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Nutrient analysis of *Psidiumguineense* Sw. (Myrtaceae) - An underutilized edible fruit found in Kerala.

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ABSTRACT

The present study concerns, *Psidium guineense* Sw., Myrtaceae, an underutilized wild plant with edible fruit. The study aimed to reveal the nutrient composition of this fruit by analyzing the proximate composition, vitamin content, mineral composition, anti-nutrient analysis. The result obtained showed that the fruit has considerable amount of moisture (78%), carbohydrate (14.4g/100g) and fiber (4.7%). Among the mineral analysis, potassium is the main component (531mg/100g). The only anti-nutrient was oxalate (3.70mg/100g). Thus, the present investigation shows that *Psidiumguineense*is a source of many nutrients, fiber, minerals and therefore could be utilized for human consumption like other common fruits.

KEY WORDS: *Psidiumguineense, Nutrient analysis, Mineral composition, Antinutrient*

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INTRODUCTION

Among the almost 500 species of tropical fruits in south east Asia, only a few such as Mango, Grapes, Pineapple, Guava, Papaya, Pomegranate, Annona and Citrus have been popularized and considered suitable for multiplication and improvement in horticulture institutions (Malik et al.,2010).On the other hand, the less attractive wild fruits have remained unattended and under-exploited. Since wild fruits are still not selected for any farm cultivation, they are not available in the common markets and techniques for their post-harvest storage have not been developed. There are still many wild fruits that are or not even known to the common public and their nutritional value and medicinal properties are yet to be tapped. In short, general information on edibility and therapeutic properties of wild fruits is almost negligible (FAO,1984 and Aloskaret al.,1992).

Analytical studies may help in the selection of wild species with desirable characters that can be utilized through plant breeding and hybridization to get suitable plants that meet the nutrient requirements of the human society. Studies have contributed and supported the fact that edible wild species can make significant contribution to nutrient intake of human populations (Henrietta *et al.*,2016).Research on these lesser-known fruits is also aimed to unravel their beneficial attributes and to conserve these species.

The present study focuses on the wild species, *Psidium guineense*Sw., familyMyrtaceae. The family comprises of about 5800 species (WCSP,2015) with centers of diversity in Australia, Southeast Asia,tropical and subtropical America and Africa(Wilson et al.,2001). Many fruits of this family have a rich history of use both as edible and as traditional medicines in divergent ethno botanical practices throughout the tropical and subtropical world (Marin et al.,2008). Myrtaceous fruits have great consumer acceptance worldwide due to the exotic flavor,high contentof vitamins,possibility of use in a wide range of food products, presence of secondary metabolites that are often related with benefits on human health (Marin et al., 2008).

Members of the family include a few genera such as *Eugenia, Myrcianthes, Campomanesia*and *Psidium* (Marin et al.,2008). The most familiar genus, *Psidium* includes about 120-150 species and is distributed throughout the tropical and subtropical countries (Pino et al.,2004). There are a lot many studies on the antioxidant activities and phytochemical composition with special focus on aromatic volatile oil of some species. The most popular species of *Psidiumviz. P. guajava* has been studied extensively.

Psidium guineense is often confused with *P. guajava*. It is a shrub or small tree growing up to a height of 3 m. When mature, the fruits turn yellow. Numerous seeds are embedded in the yellowish white pulp which has a sweet tart taste and a very pleasant aroma. These fruits can be eaten raw or in the form of desserts, drinks, ice cream and liquors (Clarissa et al.,2011). Information on the nutrient quality of fruits of *Psidium guineense* is very scanty. Hence, the objective of the present study is to determine the nutrient composition of this wild edible fruit.

MATERIALS AND METHODS

Source of material and identification

The plant, *Psidium guineense*, was identified botanically by the Curator Dr. G. Valsaladevi, Dept. of Botany, University of Kerala. Fresh fully ripened fruits of *P. guineense* were collected from the wild tracts within the campus and taken to the lab for further processing. The collected fruits were first washed in running tap water followed by distilled water. They were packed in plastic containers, labeled and stored in a deep freezer at -80°C. The edible pulp portion of the fruits was used for further analysis. The following methods were adopted for the study and the experiments are done in triplicate.

