumption of imported goods, is particularly affected with diets high in sodium and fat resulting in higher rates of NCDs (Dancause 2013). Nearly 30% of Vanuatu's population had high blood pressure or was taking medication for it, according to the 2013 WHO STEPwise approach to monitoring of non-communicable disease risk factor (STEPS) survey (WHO, 2013). A survey conducted by the Secretariat of the Pacific community in Collaboration with Statistics office revealed Cereal and products with the highest (25% of whole food categories) consumption compared to roots and tubers, protein sources and others (Vanuatu National Statistics office, 2021). Therefore, nutrient profiling on cereals and products is very important because it can be utilized to personalize the dietary energy needs and provide information on quality of the food supply.

Although nutrient profiling models for qualification of food were developed by many international recognized organizations including Food and Agriculture Organization (FAO), FDA and World Health Organization (WHO) through research, this pilot research focuses only on availability of nutrient information on products and comparative evaluation of the quality of findings. This study aimed to collect nutritional quality of nutrient on front of packed labels on imported cereals and their products, evaluate nutritional value to gain insights into their distribution and characteristics. The variables encompass macronutrients, micronutrients, vitamins, and other relevant factors.

2. Methodology

In order to carry out this survey, a study design was developed to capture the information relevant to predict trend in cereal nutritional information and to assess quality against international standards if any. To achieve our study purpose, the following hypothesis were developed.

2.1 Hypothesis Testing

1. What is the similar category of micro and macro nutrient that appear in most cereal product?
2. No differences in the presence/absence of nutrient information in all cereal products.
3. What is the quantitative range of each nutrient in all the cereals and product?
4. Does the range of nutrient in cereal product meet international standards?
5. Is there any correlation between nutrient molecules in cereal products?

2.2 Product selection and assessment

A preliminary visit was made to a retail market in Port Vila by an inspection team and obtained permission for this task and also observed availability of cereals and products. Portable tablet device was used for taking photographic image of each cereal and products for later data process into a computer database. A simple random sampling was performed on selected cereals and cereal products that are within this category following the methods of Ogudijo *et al.* 2021. Any product that falls in the category of cereals and cereal product has the likely hood of being chosen. For example, breakfast cereals include porridges, chocolate shreddies, rice crispies, cookie crisp, sugar puffs, corn flakes, bran flakes, granola, bars and frosties.

The cereals and products included must have either the retailers or manufacturers label when randomly selected. Imported cereals and product with no nutrition label or dietary information are excluded from the selection. Attention was given to the product country of origin, product weight, list of ingredients and the declaration of the amount of calories in kilocalories, fat, saturated fat, sugar, and salt per 100 g or per 100 ml of the food products. The assessment focuses on the categorization of food based on the nutrient profile of key ingredients. The food products in the present study were not limited by origin as they are randomly selected. The product selected originated from 5 different countries in Europe and the Pacific namely, Belgium, Australia, New Zealand, Fiji and Vanuatu.

2.3 Criteria for categorization

In this study, foods are categories according to USFDA (link available on footnote) criteria based on (weight) of Sugar, Sodium and Saturated fat content per 100g of cereals and products because no healthy food evaluation criteria are available for Vanuatu. Attention was not given to calorie content although it was reported to have direct effect on health of consumers (Drewnowski et al., 2016). To evaluate the availability of each nutrient on labels, data was organized in a random block design and analysis was performed using Cochrans Q test for conditions with two outcomes (nutrient present or absent on front of pack labels) for the frequency distribution of nutrient information (Stephen *et al.*,2018). To compare multiple pairwise groups for saturated fats, sugar and sodium, and assess any significant differences, the McNemar (Bonferroni) procedure was employed (Westfall *et al.*,2010; Stephen *et al.*,2018). This statistical procedure helped in examining the relationship and variations among different nutritional variables.

Descriptive statistical tools were used to explore the central tendencies, variability, and distribution of the nutritional variables in the dataset. The correlation was made between nutrient molecules to identify significance of the relationship. Overall, this methodology allowed for a comprehensive analysis of the dataset, providing insights into the central tendencies, distribution, availability of specific nutrients on labels, and potential differences among various food items. All data were analyzed using XLStat.com.

3. Results

3.1 Frequency (%) distribution of common nutrient on front of pack labels

The dataset offers valuable information on the nutritional content of the cereal products. Nutrient content on cereal nutritional facts sheet highlights the most common, major and minor nutrient in cereal product (Fig. 1). It is relatively clear that energy and major nutrient including, protein, fats, carbohydrate, fibre, sugar, sodium and Saturated fatty acid (High Red Bars) are more common on cereal products ($P < 0.05$). Trace mineral and vitamins were not so popular.

3.2 Nutritional Information and WHO guidelines

The nutrient content of cereal product surveyed is shown in Table 1. Major categories such as Energy, Protein, Total fats and Carbohydrate are within safe limits according to WHO food guidelines for adults, children and infants. Other minor nutrient molecules such as Vitamins, Minerals and other factors were also within safe limits for the category of consumers. Sugar, Sodium and Saturated Fatty Acids contents in cereal except for the daily requirements as per consumer wise.

Table 1
Distribution of Nutritional information on cereal products and WHO food requirement on gender basis

Nutritional Content	Median	Range (Weight percent)	WHO guidelines for pregnant women
Energy (KJ)	Approximately 1870 KJ (447 cal)	530 KJ to 2470 KJ (127–590 cal)	Additional 300–500 calories per day during the second and third trimesters. (1255-2092KJ)
Protein (g)	Around 7.3g	1g to 22g	Additional 0.11g of protein per Kg of body weight per day compared to non-pregnant women.
Fat (g)	Approximately 17.15g	0.9g to 48.4g	Similar recommendations as adults, with a focus on consuming healthy fats.
Carbohydrates (%)	Around 65.5%	11.2–87.1%	45–65% of daily energy intake but with a focus on consuming complex carbohydrates.
Fiber (g)	Approximately 5.1g	0.1g to 58.7g	Same recommendation as adults, with an increase focus on meeting fiber needs through whole grains, fruits, and vegetables.
Sugar (g)	Around 20.15g	0.1g to 721g	Same recommendation as adults, with a focus on minimizing added sugar consumption.
Sodium (mg)	Approximately 378mg	8mg to 1200mg	Same as adults, with a focus on moderate sodium intake.
Potassium (mg)	Around 301.5mg	107mg to 1250mg	Similar to adults, with a focus on meeting needs through balance diet.
Magnesium (mg)	Approximately 106mg	106mg to 106mg (consistent value)	Same as adults.
Iron (mg)	Around 3.9mg	3.9mg to 3.9mg (consistent value)	27-30mg per day.

