American Journal of Experimental Agriculture
4(12): 1708-1717, 2014

SCIENCEDOMAIN *international*
www.sciencedomain.org

Mineral Content of Five Tropical Leafy Vegetables and Effect of Holding Methods and Time

E. C. Nwanekezie[1*] and P. N. Obiakor-Okeke[2]

[1]Faculty of Engineering Department of Food Science and Technology Imo State University, P.M.B 2000, Owerri, Imo State, Nigeria.
[2]Faculty of Health Sciences Department of Nutrition and Dietetics, Imo State University, P.M.B 2000, Owerri, Imo State, Nigeria.

Authors' contributions

This work was carried out in collaboration between both authors. Author ECN designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author PNOO managed the analyses of the study, the literature searches and wrote up for publication. Both authors read and approved the final manuscript.

Original Research Article

Received 11th June 2014
Accepted 7th July 2014
Published 1st August 2014

ABSTRACT

Objective: This study was undertaken to determine the mineral content of five popular leafy vegetables consumed in southeast Nigeria and to evaluate the effects of time and methods of holding on minerals.
Methodology: Five vegetables Pterocarpus soyauxii ("oha"), pterocarpus santalinidies ("nturukpa"), Gongronema latifolium (utazi), Corchorus olitorious ("ahihiara") and Amaranthis Hybridus ("green") were harvested from farm. Some of the leafy vegetables were wrapped and some unwrapped. They were analyzed for minerals using standard analytical methods. Analysis of variance (ANOVA) at 5% level of significances was also calculated for mineral content of fresh leafy vegetables. The mean were separated using Turkey's test. All the experiments were carried out in triplicates.
Results: Among these five leafy vegetables, Gongronema latifolium ("utazi") had the highest content of potassium (78.5mg), calcium (68.30mg), magnesium (54.60mg) and iron (7.83mg) per 100g of each of the leaf. Amaranthis Hybridus ("green") recorded the highest sodium content of 38.90mg/100g. There was decrease in the level of minerals in all the five leafy vegetables with increases in the time of holding. The rate and percentage

**Corresponding author: Email: ngoziobiakor2001@yahoo.com;*

of loss of minerals among the leafy vegetables varied depending on the method and time of holding. Unwrapped leafy vegetables held day and night in a room recorded the highest percentage loss of minerals. While the wrapped leafy vegetables recorded the lowest percentage loss of minerals. The unwrapped Pterocarpus santalinidies ("nturukpa") held day and night in a room recorded the highest loss of 54.71% sodium in four days.
Conclusion: The rate of metabolism of nutrients (minerals) in harvested leafy vegetables was influenced by their temperature, the lower the temperature the less the loss of minerals.

Keywords: Leafy vegetables; vitamins; time; method; loss.

1. INTRODUCTION

Leafy vegetables are important as food from both economic and nutritional standpoints. They are delicacies that are generally eaten with the main course of meal [1]. Leafy vegetables are consumed as cooked complements to the major staples like cassava, cocoyam, guinea corn, maize, millet, rice and plantain [2]. They play a significant role in human nutrition [3] as they are rich in vitamins and minerals as well as dietary fiber [4]. Leafy vegetables are eaten by all economic class. They are important sources of minerals for lower income people in the developing countries where they constitute a major component of most dishes [5]. Leafy vegetables play crucial role in alleviating hunger and food insecurity by contributing to the nutritional component in the diet of people where animal products are scarce [6]. They also add flavour, variety and aesthetic appeal to diet. Leafy vegetables have low energy densities and are recommended for weight management [7]. The fiber in leafy vegetables has been reported to have beneficial effects on blood cholesterol and to aid in prevention of large bowel diseases, while in diabetic subjects it improves glucose intolerance [8,9]. Some of the minerals in leafy vegetables include calcium, potassium, magnesium, zinc, iodine and copper [7]. Minerals are essential in the body and are required for basic body functions such as heart beat, muscle contraction, movement, growth and regulatory processes [10].

There is variation in seasonality of leafy vegetables. Leafy vegetables are highly perishable especially when held at ambient conditions. They have large surface area which predisposes the leaves to much loss of moisture. The consequence is loss of crispiness, wilting and toughness when cooked. Leafy vegetables are usually subjected to various traditional holding methods by producers in the period of glut and sellers who are unable to sell them at end of the day's business. The traditional holding methods only keep the leaves fresh for few days. The storage life of leafy vegetables could be extended for much longer time under cold temperature storage. Unfortunately, cold temperature storage facilities are not available to large populations of Nigerians. As a result more than 95% of Nigerians hold their harvested or surplus vegetables at room or ambient conditions.

