Annals of Agricultural Science (2016) 61(2), 229–235

HOSTED BY
ELSEVIER

Faculty of Agriculture, Ain Shams University

Annals of Agricultural Science

www.elsevier.com/locate/aoas

Sensory evaluation and nutritional value of balady flat bread supplemented with banana peels as a natural source of dietary fiber

Nareman S. Eshak

Home Economics Dep., Specific Education Faculty, Assiut University, Egypt

Received 26 March 2016; revised 3 July 2016; accepted 17 July 2016
Available online 23 September 2016

KEYWORDS

Physicochemical;
Banana peels;
Sensory evaluation;
Nutritional value;
Balady flat bread

Abstract The aim of this study was to evaluate the effect of two different concentrations of banana peels BP (5% and 10%) as a partial replacement for wheat flour on physicochemical and sensory properties of Egyptian balady flat bread. The peel powder (0.50 mm size) from banana was prepared from their dried peel. The bread was prepared by replacing 5% and 10% of wheat flour with a banana peel. The bread prepared was designated as B1 and B2 respectively. They were tested for moisture, ash, protein, fat, crude fiber as per the standard methods. The physicochemical and sensory parameters of these two test bread were compared with a control bread 100% wheat flour designated as B0. Results showed that BP flour was owing 11.20% crude fiber which is higher than the wheat flour 1.21%. Also, BP flour has high potassium, calcium, sodium, iron and manganese compared with wheat flour. The protein and fiber content of B2 and B1 bread were higher (12.52% and 11.79% protein and 2.18% and 1.97% fiber) as compared to the control bread (10.79 protein and 1.42% fiber). B1 and B2 had the highest K, Na, Ca, Fe, Mg and Zn content compared with control bread. The water holding capacity (WHC) and oil holding capacity (OHC) of bread with BP flour were higher as compared to the bread control. The bread prepared by replacing 5% and 10% of BP (B2) is found to be sensorially acceptable. Our results showed that the nutritionally and sensory accepted bread can be prepared by replacing at most 10% of flour.

Introduction

The amount of waste from fruit peels is expected to increase with the development and progression of industrial manufacturing processes that use bananas as either green or ripe. For example accurate banana peels possibly introduce new products for various industrial and household uses (Gunaseelan, 2004; Bori et al., 2007; Emaga et al., 2007).

Fruits and vegetable flour is rich in fiber, protein and minerals and has a high water holding capacity (WHC) and oil holding capacity (OHC). Thus, it can be used in a new low-calorie and cost products (Ferreira et al., 2013).

Banana is called *Musa* spp., (Leslie, 1976) and is among the leading fruit crops in the economic value in the world. It is ranked the fifth in the world trade (Guylène et al., 2008).

Peer review under responsibility of Faculty of Agriculture, Ain-Shams University.

http://dx.doi.org/10.1016/j.aoas.2016.07.002

There is a lack of information about the content of nutritional value waste fruit but there are many sources of waste fruit in Egypt (Hanan and Abdelrahman, 2013).

Banana peels have various health benefits to excellent nutritional status, and it treats the intestinal lesion, diarrhea, dysentery, ulcerative colitis, nephritis, gout, cardiac disease, hypertension, and diabetes. (Emaga et al., 2007, 2008; Wachirasiri et al., 2008; Imam and Akter, 2011).

Banana peels are rich in phenolic compounds as they are a good source of antioxidants, which protect against heart disease and cancer (Someya et al., 2002).

Banana peel wastes from industrial processes represent about 40% of fresh bananas (Anhwange et al., 2008). These wastes pose an environmental problem for their generation of large quantities of organic waste. Researchers have shown that noodles flour from banana peels lowers glycemic index and reduces the duration of digestion due to the high content of resistant starch (Li et al., 2006; Ramli et al., 2009).

There was a general trend recently toward increasing the nutritional value of bakery products like bakery products strengthening fiber, as the bakery products are consumed widely in the international food markets (Kotsianis et al., 2002).

Bread is a staple diet that is consumed daily, and its quality and sensory attributes are highly considered by consumers (Motrena et al., 2011).

