Categorization of Food Groups According to Their Composition of Iron, Ascorbate and Calcium: Analysis of the Kenya Food Composition Tables 2018

Patrick Nyamemba Nyakundi

Department of Food, Nutrition and Dietetics, Kenyatta University, Kenya

***Abstract*— The use of food groups offers a summary that can be used to generate useful dietary patterns. Studying dietary pattern has gained popularity over single nutrient investigation and their relationship with various health conditions. The aim of this paper was to categorize various food groups according to their composition of iron, ascorbate and calcium. Data was obtained from the Kenya Food Composition Tables 2018. Univariate statistics were used to analyze the data in SPSS. Food groups with high level of iron were meat and meat products (μ=5.59mg/100g of EP) and cereals and their products (μ=3.95mg/100g of EP). Vegetables (μ=38.04 mg/100g) and fruits (μ=33.55 mg/100g) were richest in ascorbic acid and milk and milk products in calcium (μ=512.07mg/100g of EP). The categorization can be used to generate human diet intake scores that could inform dietary patterns for various groups of people to enhance their iron bioavailability and better micronutrient outcomes.**

***Keywords*—Food groups, categorization, iron, ascorbic acid, calcium**

I. INTRODUCTION

The nutrient intakes and dietary consumption patterns are recorded as the factors influencing health and disease and have led to the development of recommended intakes for various nutrients including vitamins and minerals (1). The recommended intakes address the nutritional needs of humans in the lifecycle and should result in optimal nutrition and reduced vulnerability to diseases (1). However, researchers encounter difficulties analysing a single nutrient and its relationship with health and diseases. The main reason why this is so can be attributed to the fact that people do not consume nutrients, they consume meals that contain a combination of foods (2). A huge number of confounding variables, which come to play when investigating the role of a nutrient in relation to a certain disease, proves difficult to control for during analysis (3).

Since a nutrient is found in an array of foods, it becomes necessary to categorize foods according to the richness of a particular nutrient (4). In this manner, an array of foods categorized to contain a high, moderate, low or negligible amounts of a certain nutrient can be studied in relation to a given condition (2). Furthermore, the nutritionists and international researchers have reported the population intake of nutrients using food groups instead of a single food or nutrient, purporting the necessity of categorization of foods groups according to their composition of various nutrients (5). Therefore, the aim of this paper was to categorize the different food groups according to their composition levels of iron, ascorbic acid and calcium using data obtained from Kenya Food Composition Tables 2018 (6).

II. MATERIALS AND METHODS

Data was extracted from the latest Kenya Food Composition Tables 2018(6).

A. Food Groups

Eleven food groups were identified, adopted and modified from the Kenya Food Composition Tables. They include condiments and spices, meat, poultry and eggs, vegetables and their products, starchy roots, tubers and bananas, legumes and pulses, beverage and drinks, fruits, cereals and cereal products, fish and seafood, milk and milk products, and oil and fat (7). The amounts of the nutrients in different foods were expressed as mg per 100 grams of the edible portion (EP) of a given food.

B. Statistical Analysis

Obtained data was exported into SPSS version 20 (Illinois, Chicago). Univariate statistics including means, range and the standard deviation were used to analyse the data. Condiments and spices food group was regarded an outliers and was excluded from the classification of food groups. The range of nutrient composition in various food groups was determined by getting the difference between the maximum and minimum value. Then, the difference was divide by three to get the interval of three classes of the food groups to classify them as either low category, moderate category or high category.

III. RESULTS

A. Categories of Food Groups according to their Composition of Iron

The composition of the iron content in various foods was measured in mg per 100 g of the edible portion of the food. Based on this concentration, the highest composition was

13.57mg/100g of EP and the lowest was at 0.31mg/100g of EP. However, condiments and spices was an outlier in that case excluded from the categorization. Therefore, meat and their products and cereals and cereal products had concentration of 5.59mg/100g of EP and 3.95mg/100g of EP respectively and therefore, categorized as Fe Category A. The Fe Category B consisted of the moderate composition of iron including legumes and pulses (3.30mg/100g of EP), oil and fat (3.06mg/100g of EP) and vegetables and their products (2.14mg/100g of EP). The last class was Fe Category C that had the lowest concentration of iron. It consisted of fish and seafood (1.21mg/100g of EP), beverage and drinks (1.09mg/100g of EP), starchy roots, tubers and bananas (0.77mg/100g of EP), fruits (.63mg/100g of EP), and milk and their products (0.31mg/100g of EP) (Table 1).

