Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(6): 1878-1882
Received: 15-09-2018
Accepted: 17-10-2018

Rose Angel
Department of Food Nutrition and Public Health, Ethelind College of Home Science, Sam Higginbottom University of Agriculture Technology and Science, Allahabad, Uttar Pradesh, India

Gupta Alka
Department of Food Nutrition and Public Health, Ethelind College of Home Science, Sam Higginbottom University of Agriculture Technology and Science, Allahabad, Uttar Pradesh, India

Correspondence
Rose Angel
Department of Food Nutrition and Public Health, Ethelind College of Home Science, Sam Higginbottom University of Agriculture Technology and Science, Allahabad, Uttar Pradesh, India

Comparative analysis and optimization by utilizing different maize varieties (*Zea mays* L.)

Rose Angel and Gupta Alka

Abstract
Maize (*Zea mays* L.) is a staple cereal food for millions of people in the world for their major nutrients demand as per their daily requirement. Improved varieties of maize can provide sufficient amount of protein, fibers, phenolic content, carbohydrate and minerals as well as calorific value to combat nutritional deficiencies. Processed maize can be utilized for value-addition in various food products like flour, gruels, noodles, porridges, tortilla, and muesli etc. in various food products. Therefore this study with the objective to determine the proximate composition, antioxidant activity and anti-nutritional content and assessing the organoleptic attributes of prepared food products in maize *var.* MS-2 and *var.* MS-3 was carried out in research laboratory of Food Nutrition Research, SHUATS. Compositional analysis for Moisture, Ash, Protein, Fat, Crude fibre, Carbohydrate and Energy and Minerals were done by using the standard procedure of AOAC, 2012. Experimental data obtained during investigation were statistically analyzed by analysis of variance (ANOVA), critical difference (CD) and t-test techniques. It was concluded that maize *var.* MS-3 with the nutritional value as *per* 100g was found to be as: 6.9g (Protein), 3.2g (Fat), 4.3g (Crude Fiber), 11% (Moisture), 11mg (Calcium), 6.5mg (Iron), 328mg (Phosphorus), 120mg (TPC) and 348kcal (Energy) was significantly higher as compared to *var.* MS-2 with nutrients i.e. 7.5g (Protein), 3.9g (Fat), 4.5g (Crude fiber), 10% (Moisture), 12.2mg (Calcium), 7.3mg (Iron), 335mg (Phosphorus), 110.9mg (TPC) and 350kcal (Energy). The organoleptic attributes of value added products by addition of 70% white-maize flour *var.* MS-3 with 30% of refined flour/gram-flour enhanced the palatability and flavor of value-added products namely *Muffins* and *Sev* and were acceptable to the consumer. Cost of the prepared food products was also cost effective.

Keywords: Nutra-cereal, *Zea mays* L., inbred seeded, SHIATS Makka, sensory scores, TPC

Introduction

In India, maize cultivator states are Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh, Punjab, Haryana, Maharashtra, Andhra Pradesh, Himachal Pradesh, West Bengal, Karnataka, and Jammu and Kashmir, jointly accounting for over 95% of the national maize production (Milind *et al.*, 2013) [1] This cereal provides about 50 percent of the proteins and calories in the diet of developing countries. Maize kernel contains 69.6-74.5percent carbohydrates, 7.7-13.6 percent proteins, 3.2-7.7 percent fat (in dry weight basis) and some vitamin B complex and unsaturated fatty acids (oleic, linoleic). The maize proteins are deficient in the essential amino acids lysine and tryptophan. Phytochemicals such as phenolic compounds, amongst others have also been reported on several maize genotypes. (Lopez-Martinez *et al.*, 2009) [2] Grain quality as major growing concern through breeding programs and fortification aimed for increasing acceptance of genetically improved seeds by farmers as well as by consumers and food processors. The grain quality characteristics include yield, technological properties and, when possible, nutritional elements as well. Technological properties include stability during storage, efficiency of conversion into products under given processing conditions and acceptability to the consumer. (FAO) The white-maize *var.* MS-2 and *var.* MS-3 are a composite variety. These varieties have a yield potential of 35-40 quintals per hectare and matures in 85-90 days. It also has good quality traits like 8.4 per cent protein, 4.6 per cent oil and 81 per cent starch content, which is a highly prized input for many industrial products. Due to its white coloured flour it can be mixed with wheat flour to make different food products thus helping in fortification of food products.

