International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Nutrient Composition and Nutrient-Nutrient Interaction in the Prescribed Diet that Eliminates Heart Burn Symptoms

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Abstract: ***A well planned and selected diet can reduce or eliminate symptoms of heart burn and esophageal erosions. This study analysed nutrient content of a strict diet on relieving gastro esophageal symptoms caused by excessive production of gastric acid. The food tests were carried out to establish the amounts of nutrients (vitamins, mineral elements, proteins, fats and carbohydrates) which were available in the breakfast, lunch and supper. This study established that the nutrients in the diet were provided in adequate amounts. The nutrient-nutrient interaction was also recognised.***

Keywords: Homeostatic, heartburn, nutrient-nutrient interaction

1. Introduction

Heartburn is the backward flow or regurgitation of stomach contents passing up into the esophagus resulting in acid erosion of the esophagus [1]. Certain food stuffs contain nutrients that help eliminate or reduce heartburn. A balanced diet maintains healthy body systems and alleviates heartburn. Some of the symptoms associated with heartburn include hoarseness of voice, persistent need for clearing of the throat, excess throat mucus of postnatal drip, coughing after eating or lying down, breathing difficulties or chocking episodes, troublesome or annoying cough, sensation of something sticking in the throat, heart, chest pain, indigestion or stomach acids[2].

All these symptoms can be relieved by a diet containing antioxidants. Some of the antioxidants include fat soluble vitamins (ADEK) in addition to water soluble vitamin C[3]. Some antibacterial chemicals contained in onion, pistachio nuts, ginger, origano and thyme that are used when preparing meals destroy bacteria that are responsible for producing toxins associated with heartburn[4].

Onions have a chemical (quercetine) that relieves cough, asthma, and some associated chest pains. The onion mineral salts are converted to carbonates which are alkaline, and when absorbed in the circulation system have a buffering effect of maintaining an optimum blood pH.Onions are also known to reduce blood glucose level and they contain enzymatic substances such as polyphenol oxidase and diastase which are beneficial for the digestive system. Onions contain sulphur which is required for the synthesis of essential fatty acids. These fatty acids are known to break down heavy mucus thereby facilitating expectoration of bronchial secretions.Ginger is good for digestion for the quick movement of the food through the digestive system [5].

Okra is rich in soluble mucilage fibre which is good for a protective and emollient function within the digestive system [6]. Okra is a rich source of vitamin A, vitamin C, and vitamin B group except B12. Okra is rich in mineral salts such as calcium, magnesium, iron, potassium and sodium. Okra is good for relieving stomach ulcer, throat, and bronchitis. Okra has an alkalizing effect to the blood because of its mineral salts.

Spinach is rich in vitamins and minerals [7]. It contains lutein and zeaxanthin,antioxidants that protects the retina of the eye. Spinach is good for iron deficiency anaemia. Spinach protein reduces the absorption of cholesterol and bile acids.

Lettuce is a remedy for obesity because of its ability to satisfy appetite. It is rich in vitamins and minerals[8] and has a sedative and sleep inducing substance that are not toxic. Lettuce improves digestion when eaten before a meal and is very low in carbohydrate making it suitable for people who are overweight and diabetic.

Broccoli is a rich source of vitamins and minerals [9]. Broccoli also contains anticarcinogenic phytochemicals. It is suitable for people who are obese and diabetic, because it has low calories, and it produces a certain feeling of satiety.Brocoli contains antibiotics that destroys Helicobacter-Pylori.

Lemon when mixed in the mouth with starchy foods, such as chestnut, potatoes, or bananas is useful in weightreduction. The acid in lemon inhibits the action of ptyalin, an enzyme in saliva thatinitiates carbohydrate digestion in the mouth [10].Lemons contain phytochemicals which prevent cancer and other diseases the greatest achievement of advanced nutrition science. Lemon contains organic acids, such as citric acid, formic acid, ascorbic acid, which have antiseptic effects. Flavonoids in lemon serve as antioxidants potentiating vitamin C. The antioxidants neutralizes free

radicals, prevent cell damage, and also relieve heartburn and associated symptoms.