Flat bread is as old as civilization. It is eaten with almost every meal in the Middle East. Flat bread is often served freshly baked and produced in both the bakeries and home. The consumption of flat bread is increasing all over the world: both from traditional production and commercial mechanical bread production of Middle East bread. Flat bread is simple bread made from a flattened dough of flour, salt, water, yeast and other optional components. Additional (optional) components may be used for processing aids which are essential, particularly in the bread-making process, to improve the quality and enrich the bread to get more nutritional value (Al-Dmoor, 2012).

The objective of this study was to evaluate the effect of two different concentrations of banana peels as a natural source of dietary fiber (5 and 10%) as a partial replacement for wheat flour on physicochemical and sensory properties of Egyptian balady flat bread

Materials and methods

Materials

Commercial wheat flour (72% extraction rate) and fresh compressed yeast, crystal white sugar, salt, corn oil and unripe banana were obtained from local markets, Assiut, Egypt.

Preparation of raw materials

Banana peels powder

The banana fruit was washed with the tap water and peels were separated from the pulp and cut into small pieces. Peels were dipped in 0.5% (w/v) citric acid solution for 20 min to avoid a browning reaction, then drained and dried at the room temperature for 6 days. Dried peels were ground into powder in the mixer, and sieved with a mesh of size 0.50 mm to obtain banana peel flour. All dried powders were stored in clean brown bottles at room temperature for further analysis.

Preparation of banana peels bread

Balady flat bread. Balady bread was prepared according to the method described by Hegazy et al. (2009). Flat bread contained two different concentrations of banana peels flour (5% and 10%) as a partial replacement for wheat flour (72% extraction rate). Formulas consisted of 90, 95, 100 g of flour, 2% compressed yeast dissolved in warm water (40 °C), 3.5 g corn oil, 2 g salt and 50–72 ml water as mentioned in Table 1. Flour and other ingredients were mixed and then the dough is left at room temperature for 40 min. to complete fermentation. The dough was cut into loaves, which were baked at 250 °C for 3 min in an electric oven. Then they were air cooled, and packed in polyethylene bags until use for the required analysis and measurements (the flat bread pictures at different blends are shown in Fig. 1).

Analysis

Chemical analysis

Moisture was determined according to the methods of AOAC (2000), protein was determined by Micro-Kjeldahl according to the methods of (AOAC, 2000), crude fiber was determined with an enzymatic–gravimetric procedure according to AOAC Method 991.43 (AOAC, 2000), fat was determined by Soxhlet Extractor according to AOAC (1995), and ash was determined according to the method of AOAC (1942). Total carbohydrate was calculated by difference. These analyzes were determined in Central Laboratory for Chemical Analysis, Faculty of Agriculture, Assiut University.

Determination of minerals

Potassium and sodium were determined by flame photometer according to Jackson (1973). The elements (calcium, iron, manganese, zinc, and phosphor) were determined using the ICP (Inductively Coupled Plasma Emission Spectrometer) (ICAP6200) according to Isaac and Johnson (1985). These analyzes were determined in Central Laboratory for Chemical Analysis, Faculty of Agriculture, Assiut University.

Water holding capacity (WHC) and oil holding capacity (OHC) of banana Peels Bread

1 g of the sample and 25 ml of distilled water were taken in tubes of 30 ml capacity and allowed standing at room temperature at ambient temperature for 15 min. The tubes were centrifuged for 20 min at 4000*g*, and then the supernatant was allowed to drain. The residue remains after draining of

Table 1 Formulas of flat bread with different concentrations of banana peels (g/100 g).

Samples	Formula 1(B0)	Formula 2(B1)	Formula 3(B3)
Wheat flour	100	95	90
Banana peels	---	5	10
Corn oil	3.5	3.5	3.5
Sugar	6	6	6
Salt	2	2	2
Water	50 ml	66 ml	72 ml
Yeast	3	3	3

Formula 1: Wheat flour 100% (B0) control, Formula 2: Banana peels 5% (B1), Formula 3: Banana peels 10% (B2).

Control (B0) B1 B2

Fig. 1 The Egyptian balady flat bread.

excess water were weighed and WHC and OHC of the sample were determined as g of water or oil/g sample (Alkarkhi et al, 2010).