Currently, there is growing concern to address micronutrient malnutrition through different interventions. Typically, these interventions are categorized into four major groups: pharmaceutical supplementation, industrial fortification, dietary diversification, and bio-fortification. (Tontisirin *et al.*, 2007; Meenakshi *et al.*, 2007) [5] Maize has various health benefits. The B-complex vitamins in maize are good for skin, hair, heart, brain, and proper digestion. The presence of vitamins A, C, and K together with beta-carotene and selenium helps to improve the functioning of thyroid gland and immune system.

Potassium is a major nutrient present in maize which has diuretic properties. Maize silk has many benefits associated with it. In many countries of the world such as India, China, Spain, France and Greece it is used to treat kidney stones, urinary tract infections, jaundice, and fluid retention. It also has a potential to improve blood pressure, support liver functioning, and produce bile. It acts as a good emollient for wounds, swelling, and ulcers. Decoction of silk, roots, and leaves are used for bladder problems, nausea, and vomiting, while decoction of cob is used for stomach complaints. (Kumar *et al.*, 2013) [6] The global challenge of micronutrient malnutrition can be addressed by sustainable food based approaches by integrating the framework of agriculture production as well as making available nutritionally optimal diets to population. The nutritional quality of traditional diets can be improved by value addition. It has been found that customer acceptance of traditional products is always better due to familiarity. Hence, exploring the possibility of value addition to traditional products is a better option to enhance the intake of micronutrients. (Faiza *et al.*, 2015) [7] Bio-fortification strategies based on crop breeding, targeted genetic manipulation, and/or the application of mineral fertilizers hold great potential for addressing mineral malnutrition in humans. The two major reasons are that cereal grains are generally low in essential amino acids, particularly lysine; in addition, the refine grains and processed food-products most commonly consumed (e.g., polished rice, maize flour) are very low in micro nutrients. Food-based approaches are regarded as the long-term strategy for improving nutrition, which would need mega efforts and proper planning but for certain micronutrients, supplementation, be it to the general population, to high-risk groups or as an adjunct to treatment must also be considered.

Materials and Methods

Materials

Samples of maize namely *var*. MS-2(SHIATS Makka-2) and *var*. MS-3 (SHIATS Makka-3) were procured from the Directorate of Research, SHUATS, Allahabad District, and U.P. Reagents and solvents used in the study were of analytical and laboratory grade respectively and were facilitated by Nutrition Research Laboratory, Department of Food Nutrition and Public Health (SHUATS).

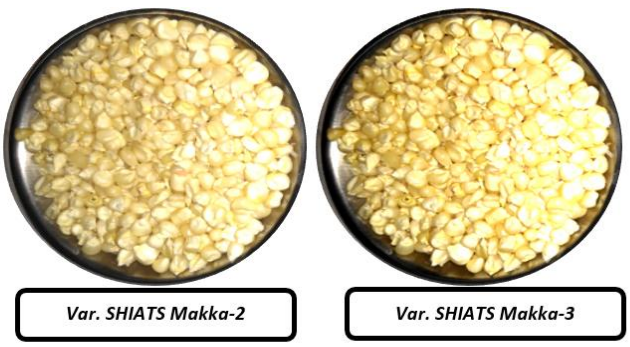

Fig 1: Varieties of white maize grain

Processing of maize flour

The maize grains (*var*. MS-2 and *var*. MS-3) were cleaned and washed thoroughly to remove adhering particles of foreign materials. The washed grains were dried at 60 °C for 8-10 hours in hot-air oven. The dried maize grains were processed under milling, sieved and stored in air-proof container at ambient temperature. (Houssou and Ayenor, 2002) [8].

Sources: Houssou and Ayenor (2002) [8]

Fig 2: Flow diagrams for the preparation of maize-flour

Standardization of food products

Table 1: Details of control and treatments for value-added product namely *Muffins* and *Sev.*

Products	Ingredients	T_0 (%)	T_1 (%)	T_2 (%)	T_3 (%)
Muffins	Refined flour	100	40	30	20
	Maize flour	-	60	70	80
Sev	Gram flour	100	40	30	20
	Maize flour	-	60	70	80

Two products namely *Muffins* and *Sev* were developed with the addition of maize flour in different ratio except basic recipe. For each product, the basic recipes (control T_0) have three distinctive variations as T_1, T_2, T_3 respectively where the amounts of addition were varied. In prepared food products T_1 (60:40), T_2 (70:30), T_3 (80:20) were selected for detailed study of treatments as illustrated in table 1. Each treatment was replicated three times. Evaluation of organoleptic attributes was performed by 9 point hedonic scale (Shrilaxmi B.) under the supervision of five selected panel judges from the Department of Food Nutrition and Public Health, SHUATS, Allahabad.