Various minerals in the body have diverse functions [11]. Phosphorus is required in the generation of bony tissue, the metabolism of glucose and lipids and regulation of acid based balance. Calcium's role in body homeostasis includes participation in the transmission of nerve impulses and muscle contractions. Sodium and potassium ions are of utmost importance. The presence of these ions around biological membranes leads to the formation of electric potentials which are essential for life function. Sodium and potassium ions utilise 30 to 70% of all ATP produced in the body [12].

In this paper the nutrient composition and nutrient-nutrient interaction for the prescribed heartburn diet is explored. Previous work by Wu *et al* [13] reported the use of strict diet in providing adequate mineral salts to maintain homeostatic mechanism especially acid base balanceto heartburn sufferers. In our previously work,a strict diet was administered to several patients and its positive effects were reported [14].

2. Method

2.1 Moisture Content

About 3.0 g food samples from the diet prescribed for breakfast, lunch and supper were separately weighed on an analytical balance and transferred into crucibles. The samples were dried for 12 h in an oven set at 50°C. The dried samples were ground, reweighed and redried until constant mass was attained. The samples were cooled and stored in a dessicator. The percentage moisture content was calculated using Equation 1.

$$Mosture\ content(\%) = \frac{Weight\ of\ dried\ sample \times 100}{Weight\ of\ original\ sample} \quad (1)$$

2.2 Crude Fibre Content

Crude fibre was determined following Weende method [15]. Solid food samples (3 g) were weighed into pyrex crucibles. The samples were then transferred to the boiling position in the hot extraction unit (Fibertec system 1). To each sample, 150 ml of 1.25% sulphuric acid preheated on a hot plate was added. This was followed by addition of 2-3 drops of n-octanol to prevent foaming, and the mixtures were gently boiled for 30 minutes. Any sediments formed were filtered by applying reverse pressure. The fibres were washed thrice with hot deionised water (50 mL each wash) using the spray device from the top of the boiling tubes. The water was sucked to leave fibre as dry as possible. To each sample 150 ml of 1.25% NaOH solution, preheated on a hot plate was added. This was followed by addition of 2-3 drops of n-octanol to prevent foaming, and the mixtures were gently boiled for 30 minutes. Any sediment formed were filtered by applying reverse pressure. Thefibres were washed thrice with hot deionised water (50 mL each wash) using the spray device from the top of the boiling tubes. The samples were transferred to the cold extraction unit, washed three times with acetone (about 25 ml each time) and vacuum dried. The samples in crucibles were removed, dried in oven at 130°C for 2 h. The crucibles were cooled in a desiccator and weighed. The weighed samples were ashed in a muffle furnace at 550°C for 3 hours. The ashed samples were cooled to room temperature and weighed. The percentage ash content was determined according to Equation 2.

$$Crude\ fibre\ (\%) = \frac{(Weight\ of\ ashed\ sample - weight\ of\ dried\ sample)\ 100}{Weight\ of\ original\ sample} \quad (2)$$

2.3 Crude Fat Content

Approximately 3.0 g samples were transferred into 25 mL round bottomed flasks containing 150 ml petroleum ether. The samples were extracted in a soxhlet extractor for approximately 4-6 h before removing the extracted fat using a rotary evaporator. Any excess solvent in sample flasks was removed in an oven (105°C) for 30 minutes. The samples were placed in desiccators, cooled and weighed. Crude fat weight was determined according to Equation 3.

$$Crude\ fat\ (\%) = \frac{Weight\ of extracted\ fat \times 100}{Original\ mass\ of\ sample} \quad (3)$$

2.4 Ash Content

Milled food samples (1 g) in crucibles were placed on a hot plate and heated until there was no smoking. The crucibles were placed in a in a Muffle furnace (550°C) for 3 hours. The crucibles were cooled to room temperature in a desiccator and the weight of ash determined (Equation 4).

$$Ash\ content\ (\%) = \frac{Weight\ of\ ashed\ sampled \times 100}{Weight\ of original\ sample} \quad (4)$$

2.5 Mineral Content

The mineral content in food samples were determined by atomic absorption spectrometer (Perkin-Elmer Model 214) following AOAC 999-10 international method of 2012 [16].

2.6 Vitamin Content

Vitamins were analysed using high perfomance liquid chromatography (Shimadzu LC-10AVP). The standards were prepared by weighing 15 mg of each vitamin powder and dissolvingin methanol making stock solutions of 1.0 mg/mL in volumetric flasks.