Nutritional Content	Median	Range (Weight percent)	WHO guidelines for pregnant women
Omega-3 (mg)	Approximately 1060mg	1060mg to 1060mg (consistent value)	Omega-3 fatty acids, particularly DHA, are important for fetal brain and eye development. The recommended intake for pregnant women is around 200-300mg of DHA per day.
Thiamin [Vitamin B1] (mg)	Around 1.83mg	1.83mg to 1.83mg (consistent value)	Same as adults, with a focus on meeting thiamin needs through balance diet.
Riboflavin [Vitamin B2] (mg)	Approximately 1.43mg	1.43mg to 1.43mg (consistent value)	Same as adults, with a focus on meeting riboflavin through a balanced diet.
Niacin [Vitamin B3] (mg)	Around 4.7mg	4.6mg to 8.3mg	Same as adults, with a focus on meeting Niacin through a balance diet.
Folate [Vitamin B9] (μ)	Approximately 300μ	300μ to 300μ (consistent value)	Folate requirement increase during pregnancy. The recommended intake for pregnant women is around 600–800μ per day.
Vitamin C (mg)	Around 2.95mg	0.1mg to 37.5mg	Similar as adults, with a focus on meeting Vitamin C needs through balance diet.
MSFA (g)	Approximately 8.55g	0.1g to 15.7g	Similar recommendations as for adults, with a focus on consuming healthy fats.
PUFA (g)	Around 8.356g	0.1g to 14.8g	Similar recommendations as for adults, with a focus on consuming healthy fats.
Trans fat (g)	Approximately 0.06g	0g to 14.8g	Similar recommendation as for adults, with a focus on minimizing trans-fat consumption.

Nutritional Content	Median	Range (Weight percent)	WHO guidelines for pregnant women
Cholesterol (mg)	Approximately 0.1mg	0.1mg to 0.1mg (consistent value)	Similar recommendation as adults following a balance diet.
Vitamin A (IU)	-	-	The WHO does not provide specific guidelines for Vitamin A. However, vitamin A daily intake for pregnant women is recommended around 770–900 micrograms per day according to other health organization.
Vitamin E (mg)	-	-	Same daily intake as adults with a recommended consumption through balance diet and nutritious diet during pregnancy.

3.3 Cereals Products Nutrient information and FDA standards

Nutrient quality is the most important component of food quality assessment and is a basis for comparison against international quality requirements. For Cereal and products, the result of this assesment showed Sugar, Sodium and Saturated fats having values beyond the maximum limits for cereal and product according to Food and Drugs Association standards (FDA) (Table 2).

Table 2
Nutrient facts sheet for Major molecule in Cereal and products

Molecule	Average ± Standardisation	FDA maximum Limit[1,2]
Energy (KJ)	1788.81 ± 352.75	NA
Protein (g)	7.75 ± 4.08	NA
Fats (g)	16.26 ± 10.68	NA
Carbohydrate (%)	60.67 ± 16.95	NA
Sugar (mg)	14.40 ± 15.65	2.5
Sodium (mg)	371.67 ± 278.75	230
Saturated Fats (g)	6.61 ± 5.76	1

NA- Not available; [1,2]Average over FDA maximum limit

3.4 Comparative assessment of nutrient content in cereals and product

The distribution of cereal products that pass and fail the FDA maximum nutrient requirement is shown in Fig. 2. Only 1.6% of products meets all requirements for Sugar, Sodium and Saturated Fatty Acids. About 43% of all cereal product failed the FDA requirement for at least two of Sugar, Sodium and SFA requirements while 37% failed all three nutrient limits.

Figure 2. Distribution (%) of products that pass and fail (either sugar, sodium or SFA) the nutrient requirement according to FDA (n = 63). Green represents pass all, Blue represent fail 1; Yellow represent fail 2; Red represent fail all.

The distribution of cereal products that meet FDA maximum requirements for Sugar, Sodium and Saturated fatty acids is presented in Fig. 3. About 30% of products meets the requirements for Sugar and Sodium while 70% were over the limits respectively. More than 80% of cereal products fail to meet the saturated fatty acid requirements of FDA. A significance number of cereals and products contained Saturated fats compared to Sugar and Sodium ($P < 0.05$).

The correlation between most common nutrient on cereal product is presented in Fig. 4. There is a significant positive correlation between total fats and Saturated fatty acids ($P < 0.05$). Dietary fiber content in cereal is directly proportional to Protein ($P < 0.05$) while Total carbohydrate is inversely proportional to total fats ($P < 0.05$).

The Vanuatu National Statistics Report on energy food survey for 2019 and 2020 showed cereals and products were the main energy food source which make up 26% of all energy food consumed (Fig. 5). Roots and tubers are the second highest with 23% consumption. Only these two food category makes up around 50% of total energy food consumed in in 2019 and 2020.

4. Discussion

4.1 Cereal consumption

Nowadays, cereals and products are the most consumed staple food in the world (Awika *et al.*,2011). Cereal grains represent a contradiction of sort when it comes to nutrition and human health. In developing countries, malnutrition incidences, particularly related to protein, iron, zinc and vitamin A deficiency, are highest in places with the highest per capita consumption of cereal grains (Awika *et al.*,2011; Bouis *et al.*, 2000; Müller and Krawinkel 2005). The two major reasons are that cereal grains are generally low in essential amino acids, particularly lysine; in addition, the refine grains most commonly consumed (e.g., polished rice) are very low in micronutrients. In the developed countries, the refined grain products have been increasingly cited as a major contributor to obesity due to their high content of easily digestible carbohydrates (or 'carbs' in the diet lingo) (Awika *et al.*, 2011). In Vanuatu, although it has long been considered food security depend on fertile soil and plentiful rain, however, now it is challenged with fast decrease in agriculture interest and frequent weather impacts like tropical cyclones or torrential rains leading to flooding. The other issue of concern is the increasing population that reduces the already available limited land in the islands that is available for gardening, reducing the capacity for own production of fresh foods (Sarah *et al.*,2015). The rapidly expanding population has a limited capacity to access fresh and nutritious food and there are many reasons like more unemployment, low wages etc. The 'nutrition transition' from local to imported food is occurring at faster rates in urban areas (Dancause *et al.*,2013), increasing the risk of food insecurity in the urban population in two ways. Imported food consumed in Vanuatu are primarily packaged foods that are high in Sodium and Fats and lower in Nutrients, such as rice, biscuits, tinned meats or chicken wings. The report of 2019 and 2020 (FAO) showed imported fresh fruits and vegetables are very expensive putting them out of reach of most urban populations and the obvious reason would be the expenditure capacity based on their economic status. Thus, majority of the population depends on imported food product of low quality and prices, thus, raising the need for nutrient profiling. To date, no data on imported food nutrient profile has ever been documented in Vanuatu which justify the urgent need of this study.