Proximate composition

The proximate composition was determined according to standard methods. Moisture and fat were analyzed according to AOAC (2005) official methods. The moisture content was determined by drying the sample in hot air oven at 100^0C until a constant weight was obtained, (AOAC, 2005).The crude fiber was determined by alternately digesting the dried, defatted sample in 1.25% HCl and 1.25% NaOH. The digested sample was then ashed in a muffle furnace at 600^0C. The crude fibre was then expressed as percent weight loss on ignition at the ashing temperature (Nyangaet al, 2013).Crude fat content was determined by continuous extraction using petroleum ether in Soxhlet extraction.. The protein quantification was done according to the standard Bradford method as described by Sadasivam et al, (1996). According to this, prepare a series of standard protein samples in different concentrations in test tubes. This is preferably prepared in PBS. Prepare the experimental samples in 100µl of PBS. Add 5ml of dilute dye binding solution to each tube. Mix well and allow the colour to develop for at least 5min but no longer than 30min. The red dye turns blue when it binds protein. Read the absorbance at 595nm.The energy value was calculated according to the method described by FAO,2003, as the fruit calorific value(expressed in Kcal) and was estimated by multiplying the percentage of crude protein, crude fat and carbohydrate by the factors with 4, 9 and 4 respectively. Carbohydrate level was estimated by subtracting the total sum of crude protein, crude fat and crude fiber from 100% dry matter sample (Nyanga et al, 2013).

The amount of total soluble sugar was calculated by phenol sulphuric acid reagent method (Dubois et al, 1951). 500mg of each sample was homogenized with 10ml of 80% ethanol. Then each sample was centrifuged at 2000rpmfor to 15 to 20min. The supernatant was collected separately, to 1ml of alcoholic extract;1ml of 5% phenol solution was addedand mixed. Then 5ml of 96% sulphuric acid was added. Each tube was gently agitated during the addition of acid and then allowed to stand in a water bath at 25-30^0 C for 20min. The OD of the characteristic yellow orange colour thus developed was measured at 490nm in a spectrophotometer. Simultaneously a standard curve was prepared by using a known concentration of glucose. The amount of sugar was expressed as mg/g fresh weight of tissue.

Determination of carotenoids and chlorophylls

Carotenoids and chlorophylls were determined according to the method of D. Martins et al, (2011). A fine powder of the sample was vigorously shaken with 10ml of acetone- hexane mixture(4:6) for 1min and filtered through What man No.4 filter paper. The absorbance of the filtrate was measured at 453, 505, 645 and 663nm. The content of β-carotene was calculated according to the following equation:

β – carotene (mg/100ml) = $0.216\times A_{663}-1.220\times A_{645}-0.304\times A_{505}+0.452\times A_{453}$

Lycopene (mg/100ml) = $-0.0458\times A_{663}+0.204\times A_{645}-0.304\times A_{505}+0.452\times A_{453}$

Chlorophyll a (mg/100ml) = $0.999\times A_{663}-0.0989\times A_{645}$

The values were further expressed in mg per 100g of dry weight.

Mineral analysis

The elemental analyses were performed with the help of Epsilon 3^{XL} bench top energy dispersive X-ray fluorescence (EDXRF) spectrometer. The instrument is equipped with SDDUltra silicon drift detector, a high-perform an ceceramic tube and have 50 kV excitation capabilities.

Analysis of anti-nutrients

Saponin content was estimated according to the method of Etong, et al, (2014) with slight modification. The samples were grounded and 20g of each were put into a conical flask and 200ml of 20% aqueous ethanol was added. The sample was stirred using a magnetic stirrer until the extraction was complete. The mixture was filtered and the residue re-extracted with another 200ml 20% ethanol. The combined extracts were reduced to 40ml over water bath at about 90^{o}C. The concentrate was transferred into a 250ml separatory funnel and 20ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated. 60ml of n-butanol was added. The combined n-butanol extract were washed twice with 10ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation, the samples were dried in the oven to a constant weight. The saponin content was calculated as mg/100g.