Some common methods used for holding the leafy vegetables in the southeastern states of Nigeria are: (i) Keeping them under shades to prevent direct contact with tropical sun rays (ii) Keeping them under shades in the daytime and taking them out in the open at nights for exposure to cool fresh air and early morning dews and (iii) Wrapping them with broad leaves of banana or cocoyam and keeping the wrapped leaves in a shade. The length of time and method of holding of the leafy vegetables no doubt could affect the integrity of their micronutrients (minerals). Hence, this study was carried out to determine the minerals of five Nigerians leafy vegetables and to evaluate the effects of holding methods and time on the minerals.

2. MATERIALS AND METHODS

2.1 Source of Materials

Pterocarpus soyauxii ("oha"), Pterocarpus santalinidies ("nturukpa"), Gongronema latifolium (utazi), Corchorus olitorious ("ahihiara") and Hybridus ("green") were harvested from three farms at Avu in Owerri West Local Government Area, Imo State Nigeria.

2.2 Sample Preparation

Some leaves destalked from the above fine leafy vegetables were analyzed for Potassium (K), Sodium (Na), Calcium (Ca), Magnesium (Mg) and Iron (Fe) 24, 48, 72 and 96 hours respectively after harvest. Subsequently, each of the leafy vegetables was divided into three lots (I, II and III). Lot I was left unwrapped and kept under a shade. Lot II was equally left unwrapped, held in a shade in the day time but taken out to the open in the night for exposure to fresh cool air and early morning dews. Lot III was wrapped with cocoyam leaves and held in a shade. Leaves were plucked from after harvest and kept on daily basis for four days that is; 24, 48, 72 and 96 hours respectively.

2.3 Analysis of Minerals

A measured weight (2g) of leaves from each lot was dispensed into a porcelain crucible and ashed in a muffle furnace set 550ºC. The resulting ash was dissolved in 10 ml diluted hydrochloric acid (0.10N). This ash solution was further diluted with 90 ml of distilled water to get 100ml mark.

Sodium and potassium content of each lot were determined with flame photometer using the method described by James [11]. Calcium and magnesium content of test samples were determined by Versenate Ethylenediamine Tetraacetic Acid (EDTA) complexiometric titration method described by James [11]. Iron content was determined using atomic absorption spectrophotometer (jenway model) as described by James [5]. All the experiments were carried out in triplicates.

2.4 Data Analysis

The mean and standard deviations from the mean were calculated for each of the experiments. Analysis of variance (ANOVA) at 5% level of significance was also calculated for mineral content of fresh leafy vegetables. The mean were separated using Turkey's test as recorded by Ihekoronye and Ngoddy [12]. The percentage loss of minerals for each lot of leafy vegetables was calculated at the end of four days holding period based on the initial or zero day value.

3. RESULT AND DISCUSSION

Result showed that oha, utazi and green are fair sources of potassium and calcium (Table 1). Potassium and calcium levels in the three leafy vegetables ranged from 53.40-78.54mg/l00g and 43.24-68.30mg/l00g respectively. It has been reported by Afolabi that potassium content of leafy vegetables is as high as 33.2mg/l00g [13]. This value is less than the range reported for the above three leafy vegetables. Potassium in diet is good for the control of diuretic and hypertensive complications because it lowers arterial blood pressure

[14]. Afolabi [15] also reported lower calcium content of 11.50mg/100g for utazi as against 68.30 mg/100g recorded in this study. Calcium in the diet is used to build healthy bone [15] and is essential for blood clotting and muscular contraction [16,17]. Calcium deficiency causes rickets in aged children [18]. Potassium is essential for normal functions of nerves and muscles and in maintaining acid balance of the body [15].