4.2 Cereal and their products quality requirements

Cereals and their products surveyed in Port Vila showed Energy, Protein, Total fats, Carbohydrate, Sodium, Sugar and Saturated Fatty Acids were common in majority of cereal products (Fig. 1). This information is important to consumers, however, more than 70% of the consumers do not know how to utilize nutrient information to judge quality of products. On the other hand, cost of quality products and access to supplies limits fast majority of people to eating healthy. The amount of nutrient per serving on product label serves as basis for calculating daily intake of a food product, however, such knowledge is lacking in many people. A survey on salt intake in Efate Island (hosts capital, Port Vila) revealed an average salt intake of 7.2 ± 2.3 g/day. This figure is above the WHO requirement of 5 g per day (Paterson et al., 2019). As it is observed from the current study, Sodium content on cereal is 371.67 mg, above the maximum limit of 230 mg according to FDA (Table 2), clearly suggest that imported food needs monitoring and developing regulations that limits access to low quality food. The median energy content (KJ) of the cereal food products was approximately 1870 KJ, suggesting a moderate energy level. Energy is obtained from Protein, Fats and Carbohydrate and thus, energy requirement needs a developed model to meet gender and age category requirements of energy intake (Drewnoski *et al.*, 2008). The Fat content varied considerably, with a median of approximately 17.15g. this indicates a wide range of fat levels in the analyzed food products (Table 1). The Carbohydrate percentage had a median of around 65.5%, indicating that carbohydrates are significant component of these foods (Table 1). Using appropriate nutrient profiling model, the energy per category can be determined for each age and gender as per WHO guidelines (Table 1), enhancing the advancement into eating healthy. Other Fats, Vitamins and Mineral contents appear to be low in Cereals and products reported in the current study, similar to reports of Sarah *et al.* (2015), suggesting that these nutrients do not have significant impact on cereals consumers. This information reported herein can be utilized by nutritionist, health professionals, and individuals seeking to make informed dietary choices.

The distribution of Cereal products (Fig. 2) that meet and don't meet the FDA's maximum requirements. Only 1.6% of products satisfy all for Sugar, Sodium and Saturated Fatty Acid requirements. Regarding the FD"s standards for at least two of the nutrients—Sugar, Sodium, and Saturated Fatty Acids—about 43.5% of all Cereal products failed, and 37.1% failed all three nutrient limits. The distribution (%) of products that pass and fail (either Sugar, Sodium or Saturated Fatty Acid) the nutrient requirement according to FDA (n = 63) has the following components; Green represents pass all, Blue represent fail in 1, Yellow represents fail in 2 and Red represents fail in all. Furthermore, Fig. 3 displays the distribution of Cereal items that adhere to the FDA's maximum standards for Sugar, Salt and Saturated Fats. About 30% of items fulfill Sugar and Salt criteria, whilst 70% exceeded such limits. More than 80% of Cereal products failed to adhere to FDA standards for Saturated Fatty Acids while 20% of them fulfilled the FDA criteria. The distribution (%) of products that pass and fail the nutrient requirement according to the FDA criteria for Sugar, Salt and Saturated fatty acids (n = 63), has the following components: Green representing pass and Red representing fail. Therefore, as observed from the results, there is less percentage of products that met the FDA requirement for Sugar, Sodium and Saturated Fatty Acids. This may have a negative impact on the livelihood and health of the people consuming these products. The increase in Sugar, Salt and Saturated Fatty Acids may lead to diabetes, high blood pressure and heart disease respectively which affects the consumers of the product.

4.3 Food intake and biological processes in humans

Looking into the normal human biological working, most body cells can absorb biological fuels, such as the sugar glucose, with the aid of insulin. As the pancreas stops generating this vital hormone and the beta cells are destroyed, glucose builds up in the blood, resulting in the excessively high glucose levels that are a hallmark of diabetes. The kidneys work too hard to turn the excess glucose into urine, which causes the body to become dehydrated. While this process continues, body cells indiscriminately break down their protein and fat reserves to produce additional fuel because they are starving amid a sea of abundance. If the breakdown of fat continues unchecked, acidic products called ketones build up. These can cause a coma and eventually death when paired with dehydration. (Atkinson & Maclaren, 1990). Also, Osmolyte excretion and renal water reabsorption occur simultaneously during the renal concentration process, resulting in a negative clearance of osmolyte-free water. Any reduction or increase in an individual's dietary salt consumption had a corresponding effect on how much osmolytes were excreted in a urine. A quantitative investigation revealed that progressively increasing salt intake reduced free water clearance. This then results in the accumulation of the free water resulting in obesity (Rakova et al., 2017). The pumping motion of the heart and the tone of the arteries creates the pressure required to allow the blood to circulate. However, due to the kidney's ability to rapidly clear excess fluid and salt over the long term due to their infinite gain attribute, blood pressure is primarily regulated by salt and water balance. A slight increase in extracellular fluid volume always results in a slight increase in blood pressure when renal functions is impaired.

Increased plasma volume always occurs before the hypertension is brought on by salt retention (Blaustein *et al.*,2006). Low-density lipoprotein (LDL) cholesterol has been demonstrated to rise as a result of dietary saturated fat intake, which has been linked to an increased risk of cardiovascular disease. Except for trans fats, saturated fat intake in humans raises LDL cholesterol. The total cholesterol (TC) to high-density lipoprotein (HDL)ratio (a risk marker for cardiovascular disease) is unaffected by saturated fat because it also raises high-density lipoprotein (HDL) cholesterol. LDL particles have a wide range of sizes, densities and chemical composition. Particularly, smaller and denser LDL particles have been strongly linked to atherosclerotic cardiovascular disease (Siri-Tarino et al., 2010). For example, in the twelve Pacific Islands Countries for which data are available, NCD's are already the most common cause of death and frequently accounting for 70% of all families (WHO, 2023). Cardiovascular disease is the leading cause of death in the Pacific, accounting for between 29% and 38% of deaths from all causes, including traumas, communicable disease, maternal and perinatal illnesses, and non-communicable diseases (Anderson 2013). Alarmingly, NCS rates are predicted to rise due to current risk factors and the shift from traditional diets to modern diets distinguished by imported goods and refined oils, sugar and confectionary and processed meats (Santos et al., 2019). Thus, as observed, having higher levels of Sugar, Sodium and Saturated Fats may contribute to a poor healthy lifestyle.