Fat soluble vitamins were extracted from 0.125g of grounded samples and placed in 10ml volumetric flasks containing 8ml of dichloroethanol. After 15 min of ultrasonication extraction dichloroethanolic acid was added (1:1) and the mixture stored in the dark.

Ground water soluble vitamin samples (0.125 g) were added to 8 mL of water in 100 mL volumetric flask. After 15 min of ultrasonication extraction a further 8 mL of water was added.
Water and fat soluble vitamins were then injected into HPLC. Prior to injection each solution was filtered through 0.2 µm filter. Samples (20 µL) were injected at 25°C and 1.0 mL/min flow rates. Vitamins A was analysed using

acetonitrile mobile phase. Other vitamins were analysed withphosphate buffer (3.4g potassium hydrogen phosphate in 1 L of water) at pH 3.2. The vitamins were detected on UV detection at 210, 245,265 and 280 nm wavelengths.

2.7 Protein and Carbohydrate Content

The quantities of proteins and carbohydratesin food samples were determined according a previously reported method [17].

3. Results

3.1 Moisture content

Table 1 shows some of the nutritional elements in the daily strict diet that were consumed by the participants.

Moisture content higher for breakfast compared to lunch and supper is attributed to the liquid nature of most foods taken during breakfast namely roibos tea and oats porridge prepared with milk. Lunch and supper consisted of mostly semi-solid foods.

Breakfast as the first meal of the day should contain foods that are easy to digest and the meal should be balanced, containing all the nutrients required by the body in adequate amounts. The body needs foods that are soft. Water dissolves nutrients for easy digestion and absorption by the body.

Crude fibre is important for the movement of food through the intestines as it increases bulk. Breakfast and supper provide adequate daily fibre of at least 4%. High fibre content (4.22%) for breakfast was attributed to whole wheat bread and oats porridge while fibre content for supper (4.43%) was due to a lot of vegetables and fruits consumed. The fibre provided for lunch is lower (2.84%) since the meal is taken as a light meal during working hours. Fibre is important for the diet of people who are overweight as it makes them feel that they are full but with fewer nutrients available to the body. Fibre prevents constipation and diseases such as hernia, varicose veins and diverticlosis[18]. Fibre also reduces heartburn as it is associated with obesity.

Total crude fat content for the day was approximately 29%. This amount was adequate for important body functions. Most of the fats taken by the body are natural since a minute amount of cooking oil was added during cooking. Food contains fats and oils which are essential for the body. Fruits and vegetables have invisible fats found inside cell structures. Metabolic fats such as cholesterol are important for the synthesis of steroid hormones. Fats and oils help with cellular development and the formation of healthy cell membranes. Essential fatty acids assist in the development and function of the brain and nervous system.

Lunch and supper contains high ash content (at least 6%) than breakfast (4.42%) since these two meals contain higher amounts of solid foods. Ash shows that there are other nutrients such as minerals, vitamins, proteins and carbohydrates in the diet. Vitamins and minerals are important for prevention of diseases. Proteins and carbohydrates are essential for body growth and for metabolic energy used by the body.

Table 1: Some elements of a daily strict diet

Meals	Content (%)t			
	Moisture	Crude fibre	Crude fat	Ash
Breakfast	80.95	4.22	10.51	4.42
Lunch	78.27	2.84	2.50	6.55
Supper	77.82	4.43	16.18	6.29

3.2 Vitamin Content

Figures 1 and 2 show daily vitamin intake from the strict diet. The daily amounts of vitamins provided by the diet were adequate as compared to the quantities stipulated by WHO [19]. The daily WHO vitamin specifications were lower than those provided by the strict diet. Vitamins supplied from the diet cannot be in excess since they are converted to other forms. One such example is the conversion of vitamin A to its retinol equivalence.

Vitamins are essential micro nutrients that are required by the body in small amounts for various functions therefore must be provided by the diet. Fat soluble vitamins ADEK are stored in the liver and the body tissues [20]. These vitamins are generally not affected by cooking or storage and are more heat and light stable.

Vitamin B forms several complexes. Pantothenic acid oxidized fats carbohydrates some amino acids, pantothenic forms part of a compound called acyl carrier protein. This protein attaches to fatty acids and shuttles them through the metabolic pathway to increase their chain length. Also a co enzyme A, donates fatty acids to proteins determines the location and function within the cell.