Oha, utazi and nturukpa are also fair sources of iron. They contain 6.83-7.82mg/100g iron. The 54.30mg/100 iron reported from green by akubugwo et al. [19] is however higher than 4.92 mg/100g iron obtained in this study. The availability of iron in food has always been of interest to food scientists and nutritionists. Iron is important for its antioxidant effects, production of red blood corpuscles, oxygen transportation and functionality of many enzymes [15]. Iron has also been reported by Tens et al. [20] to have a role in brain development. The recommended daily allowance of iron for men and women are 28 mg and 30 mg respectively [21]. Deficiency of iron results in anemia, a condition typified by tiredness, loss of health and palpitation in which subnormal levels of hemoglobin are present in the blood. Iron deficiency is also associated with alterations in many metabolic processes that may impair brain functioning, among which are neurotransmitter metabolism, protein synthesis, organogenesis, etc. [22]. The fair level of potassium, calcium and iron in oha and utazi, potassium and calcium in green and iron in nurturkpa show that these leafy vegetables are beneficial as dietary components in providing these micronutrients.

Utazi is a fair source of magnesium in a diet, as the magnesium content of this leaf is 54.0 mg/100g (see Table 5). Afolabi [13] reported a similar value (54.0mg/100g) for utazi. The recommended daily dietary requirement of magnesium is about 300-350mg [18]. Magnesium dependent enzymes are involved in the transfer of phosphate and carboxyl groups [18]. Proper functioning of some enzymes and muscular contraction are enhanced by magnesium [23,24]. The level of sodium in the five leafy vegetables varied. 'Nturukpa' contains the lowest value of 9.45 mg/100 g sodium while the highest value of 38.90mg/100g was recorded for green. Akubugwu et al. [19] reported very low value of 7.43mg per 100g of green [19].

However, sodium is always included in the form of table salt in cooked foods as a flavouring agent. Sodium is involved in maintaining water balance. It is essential for muscle and nerve activity. This notwithstanding the low level of sodium in leafy vegetables is of interest as high intake of sodium increases the risk of high blood pressure in people who are predisposed to hypertension [15].

There were decreases in the value of minerals in all the five leafy vegetables as the time of holding was increased. The percentage loss for individual minerals differed among the leafy vegetables and methods of holding. For instance, the level of potassium in unwrapped oha held throughout in a shade decreased by 22% (Table 2). It decreased as the hours/day of holding increases. Also, the potassium content of unwrapped ahihiara that were held both in the day and night in a shade decreased from 28.57mg/100g at zero day to 19.45mg/100g on the fourth (after 96 hours) day of holding. This translated to 31.92% loss of the mineral. The decrease in the mineral content of the leafy vegetables with increase in time of holding had earlier been reported by Okwu for fruits and vegetables [25]. Serrano et al. [26] also noted high prolonged storage of fruits and leafy vegetables leads to loss of high proportion of their micronutrients and organoleptic quality such a crispy texture colour and flavour [26]. Leafy vegetables still undergo both physiological and metabolic processes after harvest.

Table 1. Mineral compositions of the five Nigerian leafy vegetables

Mineral	mg/100g					
	OH	NT	UT	AH	GR	LSD
K	53.40±0.40[c]	23.65±0.08[e]	78.54±0.61[a]	28.54±0.43[b]	54.92±0.21[b]	0.91
Na	11.78±0.17[d]	9.45±0.53[e]	28.1 0±0.41[b]	19.15±0.60[c]	38.90±0.32[a]	1.11
Ca	43.24±0.24[c]	32.70±0.75[d]	68.30±0.52[a]	31.55±0.18[e]	52.48±0.42[b]	1.13
Mg	19.45±0.35[d]	13.62±0.71[e]	54.60±0.40[a]	28.84±0.22[b]	27.60±0.46[c]	1.14
Fe	6.83±0.31[b]	4.08±0.24[c]	7.82±0.72a	6.83±025[b]	4.92±0.21[c]	0.95

Means ± standard deviations. Means not followed by the same letter(s) across the rows are significantly different (p<0.05)
OH = oha; NT = nturukpa; UT = utazi; Ah = ahihiara; GR = green

Table 2. Potassium content and the percentage losses as influenced by holding methods and time