Moreover, the relationship between the most prevalent nutrient on Cereal products revealed Total Fats and Saturated Fatty Acids were significantly correlate ($P < 0.05$). Also, while Total Carbohydrate is inversely proportional to Total Lipids ($P < 0.05$), dietary fiber content in Cereal is directly proportional to Protein ($P < 0.05$). Triglycerides (TGs), diglycerides, monoglycerides, fatty acids, phospholipids and sterols are among the polar and nonpolar substance that make up lipids. Lipids in the diet affect a foods flavor, texture and caloric content. Lipids play a variety of roles in the body, including absorption of fat-soluble vitamins and other nutrients as well as serving as a source of readily available and stored energy, a structural and functional component of all cell membranes, and a precursor for eicosanoids and cell signaling molecules (Field and Robinson, 2019). The structure of Saturated Fats lacks double bonds. These are primarily found in meat and dairy fats. Saturated Fats tend to solidify at room temperature in most fats (Ruiz and Cherr, 2016). Although lipids are important for the body, excessive levels of lipids may be a concern to an individual's health. Lipotoxicity is a condition where lipid accumulation prevents cells and tissues from functioning normally. Many metabolic illnesses are assumed to have Lipotoxicity as their primary underlying cause. For instance, in lipodystrophy, tissues other than the adipose tissue experience lipid buildup, while in obesity, lipid accumulation overwhelms adipose cells. Obesity-related disorders are caused by toxic lipids in skeletal muscle, heart, liver and the pancreatic β -cells. Cells are particularly sensitive to saturated fatty acids like palmitate. Ceramides, reactive oxygen species, endoplasmic reticulum stress, short nucleolar RNAs are a few of the components that have been linked to palmitate-mediated cellular toxicity (Piccolis *et al.*,2019).

This study revealed a positive correlation between Saturated fats and total fats. Cereals with high total fats is definitely a risk for consumers understanding that saturated fats is also high. Another relationship that may be observed from Fig. 4 was the positive correlation between Dietary Fiber and Protein. Dietary fiber has been a key dietary element in the fight against chronic disease over the past 25 years (Anderson et al.,1990). A high fiber diet lowers the risk of obesity, diabetes, hypertension, certain malignancies and cardiovascular disease (Anderson 1990). Similarly, a rich protein diet enables the body to meet needs for growth of body tissues, regular metabolism and maintenance (Katz *et al.*,2019). However, in recent decades, the burden of obesity has significantly expanded in developing countries, with prevalence in many of these countries matching or even exceeding that of developed countries. The rise in NCDs is a result of behavioral shifts brought on by economic development, including an increase in packaged, processed and Western foods in diets and a decline in physical activity as the share of sedentary wage labor rises. The combined burden of infectious and chronic diseases that characterizes early stages of health transition is being felt in Vanuatu. The nutrient content and cooking techniques of tinned fish most likely have a role in its relationship with obesity. Greater amount of fat is present in tinned fish than in the majority of fresh fish varieties Dancause et al., 2013.

4.4 Challenges and limitations of food quality survey in Vanuatu

This pilot project has identified several challenges at all stages of the study. The vast quantity and varieties of food products required time to develop good knowledge of the different forms of the products. Lack of prior data on the types of imported food items suggest the need to start nutrient survey of imported food items from scratch. Shortage of labor (staff) in the Department was also a limiting factor to carry out a comprehensive assessment of the nutrient profile on imported food items. The number of products assessed is this study is relatively small, thus, a greater number of products would cover more categories. Labelling in foreign language except for English and French was another problem during profiling work. Lack of food safety and policy framework that in-cooperate private sector to participate in food quality initiative and activities. Further assessment may require these factors to be addressed in order to have a comprehensive report.

Conclusion

This research review on nutrient profiling survey on imported Cereals and their products in Port Vila has identified major and minor nutrient categories. Energy, Protein, Total fats, Carbohydrate, Sodium, Sugar and Saturated Fats being the major nutrient present in vast majority of Cereals and products. Sugar, Sodium and Saturated Fatty Acids have values beyond the maximum limits set by the USFDA. Further research is required to explore potential relationships between nutritional variables and health outcomes. Additionally, comparative studies involving different food categories or specific dietary restriction could provide deeper insights into the nutritional implication for specific populations. Finally, this preliminary finding on Cereals and products through light for an urgent need for support towards research and development of a nutrient profile model for various food categories in Vanuatu.

Declarations

Author Contribution

R.S.S. and K.K.K. wrote the main manuscript text and R.S.S. prepared the figures and tables. All authors involved in data collection and reviewed the manuscript.

Food notes

[1]https://www.fda.gov/news-events/press-announcements/fda-proposes-updated-definition-healthy-claim-food-packages-help-improve-diet-reduce-chronic-disease

[2]https://www.cnbc.com/2022/10/11/fda-redefined-healthy-these-7-cereals-do-not-qualify.html