Pyridoxine another vitamin B complex is essential for protein, carbohydrate metabolism and the formation of red blood cells, also it maintains nervous and immune system. Pyridoxine plays an enzyme role in more than 100 enzymatic reactions.

Vitamin B6 is responsible for DNA synthesis, normal cell division and for interconversion of amino acids (homocysteine, methionine). All forms of folate are converted to basic co enzyme form tetrahydrofolic acids, formation of neurotransmitters in the brain. Folate also was responsible in the elimination of shortness of breath as a symptom of heartburn.

Folate is a co enzyme in the single-carbonyl in protein and carbohydrate metabolism. Folacin (vitamin B9) is responsible for production of red blood cells.

Cobalamine (vitamin B12) is also responsible for formation of red blood cells, prevention of megaloblastic anemia and function of nervous system. Cobalamine is responsible for formation of co enzyme in the intermediary metabolism. It is important for neurotransmitter such as dopamine, serotonin, norepinephrine (noradrenaline) tryphamine, histamine and taurine for the normal function of the brain [21].

Vitamin A, good for growth, health of the body, good vision, cornea maintenance, and resistance to infection. Maintain white and red blood cell membrane. Protect regeneration of cells and mucous membrane as well as maintenance of healthy respiratory and intestinal tract together with folate vitamin A eliminates some symptoms of heartburn. Vitamin A maintains epithelial tissues /cells. Essential for immune functions for blood cells as T-lymphocytes and killer cells which play a critical role in the defense against pathogens[21].Vitamin A has other metabolic uses such as maintenance of bone growth, for spermatogenesis, and for mucopolysaccharide synthesis. Vitamin A from the diet can not cause toxicity because it has to be converted to retinol for example β-carotene to retinol the ratio is12µ β-carotene=1µ retinol and conversion depends on food matrix, presents of dietary fat efficiency of absorption and health of the subject.

Vitamin E is essential for reproductive, muscular, circulation, nervous and immune system [22]. The fat soluble antioxidant that helps maintain cell membrane, red blood cell integrity, protects vitamin A and fatty acids from oxidation. It also prevents peroxidative damage of cell membranes, in the mitochondria. Circulation and respiratory chain helps eliminate some of the heartburn symptoms.

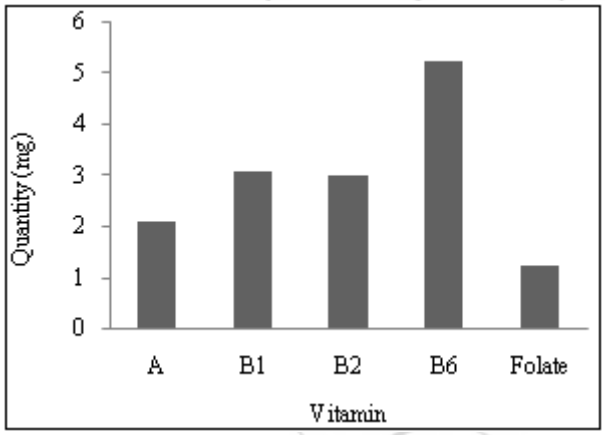

Figure 1: Daily vitamin intake

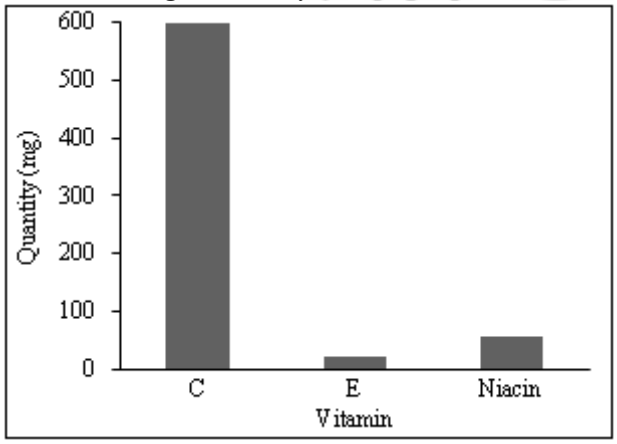

Figure 2: Daily vitamin intake

3.3 Mineral Content

The mineral content of meals taken for breakfast, lunch and supper are shown in Table 2. The mineral nutrient levels fall within the recommended daily intake.