Sensory evaluation of flat bread

Flat bread samples were sensorially evaluated after baking by 20 panelists who were graduate students, staff and non-staff members of the Department of Home Economics, Faculty of Specific Education, Assiut University. All samples were provided in plates having white color at ambient temperature. The panelists were asked to evaluate each sample of the flat bread for taste, chewing ability, texture, aroma, color, roundness, crumb, appearance and overall acceptability. The samples were rated on a 1–9-point hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely) according to Stone and Sidel (1992). Scores were collated and analyzed statistically.

Results and discussion

Due attention is paid to the recent use of waste from the food processing factories for the production dietary fiber powders due to the low cost and availability of these wastes. Residues and wastes from fruit and vegetables are the one of the products in the high content of dietary fiber (Sharoba et al., 2013).

Proximate chemical composition of wheat flour (72%)

Data in the Table 2 represent the proximate chemical composition of wheat flour (72%) and banana peels flour. The wheat flour contained 13.38 moisture, 8.68 protein, 3.21 crude fiber, 2.02 fats, 12.3 ash and 82.41 total carbohydrates. From these results, the wheat flour was suitable to make balady flat bread. The results are in agreement with results obtained by Ugwuona et al. (2012), Okorie and Onyeneke (2012), Sharoba et al. (2013) and Seleem and Omran (2014) who have reported the chemical composite of wheat flour.

The result of the proximate chemical composition of banana peels flour indicated that it contained 6.39% moisture, 8.74% protein, 11.20% crude fiber, 4.54% fats, 22.2% ash and 82.41% total carbohydrate. These results are comparable to the result reported by Anhwange et al. (2009) who reported that the banana peels are good sources of nutrients especially carbohydrates and fiber. This illustrates that the peels are useful in the treatment of constipation and improve general health to the high content of fiber. Also, the high level of carbohydrates leads to improve baked characteristics such as their textures and structures which are desirable for baked goods (Okorie and Onyeneke, 2012).

Table 2 Chemical composition of raw materials (% on DWT).*

Samples	Moisture %	Protein %	Crude fiber%	Fats %	Ash %	TC %**
Wheat flour (72%)	13.38	8.68	3.21	2.02	12.3	82.41
Banana peels	6.39	8.74	11.20	4.54	22.2	46.93

* dwt basis = dry weight basis.
** TC = Total carbohydrate was calculated by difference.

The result of mineral content of wheat flour and banana peels is tabulated in Table 3 that shows the concentration of phosphorus in wheat flour was the highest (784 mg/kg) followed by potassium, calcium, sodium, iron, manganese, and zinc (427, 238, 151, 38.03, 5.72 and 3.19 mg/kg) respectively.

In banana peels, the concentration of potassium was the highest (16303 mg/kg). The concentration of calcium, sodium, iron, manganese, zinc and phosphorus was 3321, 440, 1217, 54.73, 1.97 and 641 mg/kg respectively. The result agrees with Anhwange et al. (2009) who reported that banana fruit has a high concentration of potassium which maintains normal blood pressure and regulates body fluids. Also, Mount and Zandi-Nejad (2012), Malnic et al. (2013) and Linus and Wingo (2014) who concluded that potassium influences lots of physiological processes, including the propagation of action potentials in muscular, cardiac tissues, neuronal, systemic blood pressure control, gastrointestinal motility, insulin metabolism, and glucose and renal concentrating ability.

Calcium and phosphorus are important to form bones and teeth. Calcium in the body has other important uses such as muscle contraction and neurotransmitter release. Sodium flow in cardiac muscle begins an action potential, but during potassium flow, the cardiac myocyte experiences calcium flow, prolonging the action potential and creating a plateau phase of dynamic equilibrium. High calcium intake can lead to hypercalcemia, disordered kidney function, and decreased absorption of many minerals. Many sources suggest a relationship between high calcium intake and prostate cancer. Low calcium intake in the long term can cause poor blood clotting especially in a menopausal woman, and it can lead to osteoporosis. On the other hand a lifelong deficit can affect bone and tooth formation (Ross et al., 2011). Phosphorus is important for the primary biological as a component of nucleotides, which act as a store of energy in the cells (ATP) and form nucleic acids such

Table 3 Minerals of wheat flour and banana peels (mg/kg).