Table 1: Categories of food groups according to the average amount of iron in mg/100 g of EP

Categories	**Food Groups**	**Average (μ) Amount of iron (mg) in 100g of EP**	**Levels**
Outlier	Condiments & spices	13.57	
Fe Category A	Meat, Poultry, and Eggs	5.59	High
	Cereals And Cereal Products	3.95	
Fe Category B: Non-haeme iron	Legumes And Pulses	3.30	Moderate
	Oil and Fat	3.06	
	Vegetables and their Products	2.14	
Fe Category C	Fish and Seafood	1.21	Low
	Beverage and Drinks	1.09	
	Starchy Roots, Tubers and Bananas	0.77	
	Fruits	0.63	
	Milk And Milk Products	0.31	

*EP stands for edible portion**(Source:** Adopted and modified from Kenya Food Composition Tables(6)

B. Ascorbate Category Levels according to Vitamin C Composition

Vegetables and their products had the highest level of ascorbic acid (μ=38.04; SD= 39.47) followed by fruits (μ=33.55; SD= 41.38). Subsequently, the two food groups demonstrated a high deviation about the mean, implying that there was a wide variation of the ascorbic acid levels among the different fruits and vegetables. Therefore, it was important to show the kind of fruits and vegetables with the highest level of vitamin C (Table 2).

Table 2: Ascorbate categories according to the mean amount of vitamin C in mg per 100 g of the edible portion of different food groups

Food groups	**μ Amount of Ascorbate (mg) in 100g of EP***	**SD**	**Range**	**Levels**
Vegetables	38.04	39.47	156	High
Fruits	33.55	41.38	220	
Condiments and Spices	23.70	30.01	119	Moderate
Starchy Roots, Tubers, And Bananas	15.12	11.09	40	
Legumes and Pulses	4.27	10.51	49	Low
Meat Poultry and Eggs	1.72	4.63	21	
Beverages and Drinks	1.00	1.03	2.5	
Oil and Fat	0.92	1.66	5.8	
Milk and Milk Products	0.85	0.85	4.0	
Cereals and their Products	0.42	1.12	7.0	
Fish and their Products	0.38	0.71	20	

*EPstands for edible portion

Among the vegetables and their products, the once with the composition of 104-156 mg/100g of EP was considered the richest source of ascorbate among foods. The vegetables in these categories include capsicum, red, yellow or green, raw, boiled, grilled, or baked kale. The second category had a composition of 52-104mg/100mg of EP and they were considered to have moderate levels of ascorbic acid. The next category had vitamin C concentration of 1-52 mg/100g of edible portion and they were regarded as low ascorbate vegetables. Results also demonstrated that there were some vegetables that can be regarded as non-ascorbate source foods since they had a composition of 0mg/100g of EP. They include mushroom, fresh or dried, raw, boiled or stewed as shown in Table 3.

Table 3: Levels of ascorbic acid in various vegetables and their products

Vegetable and their products	**Ascorbate mg/100g EP**	**Categories**
Capsicum, red, yellow or green, raw, boiled, grilled, or baked Kale	104-156	High ascorbate source vegetables
Raw broccoli, tops, and stems, raw, steamed, boiled, drained; Vine(African) spinach, picked leaves, raw, boiled, drained; Amaranth, leaves, picked, raw, steamed; Cauliflower, tops, and stems, raw; Cabbage, leafhead, redraw; Kale, steamed(withoutsalt); Spiderplant, leaves, raw; Bittergourd, whole, different varieties,	52-104	Moderate ascorbate source vegetables
Raw kale, boiled, drained; Cabbage ,leafhead, white, raw, stewed or boiled (drained); Cowpea, leaves, picked, raw, steamed (without salt); Cauliflower, tops and stems, boiled, drained(withoutsalt); Jutemallow, picked leaves, raw or stewed; Bittergourd,whole,differentvarieties,boiled,drained(withoutsalt); Spinach, leaves, raw, stewed; Blacknightshade, indigenous, leaves, picked, raw; Amaranth, leaves, picked, boiled, drained; Spiderplant, leaves, steamed (withoutsalt), boiled (drained, without salt); Tomato, red or green, ripe, raw or boiled (drained), canned; Courgette, green, unpeeled, raw; Leeks, bulbandstem, raw or boiled (drained); Okra,fresh,raw; Pumpkin, leaves, raw boiled (drained); Celery, stalks, raw or boiled (drained, without	1-52	Low ascorbate vegetables

salt); Okra,fresh, boiled, drained(withoutsalt); Sweet Potato(Leaves) raw or boiled (drained); Squash, butternut, peeled or unpeeled, flesh, raw or baked; Cucumber, green, unpeeled, raw; Carrot, peeled, raw Carrot, peeled, stewed(withoutsalt); Stingingnettle, leaves, raw; Mushroom, raw, cannedinbrine(drained); Stingingnettle ,leaves, steamed, boiled, drained(withoutsalt)		
Mushroom, fresh or dried, raw, boiled (drained, without salt) or stewed	0	Non-ascorbate source vegetables