Physiochemical composition of Maize

Determination of Moisture Content

Procedure: A glass Petri-dish was accurately weighed, after which an approximately 1.0g of sample was added and reweighed and the weight recorded as (W_1). This was kept in a vacuum oven for 1 hour at the 1050C, the dish was removed from the oven, cooled and re-weighed and recorded as (W_1). This process was repeated until a constant weight was attained. This process was repeated for all the samples, and the moisture content was calculated in percentage as follows:

% moisture = (w_1-w_2/weight of sample used) x 100

Determination of Ash Content

Procedure: 1.0g of sample was accurately weighed in a platinum crucible and recorded as w1, this was transferred to muffle furnace at the temperature of 5500^{C} for 8 hours until a white ash was obtained. The platinum crucible was removed and place in a dedicator to cool and weighed, the value was recorded as w_2, Percentage as was calculated as

% ash = (w_1-w_2/weight of sample used) x 100

This was repeated for all samples.

Determination of Fats and Oil

Cold method of extraction was used to determine fats and oil in all the four samples, 10g of samples of accurately weighed into round bottom tom flasks then 50ml of n-hexane was added to each of the samples and covered for 24 hours for proper extraction of oil after which clean and dried empty beakers were weighed and weights noted. The samples were decanted into the beakers and were heated to dryness and transferred in a desiccator to cool and weighed and new weights taken. Percentage fats were calculated thus;

% fat or oil = (w_2-w_1/weight of sample used) x 100

Crude Fibre Determination

2.0g of samples were digested in 200ml of 1.25% H_2SO_4, the mixture was boiled for 30min. and was filtered and washed with hot water to reduce the acidity, this was tested with PH paper, the residue was again digested in 200ml of 1.25% NAOH. The mixture was heated for 30min. filtered and washed with hot water and dried in an oven, this was transferred to a platinum crucible and weighed (w_1) then heated in a furnace at 5500^{C} to as and weighed again (w_2). Percentage crude fibre was calculated as:

% crude fibre = (w_1-w_2/weight of sample used) x 100

Carbohydrate Determination

The carbohydrate content of the samples was estimated as the difference obtained after subtracting the values of organic protein, ash content, fat or oil, crude fibre, and moisture content from 100. That is 100- (protein + ash + oil + crude fibre + moisture content).

Protein determination

The protein nitrogen in 0.5g of dried samples was converted to ammonium sulphate by digestion with concentrated H_2SO_4 and in the presence of Cu_2SO_4 and Na_2SO_4. This was heated and the ammonia involved was steam distilled in 4% boric acid solution, the nitrogen from ammonia was deduced from the titration of the trapped ammonia with 0.1N H_2SO_4 with methyl red indicator until a pink colour was observed indication the end point of titration. Protein was calculated by multiplying the deduced value of nitrogen by a protein constant 6.25mg.

Mineral Composition

Mineral composition in maize varieties were analyzed by their ash solution extract in diluted hydrochloric acid. Iron, Calcium and Phosphorus were estimated under standard procedures followed by AOAC, 2012 [10]. Ash content of food determines the inorganic mineral content.

Total Phenolic Content

Total phenolic content (TPC) in maize varieties were estimated using Folin-Ciocalteau reagent. The TPC content was calculated from a standard calibration curve of Gallic acid (19-76µg/ml) plotted against optical density. The Total Phenolic Content was expressed as mg of Gallic acid per 100g sample. (Singleton *et al.*, 1999) [12].

Statistical Analysis

The data obtained from compositional values and sensory scores were statistically analyzed by using analysis of variance (ANOVA), critical difference (CD) and t-test (paired comparison) for their significance difference. (Gupta *et al.*, 2007) [13].