References

1. Anderson, I. (2013). *The Economic Costs of non-communicable disease in the Pacific Islands : a rapid stock take of the sitution in Samoa, Tonga and Vanuatu.* Health, Nutrition and Population.
2. Anderson, J.W., Deakins, D.A., Floore, T.L., Smith, B.M. and Whitis, S.E., 1990. *Dietary fiber and coronary heart disease.* Critical Reviews in Food Science & Nutrition, 29(2), pp.95-147.
3. Anderson, J. W. (1990). Dietary Fiber and Human Health. *HORTSCIENCE*.
4. Andresen, C. (2011). *Protein Structure and Interaction in Health and Disease.* Linkoping Studies in Science and Technology.
5. Atkinson, M. A., & Maclaren, N. K. (1990). *What Causes Diabetes?* Scientific American, a division of Nature America, Inc.
6. Awika, J.M., 2011. *Major cereal grains production and use around the world. In Advances in cereal science: implications to food processing and health promotion* (pp. 1-13). American Chemical Society.
7. Blaustein, M. P., Zhang, J., Chen, L., & Hamilton, B. P. (2006). How does salt retention raise blood pressure. *American Journal of Physiology*.
8. Blackstone S, Sanghvi T. A *comparison of minimum dietary diversity in Bangladesh in 2011 and 2014*. Maternal Child Nutrition. 2018;14(4). doi: 10.1111/mcn.12609
9. Brown, I. J., Stamler, J., Van Horn, L., Robertson, C. E., Chan, Q., Dyer, A. R., Huang, C., Rodriguez, B. L., Zhao, L., Daviglus, M. L., Ueshima, H., and Elliott, P. (2011*). Sugar-sweetened beverage, sugar intake of individuals, and their blood pressure: international study of macro/micronutrients and blood pressure.* Hypertension, 57(4), 695-701.
10. Dancause, K.N., Vilar, M., Wilson, M., Soloway, L.E., DeHuff, C., Chan, C., Tarivonda, L., Regenvanu, R., Kaneko, A., Lum, J.K. and Garruto, R.M., 2013. *Behavioral risk factors for obesity during health transition in Vanuatu, South Pacific*. Obesity, 21(1), pp. E98-E104.
11. Drewnowski, A., Aggarwal, A., Cook, A., Stewart, O. and Moudon, A.V., 2016. *Geographic disparities in healthy eating index scores (HEI–2005 and 2010) by residential property values: findings from Seattle obesity study (SOS)*. Preventive medicine, 83, pp.46-55.
12. Drewnowski, A. and Fulgoni III, V., 2008. *Nutrient profiling of foods: creating a nutrient-rich food index.* Nutrition reviews, 66(1), pp.23-39. https://doi.org/10.1111/j.1753-4887.2007.00003.

13. Fernandez, E. G., & Sanz, M. L. (2019). Food Security, Nutrition and Health. *Encyclopedia of Food Security and Sustainability*.
14. Field, C. J., & Robinson , L. (2019). *Dietary Fats.* Elsevier.
15. Global food consumption from 2015 to 2027, *by food product group*. https://www.statista.com/forecasts/1298375/volume-food-consumption-worldwide.
16. Gustafson, C. R., & Rose, D. J. (2022). *US consumer identification of the health benefits of dietary fiber and consideration of fiber when making food choices.* Nutrients, 14(11), 2341.
17. Hlaing-Hlaing, H., Dolja-Gore, X., Tavener, M., James, E. L., & Hure, A. J. (2022). *Alternative Healthy Eating Index-2010 and Incident Non-Communicable Diseases: Findings from a 15-Year Follow Up of Women from the 1973–78 Cohort of the Australian Longitudinal Study on Women's Health.* Nutrients, 14(20), 4403.
18. How to Understand and Use the Nutrition Facts Label. https://www.fda.gov/food/new-nutrition-facts-label
19. James, S.W., 2022. *Protecting Peri-urban Agriculture: A Perspective from the Pacific Islands. In New Forms of Urban Agriculture: An Urban Ecology Perspective* (pp. 101-117). Singapore: Springer Nature Singapore.
20. Katz, D. L., Doughty, K. N., Geagan, K., Jenkins, D. A., & Gardner, C. D. (2019). Perspective: The Public Health Case for Modernizing the Definition of Protein Quality. *Advances in Nutrition*.
21. Martyn, T., Yi, D. and Fiti, L., 2014. *Identifying the household factors, and food items, most important to nutrition in Vanuatu*. FAO.
22. Maalouf, J., Cogswell, M.E., Bates, M., Yuan, K., Scanlon, K.S., Pehrsson, P., Gunn, J.P. and Merritt, R.K., 2017*. Sodium, sugar, and fat content of complementary infant and toddler foods sold in the United States, 2015.* The American journal of clinical nutrition, 105(6), pp.1443-1452.
23. Morais, M. B., Vítolo, M. R., Aguirre, A. N., & Fagundes-Neto, U. (1999)*. Measurement of low dietary fiber intake as a risk factor for chronic constipation in children.* Journal of pediatric gastroenterology and nutrition, 29(2), 132-135.
24. Müller, O. and Krawinkel, M., 2005. *Malnutrition and health in developing countries*. Cmaj, 173(3), pp.279-286.
25. Paterson, K., Hinge, N., Sparks, E., Trieu, K., Santos, J.A., Tarivonda, L., Snowdon, W., Webster, J. and Johnson, C., 2019. *Mean dietary salt intake in Vanuatu: a population survey of 755 participants on Efate Island*. Nutrients, 11(4), p.916.
26. Ogundijo, D.A., Tas, A.A. and Onarinde, B.A., 2021*. An assessment of nutrition information on front of pack labels and healthiness of foods in the United Kingdom retail market*. BMC Public Health, 21, pp.1-10.
27. Oni, T., Assah, F., Erzse, A., Foley, L., Govia, I., Hofman, K. J., ... & Wareham, N. J. (2020). *The global diet and activity research (GDAR) network: A global public health partnership to address upstream NCD risk factors in urban low and middle-income contexts.* Globalization and Health, 16, 1-11.