Samples	Potassium, mg/kg	Calcium, mg/kg	Sodium, mg/kg	Iron, mg/kg	Manganese, mg/kg	Zinc, mg/kg	Phosphorus, mg/kg
Wheat flour (72%)	427	238	151	38.03	5.72	3.19	784
Banana peels	16303	3321	440	1217	54.73	1.97	641

Table 4 Proximate chemical composition of Egyptian blady bread with and without banana peels (% on DWT).*

Samples	Moisture %	Protein %	Crude fiber%	Fats %	Ash %	TC %**
Banana peels 0% (B0)	0.65	10.79	1.42	2.06	10.8	74.93
Banana peels 5% (B1)	1.61	11.79	1.97	2.24	33.5	50.5
Banana peels 10% (B2)	2.59	12.52	2.18	2.96	38.0	44.34

* DWT basis = dry weight basis.
** TC = Total carbohydrate was calculated by difference.

as DNA and RNA (Enger et al., 2007). Also its function is as a temporary storage agent to maintain the balance of acid-base in the human body (Voet and Voet, 2003).

Although much lower values had been reported for the fruit, iron concentration was high. Iron carries oxygen to the cells is important in energy production and synthesis of collagen, and improving the functioning of the immune system (Feming, 1998).

The concentration of manganese in banana peels was high (54.73 mg/kg) which helps in the formation of cartilage and skeletal. Manganese deficiency is a rare occurrence but could affect cartilage and skeletal formation, glucose tolerance, and normal reproductive (Smith et al., 1996). The human body stored about 12 mg of manganese mainly in the bones, and the rest in soft tissue is mostly concentrated in the kidneys and the liver (DRIs, 2009). The manganese in the human brain is related to manganese metalloproteins, foremost glutamine synthetase in astrocytes (Emsley, 2001). The essential minimum intake is unknown since manganese deficiency is so rare (Takeda, 2003).

The results of the chemical composition of Egyptian balady flat bread made from wheat flour and banana peels flour (BPF) formulas are shown in the Table 4. There was an increase in moisture, protein, fiber, fat and ash contents of Egyptian balady flat bread made from (BPF). The addition of banana peel powder leads to the increase in moisture content of bread. The moisture content of B1 and B2 bread was 1.61% and 2.59% which was increased from 0.65% in B0 control bread. The same results are obtained by Ndife et al. (2011) and Suresh et al., 2014 in soy flour composite bread. This due to the addition of banana fiber to bread leads to the increase in water absorption of bread as banana fiber was considered as a good water binder, so there is an increase in moisture content of bread (Chen et al., 1988). The results are the same as there is an increase in water absorption as a concentration of banana powder increased in bread as shown in the Table 4.

In addition, BPF affected the protein content of bread. The protein content of B2 and B1 bread was higher (12.52% and 11.79%) as compared to the control bread (10.79). The same result was obtained by Ndife et al. (2011) in soy flour bread and Suresh et al. (2014) in banana peels flour bread. Protein is necessary for reducing protein-energy malnutrition and physiological functioning (WHO, 2004).

The fiber content of B2 and B1 bread (2.18% and 1.97%) was increased as compared to the control bread (1.42%). The same result was obtained by Ndife et al. (2011) and Suresh et al. (2014). The fiber content of bread increased with the increase in banana flour. The increase in fiber content leads to an increase in water requirement for the bread preparation (Table 1). The fiber, in general, may cause firmer crumb structure by a thickening effect on the area that surrounds the air bubbles in fiber added dough (Schleibinger et al., 2013). Crude fiber is anti-diabetic (WHO, 2004).

The addition of banana peel powder is increasing fat content of bread in few amount. The structure of bread is improved by increasing fat content of bread. The fat content of B1 and B2 bread was 2.24% and 2.96% which was higher than the control bread (2.06%). The result was obtained by Ndife et al. (2011) who reported that fat content of bread supplemented with soy flour increased. Vegetable fat is a good source of energy and helps in absorption of minerals mostly fat soluble and vitamins (WHO, 2004).