The phytic acid was determined using the procedure described by Inuwa et al, (2011) with slight modification. 2.0 g of each sample was weighed into 250 ml conical flask. 100 ml of 2% concentrated HCl was used to soak each sample in the conical flask for 3 h and then filtered. 50 mlof each filtrate was placed in 250 ml beaker and 100 ml of distilled water was added to each to give proper acidity. 10 ml of 0.3% ammonium thiocyanate solution was added into each solution as indicator. Each solution was titrated with standard iron chloride solution, which contained 0.00195 g iron per ml. The end point color was slightly brownish - yellow which persisted for 5 min. The quantity of phytic acid was calculated.Phytin phosphorus (1ml Fe = 1.19mg phytin phosphorus) was determined and phytate content calculated by multiplying the value of phytin phosphorus by 3.55.

Tannin quantification was done by following Folin-Denis method described by Sadasivam et al, (1996). Accurately weighed 0.5g of the powdered material was transferred to a 250mL conical flask. Add 75ml water. Heat the flask gently and boil for 30 min. Centrifuged at 2,000rpm for 20 min and collect the supernatant in 100ml volumetric flask and make up the volume. Transfer 1mL of the sample extract to a 100mlvolumetric flask containing 75ml water. Add 5ml of Folin-Denis reagent, 10ml of sodium carbonate solution and dilute to 100ml with water and Shaken well. Read the absorbance at 700nm after 30 min. Standard tannic acid was used for preparing the standard curve.

The titration method as described by Agbaire (2011) was followed for the determination of oxalate. 1g of sample was weighed into 100ml conical flask. 75ml 3MH_2SO_4 was added and stirred for 1hr with a magnetic stirrer. This was filtered using a What man No 1 filter paper. 25ml of the filtrate was then taken and titrated while hot against 0.05M $KMnO_4$ solution until a faint pink colour persisted for at least 30 sec. The oxalate content was then calculated by taking 1ml of 0.05M $KMnO_4$ as equivalent to 2.2mg oxalate.

Statistical analysis

All the experiments were done in triplicate. The mean and standard deviation of the data were calculated using SPSS (17.0).

RESULT AND DISCUSSION

The proximate ,mineral and anti-nutrient composition of the fruits of *P. guineense*are given below (Tables I,II,III)

The results showed that, *P. guineense* pulp sample has a relatively high moisture content (78%).The carbohydrate content(14.4g/100g) of the fruit was found to be high . The fiber content is also noticeably high.

Table I. Nutrient composition of *Psidium guineense* Sw

No.	Nutrient	Quantity(g/100g)
1	Carbohydrate	14.400 ± 0.05
2	Protein	1.800 ± 0.04
3	Total sugar	10.300 ± 0.10
4	Crude fat	1.080 ± 0.07
5	Fiber (%)	4.700 ± 0.09
6	β-Carotene	0.650 ± 0.03
7	Lycopene	0.074 ± 0.02
8	Chlorophyll A	0.004 ± 0.00
9	Energy value (Kcal)	74.520 ± 0.09
10	Moisture (%)	78.000 ± 0.15

Values are represented as amount in g/ 100g edible portion

Table II. Mineral composition of *Psidium guineense* Sw.

No	Mineral	Quantity(mg/100g)
1	Sodium	2.6000 ± 0.02
2	Calcium	15.8000 ± 0.05
3	Copper	0.1820 ± 0.01
4	Iron	0.2400 ± 0.03
5	Magnesium	28.9000 ± 1.10
6	Manganese	0.1850 ± 0.01
7	Phosphorus	24.7000 ± 1.50
8	Potassium	531.0000 ± 2.30
9	Zinc	0.0912 ± 0.01
10	Lead	0.0112 ± 0.03
11	Tin	0.0080 ± 0.01

Values were represented as amount in mg/ 100g edible portion

The amount of Potassium was highest followed by Magnesium, Phosphorus and Calcium.

Table III. The anti-nutritional composition of *Psidium guineense* Sw

No	Anti-nutrient	Quantity(mg/100g)
1	Oxalate	3.70 ± 0.23
2	Phytate	1.07 ± 0.11
3	Saponin (%)	2.54 ± 0.05
4	Tannin	1.17 ±0.05

Values were represented as amount in mg/ 100g edible portion

Among the antinutrients, highest concentration was observed for oxalates while lowest concentration was recorded for phytate.