C. Categories of Food Groups according to their Composition of Calcium

Similarly, condiments and spices food group was an outlier as it contained very high composition of calcium (μ=512.07mg/100g of EP). The richest source of calcium was the milk and milk products which had on average 206.35mg/100g of EP and was classified as Ca Category A. The food groups that contained moderate composition of calcium include fish and seafood (112.43mg/100g of EP), oils and fat (107.39mg/100g of EP), vegetables and their products (105.51mg/100g of EP), legumes and pulses (70.45mg/100g of EP). This group was classified as Ca Category B. lastly, the class of food groups that had lowest composition of calcium included cereals and cereal products (54.02mg/100g of EP), beverage and drinks (42.22mg/100g of EP), fruits (32.15mg/100g of EP), meat, poultry and eggs (21.74mg/100g of EP) and starchy roots, tubers and bananas (21.17mg/100g of EP) as shown on Table 4.

Table 4: Categories of Food Groups according to their Composition of Calcium

CATEGORIES	**Food Groups**	**Average (μ) Amount of calcium (mg) in 100g of EP**	**LEVELS**
Ca Category A	Condiments and Spices	512.07	High
	Milk And Milk Products	206.35	
Ca Category B	Fish and Seafood	112.43	Moderate
	Oils and Fat	107.39	
	Vegetables and their Products	105.51	
	Legumes And Pulses	70.45	
Ca Category C	Cereals And Cereal Products	54.02	Low
	Beverage and Drinks	42.22	
	Fruits	32.15	
	Meat, Poultry, and Eggs	21.74	
	Starchy Roots, Tubers and Bananas	21.17	

*EP stands for edible portion

(Source: Adopted and modified from Kenya Food Composition Tables(6)**)**

IV. DISCUSSION

Three nutrients were considered for the categorization of food groups according to their concentration. These include calcium, iron and ascorbic acid. Ascorbic acid is an exogenous enhancer of iron absorption. The mechanism of this physiological reaction is accrued to the fact that vitamin C is able to convert ferric acid into the ferrous form of iron (8). Ferric acid is readily available for complexing with bioactive polyphenolic compounds e.g. tannic acids. However, the ferrous form of iron is unavailable for complexing with polyphenols and therefore available for absorption. Calcium competes for absorption with iron and it becomes an interesting factor whenever iron bioavailability is under consideration (9).

The study established that the richest sources of iron were meat, poultry and eggs and cereals and their products whereas the poorest sources were oil and fat, milk and their products, fish, and seafood and cereals and cereal products. Beef, chicken, and viscera have been classified as rich in heme-iron whereas (7, 8) legumes and their products have been reported as the richest source of non-heme iron (10). Although the current study found that the fish and seafood were poor sources of iron, it should be noted that most studies have demonstrated that some foods belonging to this group are among the richest sources of iron such as sardines (12).

The study established that vegetables and fruits had the highest average composition of ascorbic acid although fruits have a slightly lower content as compared with vegetables. The results are in line with finding of Chong et al. (13) who established that an intake of 2 serving of vegetables a day provides a high amount of vitamin C. Fruits and vegetables are significant determiners of our health as they provide vital minerals, vitamins, and phytochemicals which provide protective roles in our body through boosting immunity (13). One important way in which fruits and vegetables enhance the protective role of the immune system is the function of vitamin C (14).

Although condiments and spices had the highest composition of calcium and iron, the levels were way higher than the rest of the foods in the groups and thus it was excluded from the categorization. Milk and milk products were found to be the richest source of calcium. Five food groups were classified to be low in calcium composition, including cereals and cereal products, beverages and drinks, fruits, meat, poultry and eggs, starchy roots, tubers, and bananas. The finding of this study is congruent with the establishment of a study conducted in the U.S. investigating the calcium consumption (15). The aforementioned study found out that milk and milk products attributed half of the calcium intake.

The strengths of the study lie in its representativeness of samples as the data was extracted from the Kenya Food Composition Tables 2018. However, when applying the results it is important to note that they are based on means and the actual composition of various nutrients in foods can vary widely about the mean.

V. CONCLUSIONS

Food groups with high level of iron were meat and meat products and cereals and their products. Vegetables and fruits were richest in ascorbic acid and milk and milk products in calcium.

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