The ash content of banana peel bread increases from 10.8% in B0 to 33.5% in B1 and 38.0% in B2 as the increase in the level of banana peel flour. The same result was obtained by Ndife et al. (2011) and Suresh et al. (2014). The high ash content was similar to good sources of minerals (Anhwange et al., 2009).

Carbohydrate content (74.93%) of the control bread decreased to 50.5% and 44.34% in B1 and B2. This result is close to Suresh et al. (2014) in cake samples. Bread containing few carbohydrates is important to decrease the risk of diabetes resulting from the high glycemic index (WHO, 2004). A daily diet containing small amounts of carbohydrates leads to a reduction level of ketone bodies in the blood (Johnston et al., 2006).

Table 5 lists mineral contents [potassium (k), calcium (Ca), sodium (Na), iron (Fe), manganese (Mg) and zinc (Zn)] of Egyptian balady flat bread with BP at different concentrations. Results indicate that B1 and B2 had the highest K, Ca, Fe, Mn and Zn content compared with control bread and the increase was gradual with increase in the addition of BPF. This is in agreement with Seleem and Omran (2014) in bread supplemented with sorghum. Minerals are essential for many biological processes in the body, such as action of the nervous system, structural systems, other cellular processes and water balance (Ameh et al., 2013). The lack of intake of minerals has been correlated with mental impairment, increased disease

Table 5 Minerals of Egyptian balady bread with different concentrations of banana peels (mg/kg).

Banana peels level%	Potassium, mg/kg	Calcium, mg/kg	Sodium, mg/kg	Iron, mg/kg	Manganese, mg/kg	Zinc, mg/kg	Phosphorus, mg/kg
Banana peels 0%	873	229	5142	37.71	6.16	0.15	1232
Banana peels 5%	5353	915	5659	96	11.19	3.20	1086
Banana peels 10%	8194	663	6066	221	15.18	5.20	1180

Table 6 Water holding and oil holding capacity of Egyptian balady bread with different concentrations of banana peels (ml/g).

Samples		Water holding capacity (ml water/g)	Oil holding capacity (ml oil/g)
Control	0%	7.9	5.5
Banana peels	5%	9.7	6.9
Banana peels	10%	10.2	8.5

conditions, and severe malnutrition (Shubhangini, 2002; Abulude, 2005).

Table 6 lists the water holding capacity (WHC) and oil holding capacity (OHC) of Egyptian balady bread with different concentrations of banana peels which were increased than the control bread because of increase in fiber content. According to that result, the water increases from 50 ml to 72 ml as the concentration of banana peel flour increased in bread. The bread shows highest water absorption at the B2 concentration as shown in Table 1. The WHC of B0 was 7.9 ml/g, followed by 9.7 and 10.2 ml/g in B1 and B2 respectively while the OHC was 5.5, 6.9 and 8.5 ml/g respectively in B0, B1, and B2. This result is close to Suresh et al. (2014) who reported that in the WHC and OHC of wheat flour and banana peels. This may be due to the high WHC values were associated with the dietary fiber fraction contained in the peels which have been shown to be also closely related to oil holding capacity (OHC). Similarly, the correlation between OHC and the protein was very high (Tables 4 and 6). This implied that the OHC of the fiber source samples might also depend on the total content of protein present (Sharoba et al., 2013). Ferreira et al. (2013) reported that both WHC and OHC correlate with food quality because they are important functional properties. The WHC was high in fruit wastes flour.

Table 7 lists the sensory evaluation scores for the Egyptian balady bread supplemented with different levels of BPF. B2 showed the best in taste as compared to the bread control and B1. The highest score was obtained by B0 for taste (7.13). From the scores of the sensory evaluation table of chewing ability, B2 and B1 have the highest. The texture of the bread refers to the smoothness, feel of the bread. The results indicate that B0 is ranked as the best from in comparison with other samples in terms of texture by the panelists. The Aroma of bread was affected if the level of flour is increased. The B0 bread shows the highest score for the aroma. The color scores for B0 were much good as compared to other bread samples. The scores of roundness showed that B0, B1 and B2 are nearly equal. The increase in fiber content of bread leads to deterioration of gluten structure, so the disturbed gluten structure shows its effect on crumb structure of bread (Schleibinger et al., 2013). The appearance of B0 has a little higher mean than the other samples. The overall acceptability scores revealed slight differences between the three samples. This result is in line with that obtained by Seleem and Omran (2014).

