

MINERAL CONTENTS OF FIVE TROPICAL LEAFY VEGETABLES AND EFFECTS OF HOLDING METHODS AND TIME ON ITS MINERALS.

Abstract

Objective: This study was undertaken to determine the mineral contents of five popular leafy vegetables consumed in southeast Nigeria and to evaluate the effects of time and methods of holding on minerals.

Methodology: Five vegetable *Pterocarpus soyauxii* ("oha"), *pterocarpus santalinidies* ("nturukpa"), *Gongronema latifolium* (utazi), *Corchorus olitorious* ("ahihara") and *Amaranthis Hybridus* ("green") were harvested from farm. Some of the leafy vegetable were wrapped and some unwrapped. They were analyzed for minerals using standard analytical methods.

Results: Among these five leafy vegetable, *Gongronema latifolium* ("utazi") had the highest contents 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 were decrease in the level of minerals in all the five leafy vegetable with increases in the time of holding. The rate and percentage of loss of minerals among the leafy vegetables varied depending on the method and time of holding. Unwrapped leafy vegetable held day and night in a room recorded the highest percentage loss of minerals. While the wrapped leafy vegetable 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 vegetable was influenced by their temperature, the lower the temperature the less the loss of minerals.

Keywords: Leafy Vegetables, Vitamins, Time, Method, Loss.

Introduction

Leafy vegetable are important as food from both economic and nutritional standpoint. They are plant item that are generally eaten with the main course of meal (1). Leafy vegetable are consumed as cooked compliments 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 vegetable are eaten by all economic classes. They are important source 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 bulk to the nutritional component in the diet of the people where animal products are scarce (6). They also add flavour, variety and aesthetic appeal to diet. Leafy vegetable have low energy density and are recommended for weight management (7). The fiber in leafy vegetable 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 the leafy vegetable 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 vegetable. Leafy vegetable 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 vegetable 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 vegetable could be extended for much longer time under cold temperature storage. Unfortunately the cold temperature storage facilities are not available to large population of Nigerians. As a result more than 95% of Nigerians hold their harvested or surplus vegetable 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 board leaves of banana or cocoyam and keeping the wrapped leaves in a shade. The length of time and method of holding 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 vegetable and to evaluate the effects of holding methods and time on the minerals.

Materials and Methods

Source of Materials

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

Sample preparation

Some leaves destalked from the above fine leafy vegetable were analyzed for potassium, sodium, calcium, Magnesium and iron few hours after harvest. Subsequently, each of the leafy vegetable samples was divided into three lot (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.

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 550°C. The resulting ash was dissolved in 10ml diluted hydrochloric acid (0.10N). This ash solution was further diluted with 90 ml of distilled water to get 100ml mark.

Sodium and potassium contents of each lot were determined with flame photometer using the method described by James (11). Calcium and magnesium contents of test sample were determined by versenate ethylenediamine tetraacetic acid (EDTA) compleximetric 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.

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 significances was also calculated for mineral contents 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 vegetable was calculated at the end of four days holding period based on the initial or zero day value.

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 vegetable ranged from 53.40 - 78.54 mg/100g and 43.24 - 68.30 mg/100g respectively. It has been reported by Afolabi that potassium content of leafy vegetable is as high as 33.2 mg/100g (13). This value is less than the range reported for the above three leafy vegetable. 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 11.50 mg/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 6.83-7.82 mg/100g iron. The 54.30 mg/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 functionally 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 20mg and 30mg respectively (21). The deficiency of iron result 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 and dietary component 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. Afolabi (13) reported a similar value (54.0mg/100g) for utazi. Daily requirement of magnesium is about 300 - 350 mg (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). The level of sodium in the five leafy vegetable is low. 'Nturukpa' contains the lowest value of 9.45 mg/100g sodium while the highest value of 38.90 mg/100g was recorded for green. Akubugwo et al. reported very low value of 7.43 mg per 100g of green (19). The difference could be due to variation in soil fertility, use of fertilizer, and analytical methods.