28. Pallazola, V. A., Davis, D. M., Whelton, S. P., Cardoso, R., Latina, J. M., Michos, E. D., Sarkar, S., Blumenthal, S. R., Arnett, D. K., Stone, N. J., and Welty, F. K. (2019)*. A clinician's guide to healthy eating for cardiovascular disease prevention.* Mayo Clinic Proceedings: Innovations, Quality & Outcomes, 3(3), 251-267.
29. Piccolis, M., Bond, L. M., Weissman, J. S., Walther, T. C., & Farese, R. V. (2019). Probing the Global Cellular Responses to Lipotoxicity Caused by Saturated Fatty Acids. *Elsevier Inc*.
30. Popkin, B. M. (2006). *Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases–.* The American journal of clinical nutrition, 84(2), 289-298.
31. Rakova, N., Kitada , K., Lerchl, K., Hahlmann, A., Birukov, A., Daub, S., . . . Titze, J. (2017). Increased salt consumption induces body water conservation and decreases fluid intake. *The Jounal of Clinical Investigation*.
32. Ruiz, L. D., & Cherr, S. Z. (2016). *Nutrition and Health Info Sheet: Fat.* Davis: Center for Nutrition in Schools.
33. Santos, J. A., McKenzie, B., Trieu, K., Farnbach, S., Johnson, C., Schultz, J., . . . Webster, J. (2019). Contribution of fat, sugar and salt to diets in the Pacific Islands: a systematic review. *Public Health Nutrition*.
34. Siri-Tarino, P. W., Sun, Q., Hu, F. B., & Krauss, R. M. (2010). *Saturated Fatty Acids and Risk of Coronary Heart Disease Modulation by Replacement Nutrients.* Springerlink.
35. Stephen, D. and SAZ, A., 2018. *Cochran’s Q with pairwise McNemar for dichotomous multiple responses data: A practical approach.* Int J Eng Technol, 7(3), pp.4-6.
36. Westfall, P.H., Troendle, J.F. and Pennello, G., 2010. *Multiple mcnemar tests.* Biometrics, 66(4), pp.1185-1191
37. WHO. (2023). *Addressing noncommunicable diseases in the Pacific Islands.* World Health Organization.
38. World Health Organization. 2013. *Vanuatu NCD Risk Factors STEPS report 2013*. Suva, Fiji: WHO Government of Vanuatu.

Figures

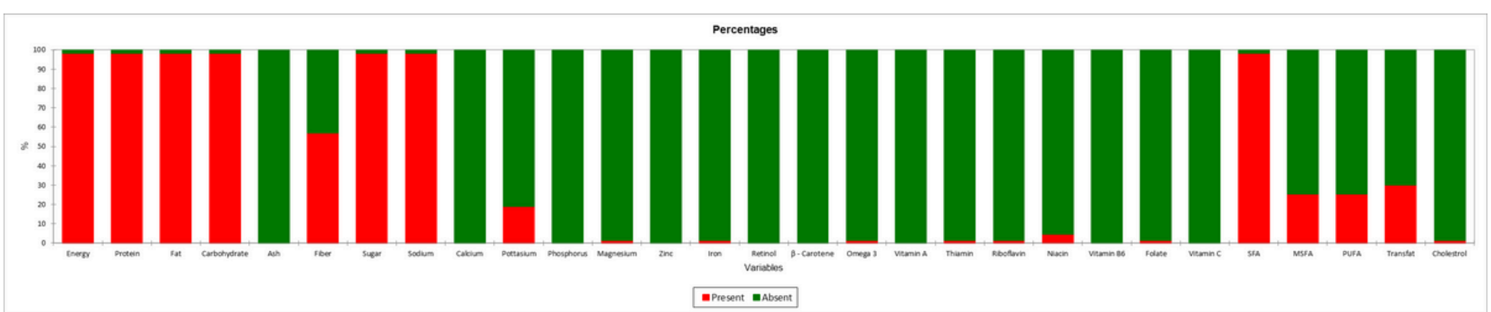

Figure 1

Percentage frequency distribution for Major and Minor nutrient molecule on Cereal Nutritional Facts sheet

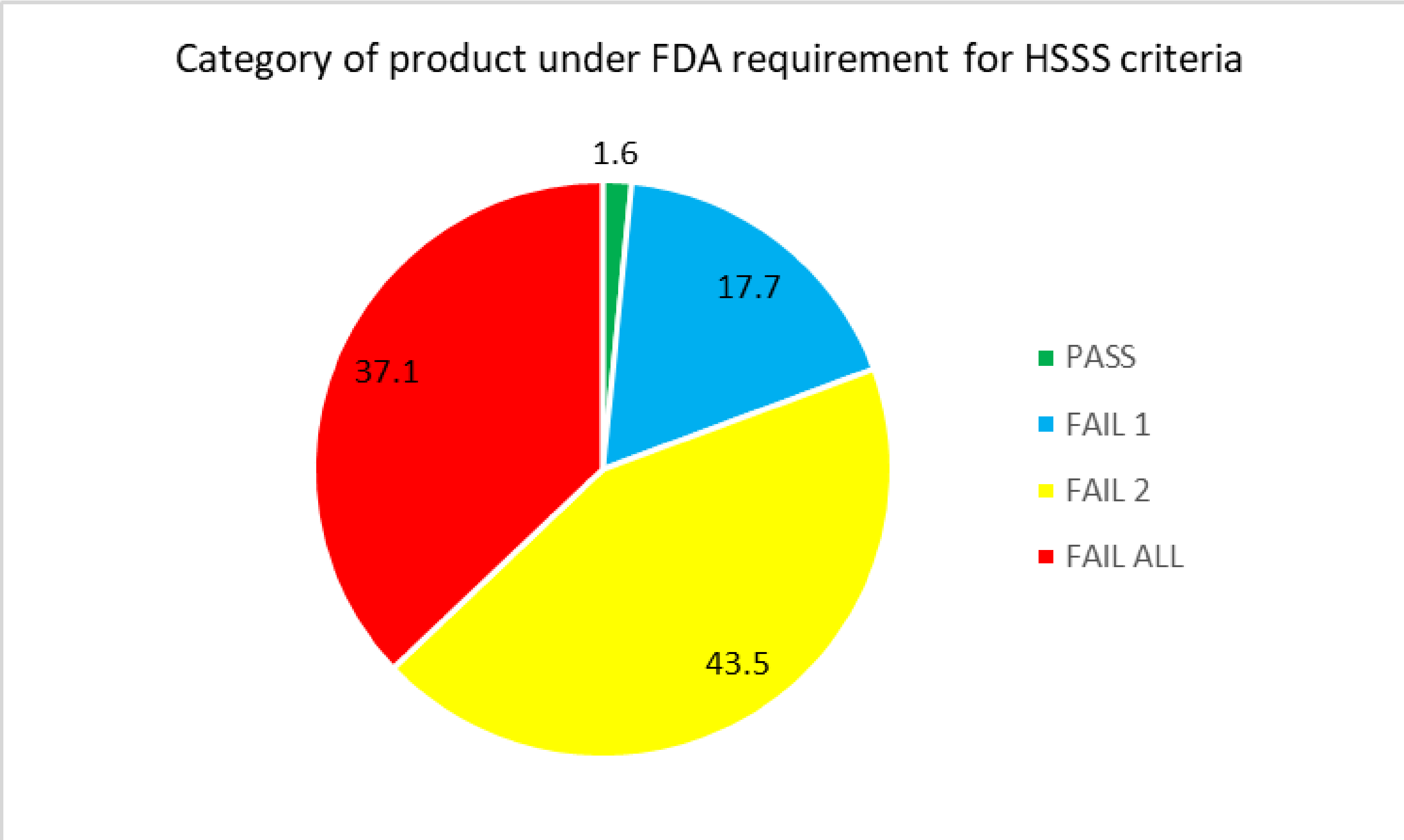

Figure 2

Distribution (%) of products that pass and fail (either sugar, sodium or SFA) the nutrient requirement according to FDA (n=63). Green represents pass all, Blue represent fail 1; Yellow represent fail 2; Red represent fail all.