Table 7 Sensory evaluation of Egyptian balady bread with different concentrations of banana peels.

Sensory evaluation	Bread control 0%	Banana peels 5%	Banana peels 10%
Taste	7.13	7.5	7.8
Chewing ability	7.07	8	8.01
Texture	8.2	7.6	7.4
Aroma	8.8	7.5	7.01
Color	8.7	8.1	7.00
Roundness	8.8	8.7	8.8
Crumb	8.7	7.8	7.4
Appearance	8.9	8.2	8.3
Overall acceptability	8.6	8.3	8.2

N = 20; 1–9 point scoring scale (1 = dislike extremely, 9 = like extremely).

Conclusion

The results of the present work showed that bread containing 5% and 10% banana peels flours was comparable in quality and acceptability to those made with 100% wheat flour. Bread 10% BP was likely moderate for taste, texture, aroma, color and crumb. Also, bread 10% BP had higher protein, carbohydrate and fat content than that made of 100% wheat flour. The B2 accepted by the panelists well in terms of chewing ability, roundness, appearance and overall acceptability. From data obtained from this work, recipes containing banana peels produce more acceptable bread of high quality of fiber.

Recommendations

1. Using banana peels in most bread industry to save the wheat as economical value.
2. Using banana peels in bakery products not only in bread industry.

References

Abulude, F.O., 2005. Distribution of selected minerals in some Nigerian white bread. Niger. Food J. 23, 139–147.

Al-Dmoor, H.M., 2012. Flat bread: ingredients and fortification. Qual. Assur. Safe. Crops Foods 4, 2–8.

Alkarkhi, Abbas F.M., bin Ramli, Saifullah, Yeoh Shin, Yong, Easa, Azhar Mat, 2010. Physicochemical properties of banana peel as influenced by variety and stage of ripeness: multivariate statistical analysis. As. J. Food Ag-Ind. 3 (3), 349–362.

Ameh, M.O., Gernah, D.I., Igbabul, B.D., 2013. Physico-chemical and sensory evaluation of wheat bread supplemented with stabilized undefatted rice bran. Food Nutr. Sci. 4, 43–48.

Anhwange, B.A., Ugye, T.J., Nyiaatagher, T.D., 2008. Chemical composition of *Musa sapientum* (banana) peels. Elect. J. Environ. Agri. Food Chem. 8 (6), 437–442.

Anhwange, B.A., Ugye, T.J., Nyiaatagher, T.D., 2009. Chemical composition of Musa sapientum (banana) peels. EJEAFChe 8 (6), 437–442.

AOAC, 1942. Official Methods of Analysis 942.05. Ash of Animal Feed; First Action. Final Action.

AOAC, 1995. Official Methods of Analysis. 16th ed., Association of Official Analytical Chemists. Washington, DC., USA.

AOAC, 2000. Official Methods of Analysis. 17th ed. Association of Official Analytical Chemists, AOAC International, Arlington, VA.

Bori, M.O., Adebusoye, S.A., Lawal, A.K., Awotiwon, A., 2007. Production of biogas from banana and plantain peels. Adv. Environ. Biol. 1, 33–38.

Chen, H., Rubenthaler, G.L., Leung, H.K., Baranowski, J.D., 1988. Chemical, physical, and baking properties of apple fiber compared with wheat and oat bran. Cereal Chem. 65, 244–247.

Cobley, Leslie S., 1976. An Introduction to the Botany of Tropical Crops. second ed. Longman Group Limited, London, pp. 153–155.

Dietary Reference Intakes (DRIs), 2009. Recommended Intakes for Individuals (PDF). Food and Nutrition Board, Institute of Medicine, National Academies. retrieved 2009-06-09.