Potassium, is a primary electrolyte in the body fluids, its main roles are fluid balance, nerve impulse transmission, influences the contractility of smooth, skeletal and cardiac muscles. It was supplied from the diet mainly from pawpaw, avocado, fish, brown rice, egg and chicken. Potassium is the major cation inside cells. Intra–cellular fluids contain 95% of potassium in the body [23].The outstanding importance of potassium for the maintenance of body is its ability to mobilise alkaline calcium salts from bone in order to neutralise acids consumed in the diet and generated by metabolism [24]. There are two major body fluid compartments namely extracellular and intracellular. The compartments are further divided into interstitial fluid and plasma components as is shown in Fig. 3[25].

The main sources of magnesium from the diet were spinach, avocado, oats, brown rice and spaghetti. Magnesium is vital for biochemical and physiological homeostasis processes. Magnesium is useful for enzymes that utilize ATP to form active ATP. It is important for nerve and heart function, as well as for insulin release from the pancreas and ultimate insulin action in the cells [26].

Fish, spinach, broccoli, oats, eggs milk and milk products were the main sources of calcium in the diet. Calcium is useful for blood clot, bone forming, and metabolism of proteins. Calcium works together with adequate Vitamin C and vitamin D to maintain homeostasis or body systems. Calcium is necessary for nerve transmission, muscle constriction, glandular secretion and the contraction and dilation of the blood vessels [27].

The major sources of phosphorous from the strict diet were eggs, fish, broccoli, brown rice, chicken, milk and milk products. Phosphorous is a component of membrane phosphorous lipids, nucleotides and nucleic acids, and a component of bones and teeth. It functions to buffer body fluids to maintain a normal pH, thereby eliminating some of the heart burn symptoms especially chest pain, indigestion and stomach acid that come up to the esophagus [28]. It stores and transfers energy derived from metabolic fuels for a short time.

The main sources of iron from the strict diet are eggs, spinach and brown rice. Iron plays an important role in the human body with the aid of vitamin C. The most important group of iron-binding proteins contains the heme units, which contain iron at their central metal ion. Redox reactions and electron transport processes that occur in humans make use of heme proteins[29]these reactions are needed for oxidative phosphorylation, the principal source of energy for human cells.

Table 2: Mineral content in the strict diet

Mineral	Quantity mg/100 g			
	Breakfast	Lunch	Supper	Total
Potassium	27.88	7.1	8.22	43.2
Sodium	40.45	44.71	52.34	137.5
Calcium	10.62	4.67	4.68	19.97
Iron	0.358	0.0739	0.142	0.5739
Magnesium	5.91	2.07	3.63	11.61
Phosphorus	1036.4	694	667	2397.4

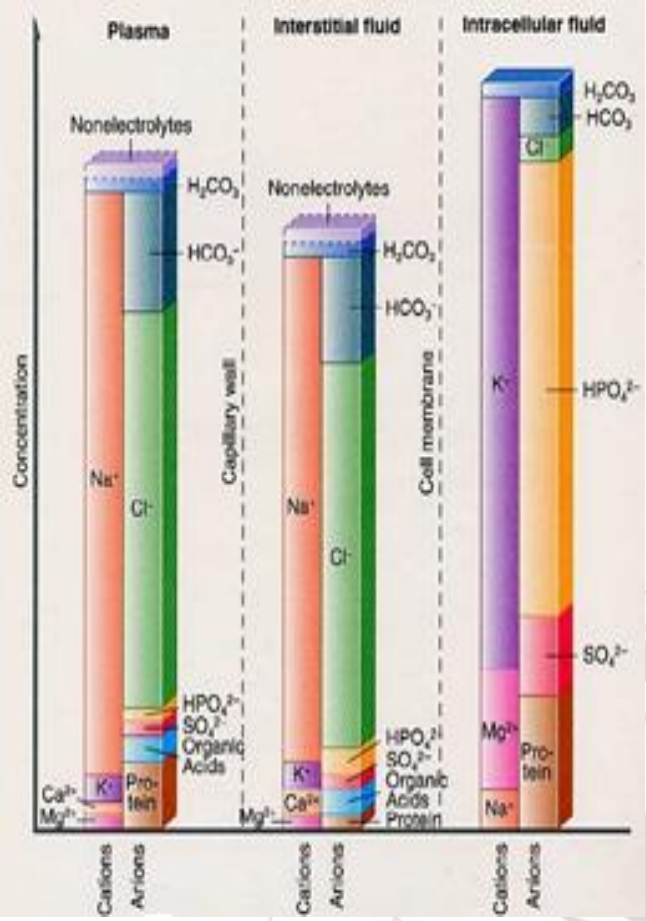

Figure 3: Electrolytic contents of body fluid compartments [25].