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 leaf vegetable 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 vegetable as the time of holding was increased. The percentage loss for individual minerals differed among the leafy vegetable and methods of holding. For instance, the level of potassium in unwrapped oha held throughout in a shade decreased by 22% (table 2). It dropped from day of holding. Also, the potassium content of unwrapped anihara held both day and night in a shade decreased from 28.57 mg/100g recorded zero day to 19.45mg/100g on the fourth day of holding. This translated to 31.92% loss of the mineral. The decrease in the mineral contents of the leafy vegetable with increase in time of holding had earlier been reported by Okwu for fruits and vegetables (25). Serrano et al. also noted high prolonged storage of fruits and leafy vegetable 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. The reasons for differences in the percentage loss of minerals among the leafy vegetable 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).

Again 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). 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 vegetable 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 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 vegetable. This could be due to evaporative cooling of the leafy vegetable brought about by the moisture that was released through transportation and respiration. The unwrapped leafy vegetable 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.

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.

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239 **Table 1: Mineral Compositions of the Five Nigerian Leafy Vegetables**

Mineral	mg/100g					LSD
	OH	NT	UT	AH	GR	
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±0.24c	7.82±0.72a	6.83±025 ^b	4.92±0.21 ^c	0.95

240 Means ± standard deviations. Means not followed by the same letter(s) across the rows are significantly different (~~p<0.05~~)
241 OH = oha; NT = nturukpa; UT = utazi; Ah = ahihiara; GR = green
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246 **Table 2: Potassium content and the percentage losses as influenced by holding methods and time**
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Holding Time (Day)			Unwrapped			Unwrapped/Exposure to Night Atmosphere					Wrapped				
	OH	NT	UT (mg/100g)	AH	GR	OH	NT	UT (mg/100g)	AH	GR	OH	NT	UT (mg/100)	AH	GR
0	53.40	23.65	78.54	28.57	45.92	53.40	23.65	78.54	28.57	45.92	53.40	23.65	78.54	28.57	45.92
	±0.40	±0.08	±0.61	±0.21	±0.21	±0.40	±0.08	±0.61	±0.43	±0.21	±0.40	±0.08	±0.61	±0.43	±0.21
1	50.24	19.24	72.40	26.92	43.24	51.85	21.60	75.85	27.85	44.36	52.76	22.78	75036	.28.19	44.85
	±0.06	±0.12	±0.62	±0.50	±0.22	±0.24	±0.47	±0.30	±0.70	±0.24	±0.35	±0.18	±0.30	±0.24	±0.41
2	48.72	18.30	69.24	25.48	41.08	50.05	20.24	72.82	26.30	42.75	50.04	21.60	75.36	27.60	42.20
	±0.13	±0.06	±0.24	±0.36	±0.45	±0.20	±0.17	±0.25	±0.44	±0.32	±0.14	±0.28	±0.31	±0.27	±0.36
3	45.30	16.38	65.30	23.80	40.32	46.17	18.78	72.08	24.16	41.30	48.38	20.32	74.80	25.46	41.86
	±0.32	±0.24	±0.71	±0.60	±0.24	±0.24	±0.33	±0.57	±0.21	±0.36	±0.17	±0.45	±0.60	±0.63	±0.18
4	41.65	15.92	63.45	19.45	32.60	43.75	16.24	70.35	21.78	39.24	45.60	18.45	71.63	23.62	40.30
	±0.33	±0.30	±0.32	±0.31	±0.71	±0.44	±0.37	±0.70	±0.32	±0.38	±0.42	±0.27	±0.21	±0.64	±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