Holding	Unwrapped					Unwrapped/exposure to night atmosphere					Wrapped				
Time	OH	NT	UT	AH	GR	OH	NT	UT	AH	GR	OH	NT	UT	AH	GR
(Day)			(mg/100g)					(mg/100g)					(mg/100)		
0	53.40 ±0.40	23.65 ±0.08	78.54 ±0.61	28.57 ±0.21	45.92 ±0.21	53. 40 ±0.40	23.65 ±0.08	78.54 ±0.61	28.57 ±0.43	45.92 ±0.2l	53.40 ±0.40	23.65 ±0.08	78.54 ±0.61	28.57 ±0. 43	45.92±0.2l
1	50.24 ±0.06	19.24 ±0.12	72.40 ±0.62	26.92 ±0.50	43.24 ±0.22	51. 85 ±0.24	21.60 ±0.47	75.85 ±0.30	27.85 ±0.70	44.36 ±0.24	52.76 ±0.35	22.78 ±0.18	75036±0.30	.28.19 ±0.24	44.85 ±0.41
2	48.72 ±0.13	18.30 ±0.06	69.24±0.24	25.48 ±0.36	4l.08 ±0.45	50.05 ±0.20	20.24 ±0.17	72. 82 ±0.25	26.30 ±0.44	42.75 ±0.32	50.04 ±0.14	21.60 ±0.28	75.36 ±0.31	27.60 ±0.27	42.20 ±0.36
3	45.30 ±0.32	16.38 ±0.24	65.30 ±0.7l	23.80 ±0.60	40.32 ±0.24	46.17 ±0.24	18.78 ±0.33	72.08 ±0.57	24.16 ±0.2l	41.30 ±0.36	48.38 ±0.17	20.32 ±0.45	74.80 ±0.60	25.46 ±0.63	41.86±0.18
4	41.65 ±0.33	15.92 ±0.30	63.45 ±0.32	19.45 ±0.31	32.60 ±0.71	43. 75 ±0.44	16.24 ±0.37	70.35 ±0.70	21.78 ±0.32	39.24 ±0.38	45.60 ±0.42	18.45 ±0.27	71.63 ±0.21	23.62 ±0. 64	40.30 ±0.32
% Loss	22.00	32.68	19.21	31.92	29.01	18.07	31.33	10.43	23.77	14.55	14.61	21.99	8.80	17.33	12.24

Means ± sd of triplicates. OH = oha, NT = nturukpa, UT = utazi, AH = ahihiara, and GR = green 10

Table 3. Sodium content and the percentage losses as influenced by holding methods and time

Holding			Unwrapped			Unwrapped/exposure to night atmosphere					Wrapped				
Time	OR	NT	UT	AH	GR	OH	NT	UT	AH	GR	OR	NT	UT	AH	GR
(Day)			(mg/l00g)					(mg/l00g)					(mg/100g)		
0	11.78±0.17	9.45±0.53	28.10±0.41	19.15±0.60	38.90 ±0.32	11.78±0.17	9.45±0.53	28.10±0.52	19.15±0.62	38 .90±0.39	11.78±0.17	9.45±0.53	28.10±0.53	19.15±0.60	38.90±0.3l
1	10.30±0.24	8.16±0.24	25.40±0.30	18.30±0.21	37.06 ±0.21	11.16±0.39	9.12±0.22	26.30±0.69	18.95±0.45	37 .20±0.26	11.24±0.17	9.28±0.48	27.56±0.71	19.06±0.50	38.24±0.31
2	8.26±0.39	7.90±0.41	21.60±0.40	17.38±0.60	34.24± 0.60	9.62±0.20	8.95±0.24	24.16±0.70	18.20±0.72	36 .28±0.33	10.90±0.27	9.02±0.10	25.30±0.22	18.31±0.42	37.60±0.36
3	7.94±0.27	5.70±0.51	19.45±0.44	33.80±0.64	8.40 ± 0.24	8.40±0.47	6.24±0.20	23.85±0.21	15.32±0.32	34 .08±0.42	10.05±0.32	8.74±0.45	24.60±0.32	16.62±0.64	35.23±0.24
4	6.24±0.33	4.28±0.62	15.40±0.34	8.92±0.60	29.44±0 .32	8.16±0.45	5.88±0.35	19.40±0.15	13.65±0.41	33.20 ±0.22	8.30±0.33	6.30±0.28	21.78±0.26	14.72±0.56	34. 16±0.31
% Loss	47.03	54.71	45.20	53.42	24.32	30.73	37.78	30.96	28.72	14.65	29.54	33.33	22.49	23.13	12.19

Table 4. Calcium content and the percentage losses as influenced by holding methods and time