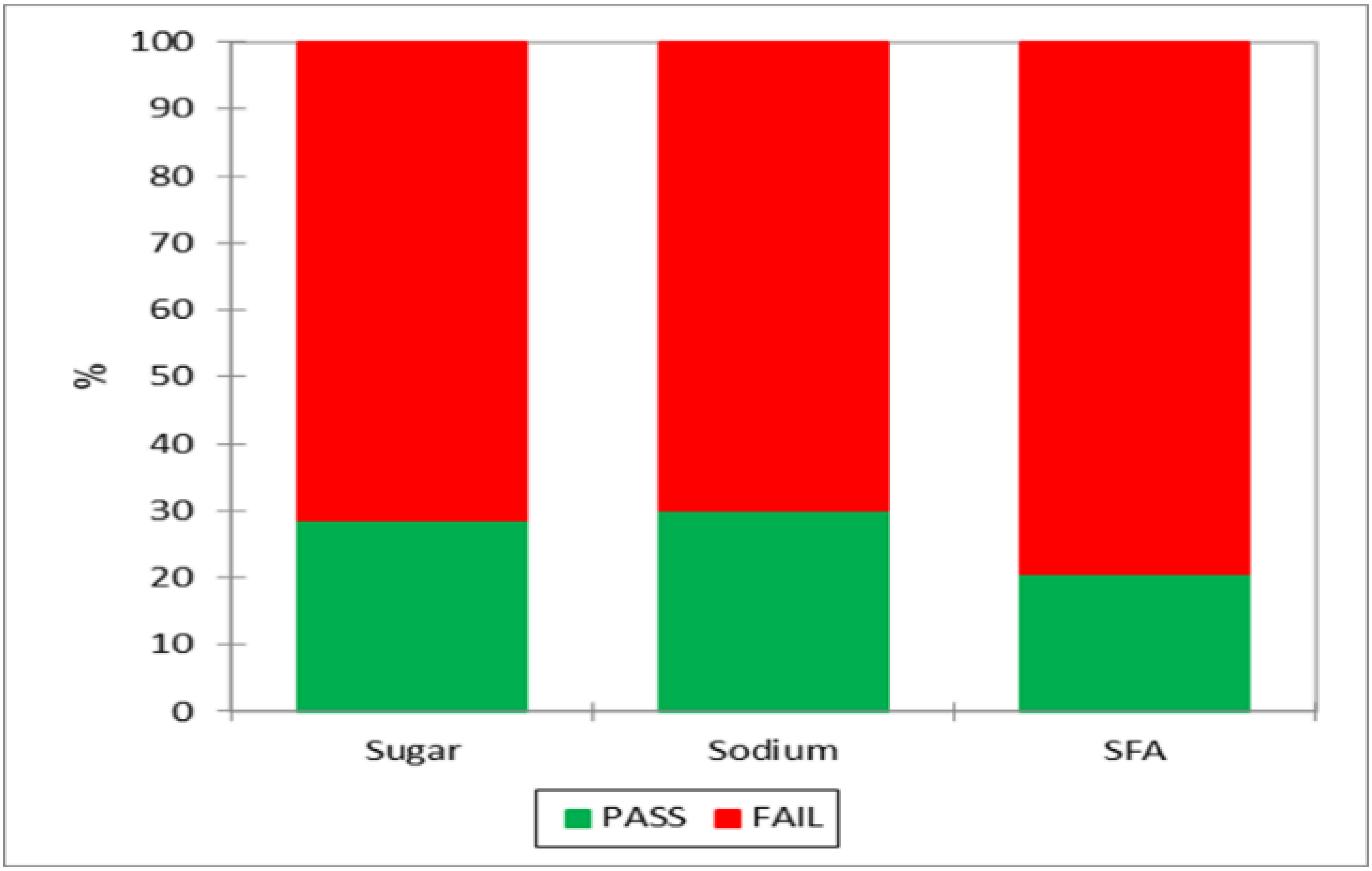

Figure 3

Distribution (%) of products that fail to meet FDA requirement for Sugar, Sodium and Saturated fatty acid (n=63). Green represents pass and Red represents fail.