248 Means ± sd of triplicates. OH = oha, NT = nturukpa, UT = utazi, AH = ahihiara, and GR = green
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254 Table 3: Sodium content and the percentage losses as influenced by holding methods and time
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Holding Time (Day)	Unwrapped					Unwrapped/Exposure to Night Atmosphere					Wrapped				
	OR	NT	UT (mg/100g)	AH	GR	OH	NT	UT (mg/100g)	AH	GR	OR	NT	UT (mg/100g)	AH	GR
0	11.78	9.45	28.10	19.15	38.90	11.78	9.45	28.10	19.15	38.90	11.78	9.45	28.10	19.15	38.90
	±0.17	±0.53	±0.41	±0.60	±0.32	±0.17	±0.53	±0.52	±0.62	±0.39	±0.17	0.53	0.53	0.60	0.31
1	10.30	8.16	25.40	18.30	37.06	11.16	9.12	26.30	18.95	37.20	11.24	9.28	27.56	19.06	38.24
	±0.24	±0.24	±0.30	±0.21	±0.21	±0.39	±0.22	±0.69	±0.45	±0.26	±0.17	±0.48	±0.71	±0.50	±0.31
2	8.26	7.90	21.60	17.38	34.24	9.62	8.95	24.16	18.20	36.28	10.90	9.02	25.30	18.31	37.60
	±0.39	0.41	±0.40	±0.60	±0.60	±0.20	±0.24	±0.70	±0.72	±0.33	±0.27	±0.10	±0.22	±0.42	±0.36
3	7.94	5.70	19.45	33.80	8.40	8.40	6.24	23.85	15.32	34.08	10.05	8.74	24.60	16.62	35.23
	±0.27	±0.51	±0.44	±0.64	±0.24	±0.47	±0.20	±0.21	±0.32	±0.42	±0.32	±0.45	±0.32	±0.64	±0.24
4	6.24	4.28	15.40	8.92	29.44	8.16	5.88	19.40	13.65	33.20	8.30	6.30	21.78	14.72	34.16
	±0.33	±0.62	±0.34	±0.60	±0.32	±0.45	±0.35	±0.15	±0.41	±0.22	±0.33	±0.28	±0.26	±0.56	±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

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

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Holding Time (Day)	OH	NT	Unwrapped			Unwrapped/Exposure to Night Atmosphere					OH	NT	Wrapped		
			UT (mg/100g)	AH	GR	OH	NT	UT (mg/100g)	AH	GR			UT (mg/100g)	AH	GR
0	43.24	32.70	68.30	31.53	52.48	43.24	32.70	68.30	31.55	52.48	43.24	32.70	68.30	31.55	52.48
	±0.24	±0.75	±0.52	±0.18	±0.42	±0.75	±0.75	±0.52	±0.18	±0.42	±0.24	±0.75	±0.52	±0.18	±0.42
1	39.25	29.16	66.25	30.24	50.16	40.36	30.92	66.70	30.95	50.72	41.28	31.28	67.16	31.15	51.30
	±0.22	±0.11	±0.41	±0.15	±0.36	±0.24	±0.30	±0.22	±0.28	±0.21	±0.44	±0.47	±0.21	±0.52	±0.56
2	37.60	27.78	63.80	27.30	47.58	38.42	29.16	64.70	29.62	49.24	40.85	30.45	66.18	30.75	50.62
	±0.17	±0.22	±0.53	±0.32	±0.36	±0.16	±0.39	±0.41	±0.42	±0.72	±0.36	±0.39	±0.25	±0.60	±0.64
3	33.80	24.30	62.70	26.45	45.36	35.26	26.45	63.40	28.32	46.24	36.75	29.34	65.74	30.28	48.30
	±0.14	±0.36	±0.22	±0.19	±0.19	±0.33	±0.35	±0.26	±0.75	±0.42	±0.45	±0.33	±0.15	±0.32	±0.42
4	28.36	21.09	58.16	25.90	40.20	30.20	23.62	59.40	27.65	43.45	32.28	25.46	63.62	29.16	45.28
	±0.14	±0.24	±0.32	±0.50	±0.62	±0.24	±0.66	±0.75	±0.52	±0.24	±0.28	±0.33	±0.62	±0.42	±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

264 **Table 5: Magnesium content and the percentage losses as influenced by holding methods and time**