3.4 Proteins and carbohydrates content

The strict diet supplied 303.6 g per 100 g of carbohydrate and 142 g per 100 g of protein. These quantities were adequate for the normal daily body functions.

3.5 Nutrient-Nutrient Interaction

Table 3 gives a summary of nutrient-nutrient interaction from the diet supplied to heartburn sufferers. Table 3 also gives some functions of the nutrients upon interaction. Most of the nutrients influence the absorption of each other.

Table 3: Nutrient-nutrient interaction summary

Vitamin	Interaction
B complex	Pantothenic acid oxidizes fats, carbohydrates and some amino acids
	Pyridoxine is essential for red blood cells formation and maintenance of nervous immune system
	Folacin is essential for erythrocytes production
	Cobalamin is useful for formation of red blood cells, nervous system, coenzyme in the intermediary metabolism, neurotransmitters.
	Folate is converted to coenzyme tetrahydrofolic acid that is used in brain neurotransmitters formation Folate works together with magnesium to stimulate enzymes that catalyze the reactions between phosphate ions and adenosine triphosphate(ATP). Magnesium also assists in cardiac and skeletal muscle contraction and helps transport sodium and potassium across cell membranes.
Vitamin C	Influences iron and calcium absorption. Calcium influences potassium and phosphorus absorption.
	Heals wounds since it is an antioxidant that donates electrons to free radicals
	Present in high concentrations in white blood cells for protection against free radicals produced during immune function.
Vitamin D	Regulates serum calcium phosphorous levels
	Regulates parathyroid hormone, Aids function of Mg, Fe and phosphate
Vitamin E	Fat soluble that helps maintain cell membrane. Red blood cell integrity and protects. Vitamin A from peroxidative damage of cell membranes in the mitochondria.
	The circulatory and respiratory chain helps to eliminate some heartburn symptoms
Vitamin A	Interacts with folate, vitamin E and vitamin K

4. Conclusion

This study has demonstrated that the nutrients provided by the strict diet were in adequate proportions. The nutrients in the diet help to reduce or eliminate heartburn and associated symptoms through their interactions in the body metabolic processes. Some of the nutrients neutralized the stomach and blood acids that were produced during digestion and metabolism. The proteins, fats and carbohydrate content were in adequate amounts to ensure normal function of the body system.Heartburn sufferers are recommended to adopt the prescribed diet.

5. Acknowledgement

The authors would like to thank Botswana National Food Technology Research Centre for providing research facilities.