Results and Discussion

Table 2: The average nutritional composition of Maize *var.* MS-2 and *var.* MS-3 *per* 100g

Nutrients	MS-2	MS-3	Difference	T. Cal	T. Tab	Results
Moisture (%)	11.0	10.0	1.0	4.83	4.303	S
Ash (g)	1.6	2.9	-1.3	16.25	4.303	S
Protein (g)	6.9	7.5	-0.6	5.54	4.303	S
Fat (g)	3.2	3.9	0.7	4.85	4.303	S
Crude fibre (g)	4.3	4.5	-0.2	2.24	4.303	NS
Carbohydrate (g)	73.0	71.2	-1.8	8.17	4.303	S
Calcium (mg)	11.0	12.2	-3.1	5.62	4.303	S
Phosphorus (mg)	328	335	-1.2	6.10	4.303	S
Iron (mg)	6.5	7.3	-0.8	7.11	4.303	S
Energy (kcal)	348	350	-7.0	5.27	4.303	S
Total phenolic content (mg)	110.9	120.0	-9.1	4.82	4.303	S

S=Significant, NS= Non significant, $P \leq 0.05$

According to the results illustrated in above table 2, pertaining of average nutritional content in maize varieties namely *var.* MS-2 and *var.*MS-3. It has been found that these maize varieties have sufficient amount of nutrients. Statistical analysis of varieties according to data obtained from nutritional composition and their mean difference has significant difference on the basis of their tabulated value with comparison to calculated table value for its chemical content except crude fiber which has no significant difference at 5% level of significance. These varieties have rich amount of carbohydrates and starch. Nutritional content of *var.* MS-2 were found to be sufficient as 11.0 percent/100g of moisture content, 1.6g/100g of ash content, 6.9g/100g of protein content, 3.2g/100g of fat content, 4.3g/100g of crude fiber, 73.0g/100g of carbohydrate content. The mineral content employed for *var.* MS-2 were as followed 328mg/100g (phosphorus), 11.0mg/100g (calcium), 6.5mg/100g of (iron), and calorific value was found to be 348kcal/100g. Similar studies (Enyisi *et al.*, 2014) [14] also reported that maize consist moisture (11.6-20.0%), ash (1.10-2.95%), protein (4.50-9.87%), fat (2.17-4.43%), fiber (2.10-26.70%) and carbohydrates contents (44.60-69.60%). Dry weight basis of white-maize flours significantly (p<0.05) contained moisture 9-15 %, ash 1.4-2.6%, protein 7.82-12.02%, crude fiber 0.95-2.01%, and total carbohydrates 65.38-78.74%. Qamar *et al.*, (2017) [15] Compositional data for *var.* MS-3 were found to be 10.0 percent/100g of moisture content, 2.9g/100g of ash content, 7.5g/100g of protein content, 3.9g/100g of fat content, 4.5g/100g of crude fiber, 71.2g/100g of carbohydrate content. The mineral content employed for *var.* MS-3 were as followed 335mg/100g, (phosphorus), 12.2mg/100g (calcium), 7.3mg/100g of (iron), and calorific value was found to be 350kcal/100g. The composition of minerals in cereal like maize has been found to be moderate because it has rich organic content as compared to inorganic compound. Processing and storage duration also affects significantly nutritional values as well as their inbred attributes of bio-fortified maize. On the basis of nutritional comparison and statistical analysis by using paired comparison test and standard mean difference it has been found that *var.* MS-3 has rich nutritional content of carbohydrates, protein, fiber, fat, calcium, phosphorus, iron and total phenolic content as compared to *var.* MS-2. Both varieties have effectiveness to contribute nutritional demand to consumers.

Total phenolic content

Data on Total Phenolic Content obtained by chemical analysis has been presented in above table 2, which shows the significance difference at 5% level of significance and composition comparison between both maize varieties on the basis of its statistical analysis. It has been found that total phenolic content in var. MS-2 and *var.* MS-3was present in rich amount of 110.9mg/100g and 120.0mg/100g respectively. Similar study of Sreeramulu D. *et al.*, (2009) [17] also reported that phenolic content in maize has been found as 112.68±0.43 mg/g. Improved maize varieties also has a higher antioxidant activity when compared to other cereals like wheat, oats, and rice.(Adom and Liu, 2002) [18]. The antioxidant properties of maize have been associated with anti-carcinogenic effects. (Liu, 2007) [19].