Holding			Unwrapped			Unwrapped/Exposure to Night Atmosphere					Wrapped				
Time	OH	NT	UT	AH	GR	OH	NT	UT	AH	GR	OH	NT	UT	AH	GR
(Day)			(mg/100g)					(mg/100g)					(mg/100g)		
0	43.24±0.24	32.70±0.75	68.30±0.52	31.53±0.18	52.48±0.42	43.24±0 .75	32.70±0.75	68.30±0.52	31.55±0.18	52.48±0.42	43.24±0.24	32.70±0 .75	68.30±0.52	3l.55±0.18	52.48±0.42
1	39.25±0.22	29.16±0.11	66.25±0.41	30.24±0.15	50.16±0.36	40.36±0 .24	30.92±0.30	66.70±0.22	30.95±0.28	50.72±0.21	41.28±0.44	3l.28±0.47	67.16±0.21	31.15 ±0.52	51.30±0.56
2	37.60±0.17	27.78±0.22	63.80±0.53	27.30±0.32	47.58±0.36	38.42±0 .16	29.16±0.39	64.70±0.41	29.62±0.42	49.24±0.72	40. 85±0.36	30.45±0.39	66.18±0.25	30.75±0.60	50.62±0.64
3	33.80±0.14	24.30±0.36	62.70±0.22	26.45±0.19	45.36±0.19	35.26±0 .33	26.45±0.35	63.40±0.26	28.32±0.75	46.24±0.42	36.75±0.45	29.34±0.33	65.74±0.15	30.28±0 .32	48.30±0.42
4	28.36±0.14	21.09±0.24	58.16±0.32	25.90±0.50	40.20±0.62	30.20±0 .24	23.62±0.66	59.40±0.75	27.65±0.52	43.45±0.24	32. 28±0.28	25.46±0.33	63.62±0.62	29.16±0.42	45.28±0.36
% Loss	34.11	35.51	14.84	17.58	23.40	30.16	27.77	13.03	12.36	17.21	25.35	22.14	6.85	7.58	13.72

Table 5. Magnesium content and the percentage losses as influenced by holding methods and time

Holding	Unwrapped					Unwrapped/Exposure to Night Atmosphere					Wrapped				
Time	OH	NT	UT	AH	GR	OH	NT	UT	AH	GR	OH	NT	UT	AH	GR
(Day)			(mg/100g)					(mg/100g)					(mg/100g)		
0	19.45±0.35	13.62±0.71	54.60±0.40	28.84±0.22	27.60±0.46	19.45±0.35	13.62±0.71	54.60±0.40	28.84±028	27.60±0.46	19.45±0.35	13.62 ±0.71	54.60±0.40	28.84±0 .22	27.60±0.46
1	18.06±0.24	11.28±0.17	53.80±0.30	26.72±0.41	26.30±0.31	18.28±0.17	12.42±0.30	54.16±0.30	27.00±0.36	26.85±0.42	19.16±0.24	12.95±0.24	54.28±0.52	27.60±0.56	27.16±0.45
2	14.24±0.33	8.74±0.69	51.36±0.51	24.15±0.20	24. 75±0.45	15.70±0.48	10.85±0.53	52J5±0.41	25.10±0.22	25.21±0.82	17.32±0.26	11.30 ±0.20	53.30±0.26	25.26±0.39	25.43±0.23
3	11.36±0.54	7.28±0.24	50.24±.042	21.80±0.20	22.84±0.14	13.62±0.24	8.70±0.17	51.62±0.27	24.34±0.51	23 .80±0.62	16.85±0.33	9.24 ±0.24	52.45±0.42	24.88±0.2 8	24.32±0.63
4	9.30±0.24	5J6±0.17	47.82±0.60	19.76±0.71	19.60±0 .60	12.58±0.30	6.30±0.10	50.12±0.60	22.25±0.85	21.30±0.70	14.70±0.75	8.72 ±0.33	47.82±0.61	23.85±0.41	22.45±0.33
% Loss	52.19	60.65	12.42	31.48	28.99	35.32	53.74	8.21	22.85	22.83	24.42	35.98	7J3	20.08	18.60

Table 6. Iron content and the percentage losses as influenced by holding methods and time