References

[1] Berardi, R.R. (2006).Self-directed options for preventing or treating heartburn. New York: Pharmacy review.
[2] Burgess, J. (2007). Stop the pain in 30 days naturally, no more heartburn. Kensington Publishers, 63, 95-96.
[3] Kalaycı, S., & Yılmaz-Karaelmas, Ö. (2011). Differences in fatty acid profiles, ADEK vitamins and sterols of the yolk between native chickens and geese. Science and Engineering Journal, 1(1), 17-22.
[4] Heidal, K., Lewis N., & Evans, S. (2004). Survey of omega-3 fatty acid intakes and omega-3 food selections in cardiac patients living in a section of the Midwestern United States, Nutrition Research, 24(9), 741-747.
[5] Femia, A.P., Caderni, G., Ianni, M.M., &Salvadori, M. (2003).Effect of diets fortified with tomatoes or onions with variable quercetin-glycoside content on azoxymethane-induced aberrant crypt foci in the colon of rats. European Journal of Nutrition, 42, 346-352.
[6] Savello, P.A., Martin, F.W., & Hill, J.M., (1980). Nutritional composition of okra seed meal, Journal of Agricultural and Food Chemistry, 28(6), 1163-1166
[7] Duodu, K.G., Minnaar, A., & Taylor, J.R.N. (1999). Effect of cooking and irradiation on the labile vitamins and antinutrient content of a traditional African sorghum porridge and spinach relish, Food Chemistry, 66(1), 21-27.
[8] Nicolle, C., Cardinault, N., Gueux, E., Jaffrelo, L., & Rock, E. (2004). Health effect of vegetable-based diet: lettuce consumption improves cholesterol metabolism and antioxidant status in the rat, Clinical Nutrition, 23(4), 605-614.
[9] Vasanthi, H.R., Mukherjee, S., & Das, D.K. (2009). Potential health benefits of broccoli- a chemico-biological overview, Mini Reviews in Medicinal Chemistry, 9(6), 749-759.
[10] Sun, J., Chu, Y.F., Wu, X., & Liu, R.H. (2002).Antioxidant and antiproliferative activities of common fruits, Journal of Agricultural and Food, 50(25), 7449-7454.
[11] Thompson J., Manore, M., & Vaughan L.A. (2013). The Science of Nutrition. (3rd Ed.). New York: Benjamin Cummings
[12] He, F.J., & MacGregor G.A. (2008). Beneficial effects of potassium on human health. Physiolo. Plant, 133(4), 725-735.
[13] Wu, W.X., Liu, J.X., Xu, G. Z., & Ye, J.A. (2008). Calcium homeostasis, acid–base balance, and health status in periparturient Holstein cows fed diets with low cation–anion difference, Livestock Science, 117(1), 7-14.
[14] Usai, T., Zvidzai, C., &Mushawarima, T. (2013). Designing of a dietary regimen and lifestyle guidelines for people who are prone to gastro esophageal reflux disease, IOSR Journal of Engineering, 3(7), 1-4.
[15] Henneberg, W., &Stomann, F. (1865). Beitragezurbegrundungeinerrationellefutterung der weiderkauer, 1, 2, Schwetscke u sohnbrrunswick.
[16] Official Methods of analysis of AOAC INTERNATIONAL (2012) 19th Ed. (2012). Biochemistry Research, Gaithersburg.
[17] Suzanne, S., (2009). Food analysis. (4th Ed.). New York: Amazon
[18] Winge, K., Rasmussen, D., &Werdelin, L. (2003). Constipation in neurological diseases, Journal of Neurolology, Neurosurgery and Psychiatry, 74(1), 13–19.
[19] Peter L., &Pellett, P. (1988). Commentary: The R.D.A. Controversy revisited. Ecology of Food and Nutrition, 21, 315-319.
[20] Insel, P., Ross, D., McMahon, K., & Bernstein, M. (2011). Nutrition. New York: Jones and Barlett Publishers.
[21] Wardlaw, G.M., Hampl, S.S., &DiSilvestro R.A. (2004). Perspectives in Nutrition. (6th Ed.). New York: McGraw Hill.
[22] Traber, M.G. (2007). Vitamin E regulatory mechanisms, Annual Review of Nutrition, 27, 347-362.
[23] Much, W.E., & Wilcox, C.S. (1982). Disorders of body fluids, sodium and potassium in chronic renal failure, The American Journal of Medicine, 72(3), 536-550.
[24] Kiwull-Schöne, H., Kalhoff, H., &Manz, F. (2005). Food mineral composition and acid–base balance in rabbits, European Journal of Nutrition, 44, 499-508.
[25] Matsumura, M., Nakashima, A., &Tofuku, Y. (2000). Electrolyte disorders following massive insulin overdose in a patient with type 2 diabetes. Inter. Med. 39(1), 55-57.
[26] Vormann, J. (2003). Magnesium: nutrition and metabolism, Molecular Aspects of Medicine, 24(1-3), 27-37.
[27] Nicholls, D.G. (2009). Mitochondrial calcium function and dysfunction in the central nervous system, BiochimicaBiophysicaActa (BBA)-Bioenergetics, 1787(11), 1416-1424.
[28] Hibino, H., Inanobe, A., &Furutani, K. (2010). Inwardly rectifying potassium channels: their structure, function, and physiological roles, Physiological Reviews, 90(1), 291-366.
[29] Holberg, L., Hallten, L., &Gramatkovski, E. (1997). Iron absorption from the whole diet in men: how effective is the regulation of iron absorption? American Journal of Clinical Nutrition,66(2), 347-356.