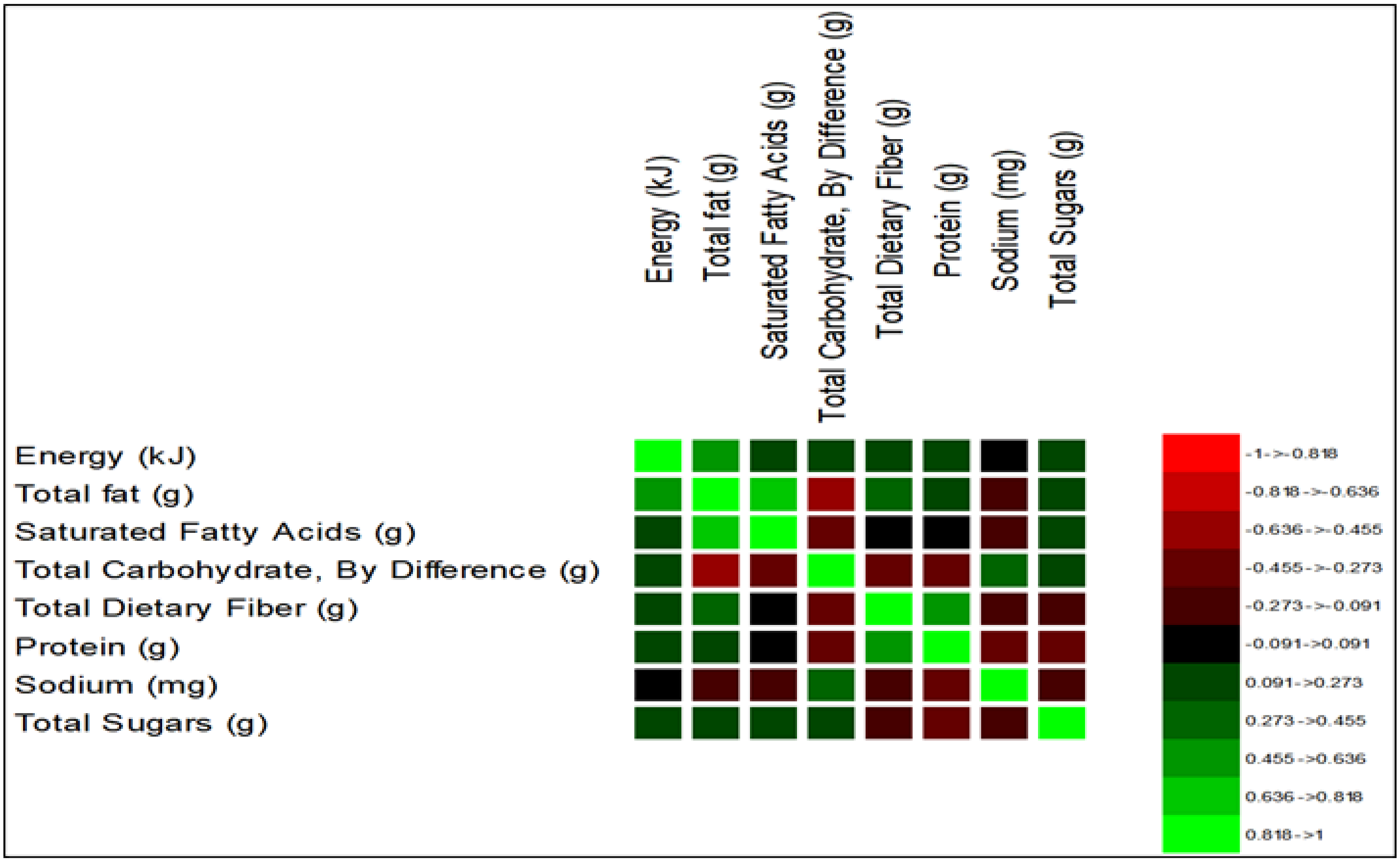

Figure 4

Correlation coefficient of nutrient content in cereals and product food matrices (n = 63)

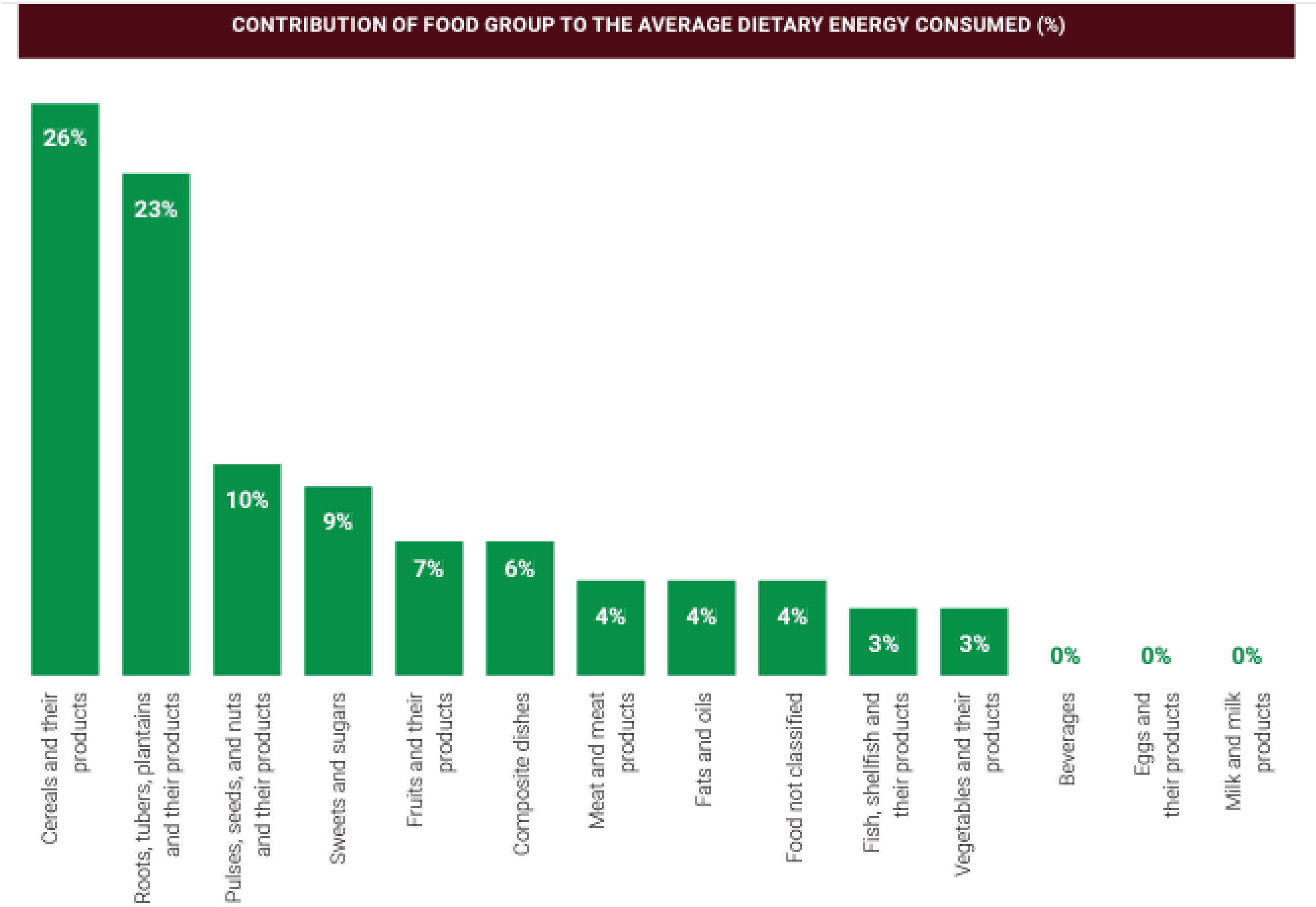

Figure 5

The Contribution of food group to the average dietary energy consumed in Vanuatu for the year 2019 and 2020. *Adopted from Food Security Vanuatu report of 2021*. (Available at https://www.fao.org/3/cb3785en/cb3785en.pdf)