Sensory Analysis

On the basis of nutritional composition of maize *var.* MS-3 was significantly higher in nutrients as compared to *var.* MS-2. Therefore, maize *var.* MS-3 was utilized for value addition in development of nutritionally rich food products namely *Muffins* and *Sev.*

Table 3: Average sensory score of different parameters in control and treated sample of prepared food product - *Muffins.*

Control and treatments	Colour and appearance	Body and texture	Taste and flavor	Overall acceptability
T_0	7.2±0.2	7.2±0.2	7.0±0.2	7.2±0.2
T_1	7.5±0.2	7.7±0.1	7.7±0.1	7.6±0.1
T_2	8.5±0.1	8.2±0.1	8.3±0.2	8.4±0.2
T_3	7.0±0.1	7.0±0.2	7.0±0.2	6.46±0.2
F(cal)	10.0	11.25	5.3	31.5
F (tab)	4.76	4.76	4.76	4.76
CD	0.69	0.54	0.34	0.34
Results	S	S	S	S

S= significant, NS= significant, ±= S.E, $P \leq 0.05$

The data pertaining above in table 3, shows that the sensory attributes of prepared food product *Muffins* illustrated that according to nine point hedonic scores for overall acceptability (8.4±0.2) was higher in treatment T_2 (70% of *var.* MS-3 flour and 30% refined flour) followed by treatments T_1 (7.6±0.1), T_0 (7.2±0.2) and T_3 (6.46±0.2) on the basis of average mean scores. Overall acceptance of product depends upon evaluating parameters of sensory scores to assess the products organoleptic qualities. Therefore it is concluded that treatment T_2 has highest average mean scores on the basis of its colour and appearance (8.5±0.1), body and texture (8.2±0.1), taste and flavor (8.3±0.2). Statistical analysis of variance (ANOVA) of prepared product *Muffins* from data obtained by average mean score of different evaluating parameter for treatments has evident that the calculated value of F (31.5) is greater than tabulated value (4.76) on degree of freedom (3,2) at 5% probability level so there was significance difference between treatments regarding all sensory aspects of *Muffins.*

Table 4: Average sensory score of different parameters in control and treated sample of prepared food product – *Sev*

Control and treatment	Colour and appearance	Body and texture	Taste and flavor	Overall acceptability
T_0	7.0±0.1	7.2±0.2	7.0±0.4	7.2±0.2
T_1	7.5±0.2	7.5±0.2	7.8±0.1	7.5±0.3
T_2	8.0±0.1	8.2±0.2	8.4±0.1	8.4±0.1
T_3	7.0±0.1	7.1±0.2	7.2±0.2	7.3±0.2
F (cal)	10.83	10.57	12.0	9.7
F (tab)	4.76	4.76	4.76	4.76
CD	0.48	0.48	0.54	0.58
Results	S	S	S	S

S= significant, NS= significant, ±= S.E, $P \leq 0.0$

The data pertaining above in table 4, shows that the sensory attributes of prepared food product *Sev* illustrated that according to nine point hedonic scores for overall acceptability (8.4±0.1) was higher in treatment T_2 (70% of *var.* MS-3 flour and 30% gram flour) followed by treatments T_1 (7.5±0.3), T_3 (7.3±0.2) and T_0 (7.2±0.2) on the basis of average mean scores. Overall acceptance of product depends upon evaluating parameters of sensory scores to assess the products organoleptic qualities. Therefore it is concluded that treatment T_2 has highest average mean scores on the basis of its colour and appearance (8.0±0.1), body and texture (8.2±0.2), taste and flavor (8.4±0.2). Statistical analysis of variance (ANOVA) of prepared product *Sev* from data obtained by average mean score of different evaluating parameter for treatments has evident that the calculated value of F (9.7) is greater than tabulated value (4.76) on degree of freedom (3,2) at 5% probability level so there was significance difference between treatments regarding all sensory aspects of *Sev.*

Conclusion

On the basis of compositional analysis, it is concluded that inbred maize *var.* MS-2 and *var.*MS-3 contains good amount of nutrients i.e. carbohydrates, fiber, fat, macro-minerals and moderate amount of protein. Antioxidant content in maize samples was found in sufficient amount. These inbred maize was found to be significantly different at $P<0.05$ on the basis of comparative analysis. Therefore, *var.* MS-3 was significantly higher as compared to *var.* MS-2. On the basis of organoleptic analysis, it is concluded that inbred maize-flour can be successfully incorporated for the development of the value added food products such as *Muffins* and *Sev*. Organoleptic attributes of prepared food products were found significantly acceptable until T_2 (70% white-maize flour: 30% refined flour or gram flour) on the basis of their overall acceptance score followed by colour and appearance, flavor and aroma, body and texture.