Holding Time (Day)	Unwrapped					Unwrapped/Exposure to Night Atmosphere					Wrapped				
	OH	NT	UT (mg/100g)	AH	GR	OH	NT	UT (mg/100g)	AH	GR	OH	NT	UT (mg/100g)	AH	GR
0	19.45	13.62	54.60	28.84	27.60	19.45	13.62	54.60	28.84	27.60	19.45	13.62	54.60	28.84	27.60
	±0.35	±0.71	±0.40	±0.22	±0.46	±0.35	±0.71	±0.40	±0.28	±0.46	±0.35	±0.71	±0.40	±0.22	±0.46
1	18.06	11.28	53.80	26.72	26.30	18.28	12.42	54.16	27.00	26.85	19.16	12.95	54.28	27.60	27.16
	±0.24	±0.17	±0.30	±0.41	±0.31	±0.17	±0.30	±0.30	±0.36	±0.42	±0.24	±0.24	±0.52	±0.56	±0.45
2	14.24	8.74	51.36	24.15	24.75	15.70	10.85	52.5	25.10	25.21	17.32	11.30	53.30	25.26	25.43
	±0.33	±0.69	±0.51	±0.20	±0.45	±0.48	±0.53	±0.41	±0.22	±0.82	±0.26	±0.20	±0.26	±0.39	±0.23
3	11.36	7.28	50.24	21.80	22.84	13.62	8.70	51.62	24.34	23.80	16.85	9.24	52.45	24.88	24.32
	±0.54	±0.24	±0.42	±0.20	±0.14	±0.24	±0.17	±0.27	±0.51	±0.62	±0.33	±0.24	±0.42	±0.28	±0.63
4	9.30	5.6	47.82	19.76	19.60	12.58	6.30	50.12	22.25	21.30	14.70	8.72	47.82	23.85	22.45
	±0.24	±0.17	±0.60	±0.71	±0.60	±0.30	±0.10	±0.60	±0.85	±0.70	±0.75	±0.33	±0.61	±0.41	±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	7.3	20.08	18.60

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

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Holding Time (Day)	Unwrapped					Unwrapped/Exposure to Night Atmosphere					Wrapped				
	OH	NT	UT (mg/100g)	AH	GR	OH	NT	UT (mg/100)	AH	GR	OH	NT	UT (mg/100g)	AH	GR
0	6.83	4.08	7.82	6.83	4.92	6.83	4.08	7.82	6.83	4.92	6.83	4.08	7.82	6.83	4.92
	±0.31	±0.24	±0.72	±0.25	±0.21	±0.31	±0.24	±0.72	±0.25	±0.21	±0.24	±0.24	±0.72	±0.31	±0.21
1	5.80	3.40	6.20	5.16	4.18	5.95	3.82	6.94	5.85	4.24	6.30	3.95	7.16	6.16	4.70
	±0.07	±0.21	±0.60	±0.60	±0.42	±0.24	±0.33	±0.27	±0.45	±0.26	±0.42	±0.19	±0.80	±0.71	±0.56
2	5.05	2.90	5.31	4.12	3.75	5.12	3.40	6.18	5.30	3.90	6.16	3.62	6.94	5.92	4.08
	±0.30	±0.17	±0.50	±0.30	±0.08	±0.26	±0.17	±0.42	±0.28	±0.25	±0.17	±0.26	±0.20	±0.60	±0.42
3	4.30	2.16	4.95	2.85	2.90	4.85	2.78	5.85	3.95	3.74	3.74	5.74	2.95	4.76	3.92
	±0.35	±0.10	±0.71	±0.08	±0.10	±0.53	±0.24	±.33	±0.62	±0.62	±0.55	±0.20	±0.42	±0.62	±0.27
4	3.18	1.80	3.82	2.30	2.58	3.24	2.40	4.78	3.16	2.70	3.60	2.60	5.16	3.24	2.85
	±0.24	±0.09	±0.10	±0.10	±0.00	±0.17	±0.41	±0.25	±0.75	±0.41	±0.18	±0.24	±0.31	±0.46	±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

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