In order to substantiate the nutrient quality of *Psidium guineense,* a comparison has to be made between the nutrient/ant nutrient composition of *Psidium guineense* and other commonly available commercial fruits. The values used in the ensuing discussion are represented in either g/100g or mg/100g unless otherwise stated. The information used is from an authentic database (USDA,United States Department of Agriculture Agricultural Research Service. National Nutrient Database for Standard Reference (Release 28, released September 2015, slightly revised May 2016)).

Table .Nutrient composition of 11 commonly used fruits

No.	Nutrient	Apple	Grapes	Strawberry	Common guava	Pomegranate	Papaya	Jackfruit	Watermelon	Kiwi	Guava strawberry	Banana
1	**Water**	85.50	90.89	90.95	80.80	77.93	88.06	73.46	91.45	83.07	80.66	74.91
2	**Carbohydrate (g/100g)**	13.81	8.08	7.68	14.32	18.70	10.82	23.35	7.55	14.66	17.36	22.84
3	**Protein (g/100g)**	0.26	0.63	0.67	2.55	1.67	0.47	1.72	0.61	1.14	0.58	1.09
4	**Lipid (g/100g)**	0.17	0.10	0.30	0.95	1.17	0.26	0.64	0.15	0.52	0.60	0.33
5	**Energy (Kcal)**	52.00	32.00	32.00	68.00	83.00	43.00	95.00	30.00	61.00	69.00	89.00
6	**Fiber (g/100g)**	2.40	1.10	2.00	5.40	4.00	1.70	1.50	0.40	3.00	5.40	2.60
7	**Sugar (g/100g)**	10.39	6.98	4.89	8.92	13.67	7.82	19.80	6.20	8.99	-	12.23
8	**Calcium (mg/100g)**	6.00	12.00	16.00	18.00	10.00	20.00	24.00	7.00	34.00	21.00	5.00
9	**Iron (mg/100g)**	0.12	0.09	0.41	0.26	0.30	0.25	0.23	0.24	0.31	0.22	0.26
10	**Magnesium (mg/100g)**	5.00	8.00	13.00	22.00	12.00	21.00	29.00	10.00	17.00	17.00	27.00
11	**Phosphorus (mg/100g)**	11.00	8.00	24.00	40.00	36.00	10.00	21.00	11.00	34.00	27.00	22.00
12	**Potassium (mg/100g)**	107.00	139.00	153.00	417.00	236.00	182.00	448.00	112.00	312.00	292.00	358.00
13	**Sodium (mg/100g)**	1.00	-	1.00	2.00	3.00	8.00	2.00	1.00	3.00	37.00	1.00
14	**Zinc (mg/100g)**	0.04	0.07	0.14	0.23	0.35	0.08	0.13	0.10	0.14	-	0.15

Values were taken from USDA Food and Nutrition database(USDA, United States Department of Agriculture Agricultural Research Service. National Nutrient Database for Standard Reference (Release 28, released September 2015, slightly revised May 2016).

The most prominent component in fruits being water, intake of fruits and fruits juices are the most pleasant way of hydrating organisms (Getahum, 1974). Like the commonly available fruits, the underutilized /wild, *Psidium guineense* was noted to contain a high amount of moisture (78%). The value is comparable to an earlier report (Clarissa et al, 2011) in *P.guineense* (80%) as well as that in the common guava, *Psidium guajava* [(80.8%) (Table VI)].

The main constituent of the fruit pulp is carbohydrate, (14.4 gm). When compared with other regularly used fruits like apple, common guava, papaya and kiwi fruit, the carbohydrate content is acceptable for an underutilized wild edible fruit such as *P. guineense*. The protein content of the fruit (1.8gm) is almost equal to that in guava, pomegranate, kiwi fruit and greater than orange (0.7 gm/100g) (Udemej et al.,2013), grapes, strawberry and papaya. The amount of crude fat detected in *P.guineense* was 1.08gm, which is almost equal to that in common guava and pomegranate, while the value is higher than that in grapes and apple.