Acknowledgement
Research scholar wants to take this privilege to express her heartfelt regards and gratitude to all respected SAC members: Dr. (Mrs.) Alka Gupta, Prof. (Dr.) Ranu Prasad, Prof. (Dr.) Virginia Paul, Dr. S.G.M. Prasad, and Prof. (Dr.) A.K. Gupta, Prof. (Dr.) Shailesh Marker for their constant guidance, valuable suggestion, and their blessings to carry out this research.

References

1. Milind P, Isha D, Zea maize. A modern craze. International Research Journal of Pharmacy. 2013; 4:39-43.
2. Lopez-Martinez LX, Oliart-Ros RM, Valerio-Alfaro G, Lee CH, Parkin KL, Garcia HS. Antioxidant activity, phenolic compounds and anthocyanins content of eighteen strains of Mexican maize. *Lebensmittel-Wissenschaft & Technology* Food Science Technology. 2009; 42:1187-1192.
3. FAO. Maize in human nutrition. FAO Food and Nutrition Series No. 25, 1992. ISBN 92-5-103013-8.
4. Tontisirin K, Nantel G, Bhattacharjee L. Food-Based Strategies to Meet the Challenges of Micronutrient Malnutrition in the Developing World. Proceeding of Nutrition Society. 2002; 61(2):243-50.
5. Meenakshi JV, Johnson N, Manyong VM, De Groote H, Javelosa J, Yanggen D, *et al*. How cost effective is biofortification in combating micronutrient malnutrition? An ex-ante assessment. Harvest Plus, 2007, 188-209.
6. Kumar D, Jhariya NA. Nutritional, Medicinal and Economical Importance of Corn: A Mini Review. Research Journal of Pharmaceutical Sciences. 2013; 2:7-8.
7. Faiza S, Shyamala BN, Oghbaei M, Prakash J. Formulation of Nutritious Premixes Based On Natural Ingredients and Evaluating Their Efficacy for Value Addition. International Food Research Journal. 2015; 22(2):546-555.
8. Houssou Paul, Ayernor GS. Appropriate processing and food functional properties of maize flour. African Journal of Sciences and Technology. 2002; 3:1.
9. Srilakshmi B. Food Science New Age International (P) Limited Publishers. 5th edition, 2011, 289.
10. AOAC. Official Methods of Analysis, 19th edition. Association of Official Analytical Chemist, Gaithersburg, 2012.
11. Lowry OH, Roserbrough NJ, Farr AL, Randall RJ. Protein measurement with folin phenol reagent. Journal Biological Chemistry. 1951; 193:265-275.
12. Singleton VL, Orthofer R, Lamuela-Raventos RM. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteaue Reagents. Methods Enzymol, 1999, 152-178.
13. Gupta AK. Practical Manual of Agricultural Chemistry, Analysis of Plant, Food and Biological Samples, 3rd edition, 2007.
14. Enyisi IS, Umoh VJ, Whong CMZ, Abdullahi IO, Alabi O. Chemical and Nutritional Value Of Maize and Maize Products Obtained From Selected Markets In Kaduna State, Nigeria. African Journal of Food Science and Technology. 2014; 5(4):100-104.
15. Qamar Shaista, Aslam Muhammad, Huyop Fahrulzaman, Javed Arshad Muhammad. Comparative Study for the Determination of Nutritional Composition in Commercial and Non-Commercial Maize Flours. Pakistan Journal of Botany. 2017; 49(2):519-523.
16. Dakare Monday, Danladi Ameh A, Abel Agbaji S, Atawodi Sunday. Chemical Composition and Antinutritional Content of Yellow Maize, Raw and Processed Composite Mango (Magnifera Indica) Seed Kernel from Zaria, Kaduna State, Nigeria. International Journal of Advanced Research. 2014; 2(7):90-97.
17. Sreeeamulu DC, Vijaya Reddy K, Raghunath M. Antioxidant Activity of Commonly Consumed Cereals, Millets, Pulses and Legumes in India. Indian Journal of Biochemistry & Biophysics. 2009; 46:112-115.
18. Adom KK, Liu RH. Antioxidant Activity of Grains. Journal of Food Chemistry. 2002; 9; 50(21):6182-6187.
19. Liu RH. Whole grain phytochemicals and health. Journal of Cereal Science. 2007; 46:207-219.