Holding	Unwrapped					Unwrapped/Exposure to Night Atmosphere					Wrapped				
Time	OH	NT	UT	AH	GR	OH	NT	UT	AH	GR	OH	NT	UT	AH	GR
(Day)			(mg/100g)					(mg/100)					(mg/100g)		
0	6.83±0.31	4.08±0.24	7.82±0.72	6.83 ±0.25	4.92± 0.21	6.83±0.31	4.08±0.24	7.82±0.72	6.83±0.25	4.92±0 .21	6.83±0.24	4.08±0.24	7.82±0.72	6.83±0.31	4.92±0. 21
1	5.80±0.07	3.40±0.21	6.20±0.60	5.16±0.60	4.18±0.4 2	5.95±0.24	3.82±0.33	6.94±0.27	5.85±0.45	4.24±0.26	6.30±0.42	3.95±0.19	7.16±0.80	6.16±0.71	4.70±0.56
2	5.05±0.30	2.90±0.17	5.31±0.50	4.12 ±0.30	3.75 ±0 .08	5.12±0.26	3.40±0.17	6.18±0.42	5.30±0.28	3.90±0.25	- 6.16±0.17	3.62±0.26	6.94±0.20	5.92±0.60	4.08±0.42
3	4.30±0.35	2.16±0.10	4.95±0.71	2.85±0.08	2.90 ± 0.10	4.85±0.53	2.78±0.24	5.85±.33	3.95±0.62	3.74±0. 62	3.74±0.55	5.74±0.20	2.95±0.42	4.76±0.62	3.92±0.2 7
4	3.18±0.24	1.80±0.09	3.82±0.10	2.30±0.10	2.58 ±0. 00	3.24±0.17	2.40±0.41	4.78±0.25	3.16±0.75	2.70±0.4 1	3.60±0.18	2.60±0.24	5.16±0.31	3.24±0.46	2.85±0.15
% Loss	53.44	55.88	51.15	66.33	47.50	52.56	41.18	38.87	53.73	45.12	47.29	35.78	34.02	52.56	42.07

Table 3 showed the sodium content and the percentage losses as influenced by holding methods and time. This table revealed that there is increasing loss of sodium as the holding period increases for all the samples and for all the different conditions of holding. The highest percentage loss was witnessed in the unwrapped samples nturukpa (NT) having the highest of 54.71% loss while the least was witnessed in the wrapped samples and green (GR) having the least of 12.19% loss. This therefore showed that these vegetables are better stored /kept when wrapped to prevent nutrient loss.

The reasons for differences in the percentage loss of minerals among the leafy vegetables could be due to differences in their physiological and metabolic process rates. Unwrapped ahihiara held throughout in a shade recorded the highest loss of 66.33% of iron in four days (Table 6 above).

The rate at which the minerals decreased were found to be affected by the method of holding. For instance, 23.40% of calcium was lost in unwrapped green held day and night in a shade for four days (Table 4 above). The percentage loss of calcium for unwrapped green held a shade during the day time and taken out in the open at nights (for exposure to fresh cool air and early morning dews) was reduced to 17.21 within 4 days holding period. Wrapping of the green with cocoyam leaves and holding in a shade within the same four days period further reduced the loss of calcium to 13.72%. Wilhelmina had reported that wrapping of leafy vegetables helped retain the ascorbic acid even more than optimal storage temperature [27]. Wrapping of broccoli florets left about half of their carotenoids under the same condition [28].

The reason for varying percentage loss of minerals could be due to differences in the temperature of the leafy vegetables. The three methods used for holding the leafy vegetables no doubt varied with the temperatures at which the leaves were held. The rates at which nutrients are loss in harvested crops are influenced by physiological and metabolic process rate and these in turn are affected by temperature. Wrapping conferred lower cooling temperature on the leafy vegetables. This could be due to evaporative cooling of the leafy vegetables brought about by the moisture that was released through transportation and respiration. The unwrapped leafy vegetables samples which were taken out of shade at nights for exposure to cool air and early morning dews were cooler than the unwrapped ones held both day and night in a shade.

4. CONCLUSION

The rates of metabolic of nutrients (minerals) in harvested leafy vegetables was influenced by their temperatures, the lower the temperatures, the less the loss of minerals.