The consumption of dietary fiber has been related to the prevention of cardiovascular disease, maturity onset diabetes, and digestive tract disease considering that it lowers the glycemic index of food as well as serum cholesterol level (Vadivel et al., 2012, Eromosele and Eromosele, 1991). *Psidium guineense* has rather an excellent amount of fiber (4.7mg) when compared to other fruits, which makes it suitable for consumption.

Psidium guineense could be a good source of minerals as the values are almost equivalent to those reported for many fruits. The major element potassium (531mg) is comparable to that in many other fruits.Besides, the fruit also serves as a good source of magnesium (28.9mg) and phosphorus (24.7mg). The amount of phosphorus in *P.guineense* is quite high, but not as high as in the common guava. The amount of calcium in *P. guineense* (15.8mg) is comparable to that in the commonly available fruits.

The microelements append the nutritional quality of fruits. The copper content in *P. guineense* is 0.182mg. When compared to the other fruits like banana (0.078mg/100g) guava (0.23mg/100g) litchi (0.14mg/100g) and pineapple (0.11mg/100g), this amount is considerably good (Ajay kumar et al., 2012). The amount of manganese in *P.guineense* (0.185mg/100g) is comparable to that in certain fruits like guava (0.15mg/100g) and pomegranate (0.11mg/100g), higher than in mango (0.027mg/100g) and apple (0.035mg/100g) while lesser than in grapes (0.71mg/100g) and pineapple (0.92mg/100g) (Ajay kumar et al., 2012). The iron content of the fruit (0.24mg) is also comparable to that in jackfruit, papaya, watermelon, common guava and banana but higher than in kiwifruit and strawberry. When comparing this value with other conventional fruits like apple, grape fruit and pomegranate *P.guineense* could be considered as a good source of iron. Though zinc content (0.0912mg/100g) in fruits is lower than in other fruits such as papaya, jackfruit, strawberry, grapefruit and banana, the value is not too small to avoid as zinc is said to be an essential trace element for protein and nucleic acid synthesis and normal body development. It plays a central role in growth and development, vital during periods of rapid growth such as infancy, adolescence and during recovery from illness (Bello et al., 2008).

The anti-nutritional factors also stand as indices for judging the nutritional value of any given food substance(Binita&Khtarpaul,1997). When considering the results, it is evident that oxalate content is highest (3.7mg/100g). Some fruits like dates show higher amounts of oxalate as 6.90mg/100g (Umaru, 2007).Oxalate can bind with calcium in food thereby rendering calcium unavailable for normal physiological and biochemical role (Ladeji et al., 2004).Saponin concentration in the fruit of *P. guineense*is also found to be lesser than in pineapple(13.72mg/100g) (Udemej et al., 2013) and banana(5.99mg/100g) (Akinsanmi et al., 2015). It affects protein digestibility by inhibiting various digestive enzymes such as trypsin and chymotrypsin (Shimoyamada et al., 1998; Makkar et al., 2007). The fruit shows tannin content of 1.17mg/100g which is less than that in dates (5.25mg/100g) (Umaruetal., 2007) and banana(4.24mg/100g) (Akinsanmi et al., 2015). Tannin is known to inhibit the activities of digestive enzymes and nutritional effects of tannin are mainly related to their interaction with protein. Tannin protein complexes are insoluble and the protein digestibility is decreased (Carnovale et al., 1991). The phytate content is 1.07mg/100g, which is considerably low when compared with banana (9.064mg/100gm)(Akinsanmi et al.,2015) and pineapple (2.50mg/100g) (Udemej et al., 2013). The knowledge of phytate levels in food is necessary because high concentration can cause complicated effect in human digestive system (Nwoko et al., 1977).

CONCLUSION

The present study reveals that *Psidium guineense* is healthy fruit with relatively high quantities of nutrients, macro, micro-elements. Anti-nutrient factors though present, were found to be very low when compared to that in other commonly utilized fruits. Thus, it is recommended that these nutrient rich underutilized fruits could be included in the human diet.