Emaga, T.H., Andrianaivo, R.H., Wathelet, B., Tchango, J.T., Paquot, M., 2007. Effect of the stage of maturation and varieties on the chemical composition of banana and plantain peels. Food Chem. 103, 590–600.

Emaga, T.H., Robert, C.S.N., Ronkart, B., Wathelet, B., Paquot, M., 2008. Dietary fibre components and pectin chemical features of peels during ripening in banana and plantain varieties. Bioresour. Technol. 99, 4346–4354.

Emsley, John., 2001. Manganese; Nature's Building Blocks: An A-Z Guide to the Elements. Oxford University Press, Oxford, UK, pp. 249–253.

Enger, Elton, D., Smith, Bradley, 2007. Environmental Science: A Study of Interrelationships. Mc Graw Hill.

Feming, D.J., 1998. Dietary determination of iron stones in a free – living elderly population. The Framingham Heart Study. Am. J. Clin. Nutr. 67, 722–7313.

Ferreira, Mariana S.L., Santos, Mônica C.P., Moro, Thaísa M.A., Basto, Gabriela J., Andrade, Roberta M.S., Goncalves, Edira C.B. A., 2013. Formulation and characterization of functional foods based on fruit and vegetable residue flour. J. Food Sci. Tech. 13197-013-1061-4.

Gunaseelan, N., 2004. Biochemical methane potential of fruits and vegetable solid waste feedstocks. Biomass Bioenergy 26, 389–399.

Guylène, A., Berthe, P., Louis, F., 2008. Bananas, Raw materials for making processed food products. Trends Food Sci. Technol. 20 (2), 1–3.

Hanan, M.A. Al-Sayed, Abdelrahman, R. Ahmed, 2013. Utilization of watermelon rinds and sharlyn melon peels as a natural source of dietary fiber and antioxidants in cake. Ann. Agr. Sci. 58 (1), 83–95.

Hegazy, A.L., Ammer, M.S., Ibrahium, M.I., 2009. Production of Egyptian gluten-free bread. World J. Dairy Food Sci. 4 (2), 123–128.

Imam, Mohammad Z., Akter, S., 2011. *Musa Paradisiaca* L. and *Musa Sapientum* L.: A phytochemical and pharmacological review. J. Appl. Pharm. Sci. 1 (5), 14–20.

Isaac, R.A., Johnson, W.A., 1985. Elemental analysis of plant tissue by plasma emission spectroscopy: collaborative study. J. Assoc. Off. Anal. Chem. 68 (3), 499.

Jackson, M.L., 1973. Soil Chemical Analysis. Prentic-Hall Inc., Engle Wood Cliffs, NJ, USA.

Johnston, Carol S., Tjonn, Sherrie L., Swan, Pamela D., White, Andrea, Hutchins, Heather, Sears, Barry, 2006. Ketogenic low-carbohydrate diets have no metabolic advantage over nonketogenic low-carbohydrate diets. Am. J. Clin. Nutr. 83, 1055–1061.

Kotsianis, I.S., Giannou, V., Tzia, C., 2002. Production and packaging of bakery products using MAP technology. Trends Food Sci. Technol. 13, 319–324.

Li, Yunfeng, Changjiang, Guo, Jijun, Yang, Wei, Jingyu, Xu, Jing, Cheng, Shuang, 2006. Evaluations of antioxidant properties of pomogranate peel extract in comparison with pomogranate pulp extract. Food Chem. 96, 254–260.

Linus, S., Wingo, C.S., 2014. Disorders of potassium metabolism. In: Freehally, J., Johnson, R.J., Floege, J. (Eds.), Comprehensive Clinical Nephrology. fifth ed. St. Louis: Saunders, p. 118.

Malnic, G., Giebisch, G., Muto, S., Wang, W., Bailey, M.A., Satlin, L. M., 2013. Regulation of K+ excretion. In: Alpern, R.J., Caplan, M.J., Moe, O.W. (Eds.), Seldin and Giebisch's the kidney: physiology and pathophysiology. fifth ed. Academic Press, London. PP. 1659–1716.