ACKNOWLEDGEMENT

Were appreciate the effort of the staff and laboratory attendants of Food science Laboratories of Michael Okpara University of Agriculture Umudike, Umuahia, Abia State, Nigeria. I all thank Cynthian that helped to typeset this paper may God reward you well.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Tanzer C. Biology and Human Progress, 7th Edition. Prentice Hall Inc. Englewood Cliffs New Jersey. 1986;544.
2. Ogunatona T. Green Leafy vegetables: In Nutritional Quality of paint Foods Osagie A, Eka OU. (eds); 1998.
3. Aletor VA, Adeogun OA. Nutrient and antinutrients composition of some tropical leafy vegetables. Food chemical. 1995;53(4):375-379.
4. Hart AD, Obinna-Echem PC, Azubike CU, Omeowuru CP. Fruits and vegetables consumption pattern of students and river state university of science and Technology (RSUST), Port Harcourt. Nigerian journal of Nutritional science. 2007;28(1):81-86.
5. Oshodi AA. Comparison of proteins minerals and vitamin C content of some dried leafy vegetable Pakistan of science and industrial Research. 1992;35:267-269.
6. Mepba HD, Eboh L, Banigbo DE. Effects of Processing Treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetable. African journal of Food, Agriculture and Nutritional Development. 2007;7(1):1-18.
7. MMWA. Fruits and vegetable consumption among adult in United States. 2005. Morbidity and Mortality Weekly Report. 2007;56(10):213-217.
8. IFT. Quality of fruits and vegetable. A scientific status summary by the institute of food technology Expert on food safty and Nutrition. Food technology. 1990;44(6):1-5.
9. Jenkins DJA. Dietary fiber, fiber analogues and glucose tolerance: Importance of Viscosity. British Medcial Journal. 1978;1:1392-1394.
10. Okaka JC, Akobundu ENT, Okaka ANC. Human Nutritions an Integrated Approach, 2nd Edition. Ocjanco Academic publishers Enugu. 2002;127-145.
11. James CS. Analytical chemical of foods. Chapman and Hall, New York. 1995;28:405,512.
12. Ihekoronye AI, Ngoddy PO. Integrated food science and technology for the Tropics, 2nd edition. Macmilliam publishers. London. 1985;293-259.
13. Afolabi FE. Chemical composition and anti-bacterial activity of latifolium G, Zhejaing J; 2007.
14. George PM. Encyclopedia of foods, human press, Washington D.C.P. 2003;1:526.
15. Tolonen M. Vitamins and Minerals in Health and Nutrition. Ellis horwood Ltd, England. 1990;45 -68.
16. Potter NN, Hotchkiss JH. Food science and distributors, New Delhi, 1996
17. Bead JL. Iron deficiency and neural development: An update. Actives of Lationoam Nutrtion. 1995;49(3 supp. 2):34-39.
18. Sivasankar B. Vitamins and Minerals. In: Food Processing and Preservation. PHL Learning Private Limited, New Delhi India. 2012;82-92.
19. Akubugwo IE, Obasi NA, Chinyere GC, Ugobogu AE. Nutritional and chemical value of *Amaranthus hybridus L*. leaves from afikop, Nigeria. African Journal of biotechnology. 2007;6(24):2833-2839.
20. Tens JV, Burns DL, Jones HR. Serve ataxia, Myolepathy and peripheral neuropathy due to acquired copper deficiency in patient with history of gastrectomy. Journal of paenteral Nutrition. 2006;30:446-450.
21. Narasingha- Roa BS, Deosthale YG, Pant KC. Nutrients composition of India foods. National Instituted of Nutrition, Hyderabad-507, India. 1989;94.
22. Postharvest Research Unit, University of Benin, Benin city. 2003;120-133.
23. Oram RF. Biology: Living System. Charles E. Merril publishing Company and A. bell and Howell Company, Columbus, Ohio. 1983;758.
24. Kirk RS, Sawyer R. Person's Composition and Analysis of Foods, 9th Edition. Longman Scientific and technical, Longman Group UK Ltd. Essex England; 1991.

25. Okwu DE. The photochemical and vitamin content of indigenous specie of southeastern Nigeria. Journal of Sustainable Agriculture and Environment. 2004;6:30- 34.
26. Serrano N, Va-Verde JM, Gullen F, Castillo S, martinz- Ronero D, Valero D. Use of aloe-vera gel coating preserves the functional properties of table grapes. Journal of Agriculture and food Chemistry. 2006;54:3882-3888.
27. Wilhemina K. Effects of production and Processing fact on major fruit and vegetable antioxidants. Journal of Food Science. 2005;70(1):11-19.
28. Barth MM, Zuhang H. Packaging design effects of antioxidant vitamins retention and quality of broccoli florets during postharvest storage. Postharvest Biology and Technology. 1996;9(2):141-150.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=586&id=2&aid=5595