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REFERENCE

1. Agbaire P.O. Nutritional and Anti-nutritional Levels of Some Local Vegetables (*Vernomiaanydalira, Manihotesculenta, Teiferiaoccidentalis, Talinumtriangulare, Amaranthusspinosus*) from Delta State, Nigeria.Journal of Applied Science and Environmental Management,2011;15(4): 625 – 628.
2. Ajay Kumar. M, Satarupa M, Uday C. B, Ptratap C. Nutrient analysis of some selected wild edible fruits of deciduous forests of India: an explorative study towards non conventional bio-nutrition. Advanced journal of Food Science and Technology, 2012;4 (1):15-21.
3. Akinsanmi A, Oduje, Akinyemi J, Ayodele, Oboh. G, Adefegha A, Stephin. Assesment of Nutritional, Anti-nutritional and Anti oxidant capacity of Unripe, ripe, and over ripe Plantain (*Musa paradisica*) peel. International Journal of Advanced Research, 2015;3(2): 63-72.
4. Aloskar L. V, Kakkar K. K, Chakra O. J *Second Supplement to Glossary of Indian Medicinal Plants with Active Principles*, Part-1 (A-K), 1965-1981, NISC, CSIR, New Delhi.1992; 265-266.
5. AOAC Official Methods of Analysis of the Association of Official Analytical Chemists, Washington D.C.2006
6. AOAC Official Methods of Analysis of the Association of Official Analytical Chemists, 16th Edition, Washington D.C. 2005

7. Bello M. O, Falade O. S, Adewusi S. R, Olawore N. O. Studies on the chemical composition and anti-nutrients of some lesser known nigerian fruits. African journal of biotechnology.2008; 7(21): 3972-3979
8. Binita R, Khtarpaul N. Probiotic Fermentation: Effect on Ant nutrients and Digestibility of Starch and Protein of Indigenously Developed Food Mixture. Nutrition and Health,1997;11(3):139-147.
9. Carnovale E, Marietta L, Marconi E, Brosio E. Nutritional and hydration properties in cowpea. In Ng NQ Monti LM (Eds.), Cowpea genetic resources, IIT, Ibdan.1991;111-118.
10. Clarissa D, Eduardo Valerio de Barros V. B, Asqieri E. R, Lage M. E, Oliveira R. A, Silva F. A, Pnto D. M, Rodrigues L. J, Silva E. P, Paula R. F. Characterization of fruit from savanna: Araca (*Psidiumguineense* Sw.) and Marlo (*Annonacrassiflora* Mart.). Ciencia e Tecnologia de Alimentos, .2011; 31(3):723-729.
11. Dubois M. K, Gilles J. K, Robers P. A Smith F. Calorimetric determination of sugar and related substance. Analytical Chemistry.1951;26:51-356.
12. Eromosele I. C, Eromosele C. O, Kuzhkzha D. M. Evaluation of mineral elements and ascorbic acid contents in fruits of some wild plants. Plant Foods for Human Nutrition.1991;41:151-154.
13. Etong D. I, Abbah E. A. Estimation of Nutrients and Anti-nutrients Components of Three Nigerian Leafy Vegetables. Food Science and Quality Management, 2014; 33:10-20.
14. FAO Food and Fruit Bearing Forest Species. Examples of South Eastern Asia. Forestry Paper no. 44/2 FAO, Rome.1984.
15. FAOFood and energy methods of analysis and conversion factors. Food and nutrition paper 77,FAO,Rome.2003
16. Getahum, A. A. The role of wild plants in the native diet of Ethiopia. Agro-Ecosystems.1974; 1: 45-56.
17. Henrietta N. E, Helen O. O, Ukamaka V.A. Nutrient and photochemical composition of two varieties of Monkey kola (*Cola parchycarpa* and *Cola lepidota*): An underutilized fruit. Food Chemistry .2016; 193:154-159.
18. Inuva H. M, Aina V.O, Gabi B, Aimola, Toyin A. Comparative Determination of Ant nutritional Factors in Groundnut Oil and Palm Oil. Advanced Journal of Food Science and Technology.2011; 3 (4):275-279.
19. James C.S, Analytical Chemistry of Food. Chapman and Hill.1st edition. London.1995; 64-65.