Motrena, S.G., Carvalho, M.J., Canada, J., Alvarenga, N.B., Lidon, F.C., Elisa, B.P., 2011. Characterization of gluten-free bread prepared from maize, rice and tapioca flours using the hydrocolloid seaweed agar-agar. Recent Res. Sci. Technol. 3, 64–68.

Mount, D.B., Zandi-Nejad, K., 2012. Disorders of Potassium Balance. In: Taal, M.W., Chertow, G.M., Marsden, P.A., Skorecki, K.L., Yu, A.S.L., Brenner, B.M. (Eds.), The Kidney. ninth ed. Elsevier, Philadelphia. PP. 640–688.

Ndife, Joel., Abdulraheem, L.O., Zakari, U.M., 2011. Evaluation of the nutritional and sensory quality of functional reads produced from whole wheat and soy bean flour blends. Afr. J. Food Sci. 5 (8), 466–472.

Okorie, S.U., Onyeneke, E.N., 2012. Production and quality evaluation of baked from blend of sweet potatoes and wheat flour. Nat. Appl. Sci. 3 (2), 171–177.

Ramli, Saifullah, Alkarkhi, Abbas F.M., Sing Yong, Yeoh, Easa, Azhar Mat, 2009. Utilization of banana peel as a functional ingredient in yellow noodles. J. Food Ag.-Ind. 2 (3), 321–329.

Ross, A.Catharine, Taylor, Christine L., Yaktine, Ann L., Del Valle, Heather B. (Eds.), 2011. Committee to review dietary reference intakes for Vitamin D and calcium. Institute of Medicine, Dietary Reference Intakes for Calcium and Vitamin D. ISBN 978-0-309-16394-1.

Schleibinger, M., Meyer, A.L., Afsar, N., Gyorgy Nagy, A., Dicker, V., Schmitt, J.J., 2013. Impact of dietary fibers on moisture & crumb firmness of brown bread. Adv. J. Food Sci. Tech.

Seleem, Hinar A., Omran, Azza A., 2014. Evaluation quality of one layer flat bread supplemented with beans and sorghumBaked on hot metal surface. Food Nutr. Sci. 5, 2246–2256.

Sharoba, A.M., Farrag, M.A., Abd El-Salam, A.M., 2013. Utilization of some fruits and vegetables waste as a source of dietary fiber and its effect on the cake making and its quality attributes. J. Agroaliment. Process. Technol. 19 (4), 429–444.

Shubhangini, A.J., 2002. Nutrition and Dietetics. Tata McGraw-Hill Publishing Co., Ltd., New Delhi.

Smith, G.C., Clegg, M.S., Keen, C.L., Grivetti, L.E., 1996. Mineral values of selected plant foods common to Southern Burkina Faso and Niamey, Niger, West Africa. Int. J. Food Sci. Nut. (UK) 47 (1), 41–53.

Someya, S., Yoshiki, Y., Okubo, K., 2002. Antioxidant compounds from banana (*Musa cavendish*). Food Chem. 79, 351–354.

Stone, H., Sidel, J.L., 1992. Sensory Evaluation Practices. Academic, San Diego.

Suresh, Bandal, Mohammed, Talib, Vishal, Parate, 2014. Utilization of banana and pomogranate peel flour in fortification of bread. Int. J. Eng. Res. Technol. (IJERT) 3 (7), 1100–1105.

Takeda, A., 2003. Manganese action in brain function. Brain Res. Rev. 41 (1), 79–87.

Ugwuona, F.U., Ogara, J.I., Awogbenja, M.D., 2012. Chemical and sensory quality of cakes formulated with wheat, soybean and cassava flours. Ind. J. Life Sci. 1 (2), 1–6.

Voet, D., Voet, J.G., 2003. Biochemistry, 607–608.

Wachirasiri, P.S., Julakarangka, S., Wanlapa, S., 2008. The effects of banana peel preparation on the properties of banana peel dietary fibre concentrate. J. Sci. Technol. 31 (6), 605–611.

WHO, 2004. Complementary feeding of young children in developing countries. <www.int/child-adolesencehealth/NUTR on/complementaryhtm2>, 24p, Retrieved 14th May.