20. Kumar Ashok, Rajput Gaurav Kumar. To Develop a Simple (UV-VIS Spectrometric) Method for the Estimation of Multivitamin with Special Reference to Capsules & Tablets. International Journal of Pharmagenesis.2011; 2(1): 43-48.
21. Ladeji O, Akin C. U, Umaru H.A. Level of ant nutritional factors in vegetables commonly eaten in Nigeria. African Journal of Natural Science.2004; 71-73.
22. Makkar H. P. S, Siddhuraju S, Becker K. Plant secondary metabolites*;* Methods in Molecular Biology. New York: Springer..2007;393
23. Malick S.K, Chaudhury R, Dhariwal O.P, Bhandari D.C. Genetic Resources of Tropical Underutilized Fruits in India. NBPGR, New Delhi..(2012)
24. Marin R, Apel M. A, Limberger R.P, Raseira M.C.B, Pereira J.F.M, Zuanazzi J.A.S, Henriques A. T. Volatile Components and Antioxidant Activity from some Myrtaceous Fruits cultivated in Southern Brazil. Latin American Journal of Pharmacy,2008;27(2) :172-177.
25. Martins D, Barros L, Carvalho M. A, Ferreira I. C. F. R. Nutritional and *in vitro* antioxidant properties of edible wild greens in Iberian Peninsula traditional diet. Food Chemistry. 2011;125: 488-494.
26. Nwoko E.N, Bragg B.B. Influence of Phytic acid and crude fibre on the availability of minerals from protein supplements in growing chicks. Journal of AnimalScience.1977;57:475-477,
27. Nyanga L. K, Gadaga T. H, Nout M. J. R, Smid E. J, Boekhout T, Zwietering M. H. Nutritive value of masau (*Ziziphusmauritiana*) fruits from Zambezi Valley in Zimbabwe. Food Chemistry.2013; 138:168-172.
28. Okwu D. E, Josiah C. Evaluation of the chemical composition of two Nigerian medicinal plants. African Journal of Biotechnology.2006; 5(4): 357-361.
29. Pino J.A, Bello A, Urquiola A, Marbot R., Marti M. P. Leaf oils of *Psidium parvifolium* Griseb. And *Psidium cattleianum* Sabine from Cuba. Journal of Essential Oil Research 2004; 16: 370-371.
30. Rosenberg H.R. Chemistry and physiology of vitamins. Inter Science Publishers Inc., New York.1992; 452-453.
31. SadasivamS, Manickam A. *Biochemical methods.* 2nd edn. New Age International Ltd. Publisher, New Delhi, India 1996.
32. Shimoyamada M, Ikedo S, Ootsubo R., Watanabe K. Effects of soybean saponins on chymotrypsin hydrolysis of soybean protein. Journal of Agriculture and Food Chemistry,.1998; 46(12):4793- 4797

33. Udemej O, Kpobari N, Joyce O. A, Augustine A. U. Proximate, Phytochemical and Mineral Elements Compositions of Some Edible Fruits grown in Oil Producing Community of Rivers State, Nigeria. IOSR Journal of Environmental Science, Toxicology and Food Technology,2013; 5(2):38-46.
34. Umaru H. A, Adamu R., Dahiru D Nadro M. S. Levels of ant nutritional factors in some wild edible fruits of Northern Nigeria. African Journal of Biotechnology. 2007;6(16):1935-1938.
35. US Department of Agriculture, Agricultural Research Service. National Nutrient Database for Standard Reference (Release 28, released September 2015, slightly revised May 2016;
36. Vadivel V, Kunyanga C. N, Beisalski H. K. Health benefits of nut consumption with special refferance to body weight control. Nutrition,2012;28: 1089-1097.
37. Wilson P. G, Brian M. M, Gadek D. A, Quino C. J. Myrtaceae revisited; A Re-assessment of infra familial groups. American Journal of Botany, 2001;88 (11): 2013-2015.
38. World Checklist of Selected Plant Species (WCSP) The board of trustees of the royal botanical garden, Kew. www.kew.org/WCSP. Accessed 29 Jan 2015.