EFFECT OF PRESERVATION METHODS AND STORAGE ON NUTRITIONAL QUALITY AND SENSORY PROPERTIES LEAFY VEGETABLES CONSUMED IN NIGERIA

Sobowale, S.S[1*], Olatidoye, O.P[2], Olorode, O.O[1] and Sokeye, O.K[3]
[1]Department of Food Science and Technology, Moshood Abiola polytechnic, Nigeria
[2]Department of Food Science and Technology, Igbinedion University Okada, Nigeria
[3]Department of Food Technology, Federal polytechnic, Ilaro, Nigeria.
E-mail: waledoye@yahoo.com

ABSTRACT

In Nigeria, leafy vegetables are preserved by sun-drying and used like freshly harvested vegetables in soups. An experiment to investigate the effect of different drying methods on the nutritional quality and sensory qualities of leafy vegetable (Celosia argentea, fluted pumpkin leaf (Telfaria accidentalis) and waterleaf (Talinum triangulare) was conducted. The leafy vegetables were washed, shredded, weighed and divided into four equal parts. one part (1kg) was subjected to sun drying for 5 hrs daily for 2 days, while the other three parts(1kg each) was subjected to blanching, cooking and oven drying at a temperature of 45^0C until constant was attained. The dried leafy vegetables (sun-dried and oven-dried) were milled into coarse using hand milling machine. Samples (250g each) of fresh (raw), sun-dried, oven-dried, blanched and cooked vegetables were used separately to prepared soup for 5min in soups. K, Fe, Na, Mg and Ca were the predominant mineral elements analyzed. Sun drying caused significant ($P \leq 0.05$) reductions in the K, Na, Ca, Mg, Zn, Fe, and P contents of the vegetables and accounted for 44.8-47.1% loss of vitamin C while oven drying accounted for 36.8–39.6% respectively. Among the treatments, cooking accounted for 64.3–67.5% loss of vitamin C while blanching and sun drying accounted for 44.8-47.1% and 36.8–39.6% respectively. Panelists rated the soups significantly ($P\leq 0.05$) higher for colour, taste, texture, flavour and overall acceptability. Fresh fluted pumpkin soup was rated significantly ($P\leq 0.05$) higher for colour, taste, texture and flavour characteristics, while fresh water leaf vegetable soup was highly rated for taste, flavour and overall acceptability. When compared with other dried vegetable soups, dried water leaf vegetable soup had the highest score for flavour and taste while dried fluted pumpkin soup had the highest score for colour and overall acceptability. Generally, panelists preferred the fresh to dried vegetable soups.

Keywords: Sun-dried, Oven-dried, Blanching, Cooking, Nutritional quality, sensory properties, Leafy-vegetables

INTRODUCTION

The most serious threat to survival of humanity is the increasing gap between population growth and food supply. It has been estimated that over 500 million people in the world today are malnourished [1]. Much effort has been concentrated on seeds while leafy vegetables sources have been ignored. Leaves are reportedly inexpensive and easy to cook and rich in vitamins and provide roughage [2]. Vegetables play an important role in human nutrition, especially as a source of vitamins (A, B, C and E), minerals and dietary fibre [3]. They are also rich in carotenoids as well as in iron, calcium, ascorbic acid, riboflavin and folic acid and appreciable amounts of other minerals [4,5,6,]. Nuts, fruits and vegetables are known to contribute 91%of vitamin C, 48% of vitamin A, 27% of vitamin B, 17% thiamine

and 15% niacin in the U.S diets. Vegetables also supply 16% of Mg,19% of Fe and 9% of the per capital availability of protein in the U.S diets and their protein are of high quality due to their proportion of essential amino acid content. Other important nutrients supplied by vegetables include folic acid, riboflavin, Zinc, calcium, potassium and phosphorus [8,9] Gockowski et al., 2003, ECHO, 2003]. Vegetables play crucial roles in alleviating hunger and food security by contributing bulk of the nutritional components in the diets of people where animal products are scarce.

For perishable commodities with very high moisture contents, dehydration results in substantial reduction in weight and bulk with consequent savings in storage and distribution costs. Echetama *et al.,* [10] 1997] reported that Okra dehydrated in a solar dryer with appropriate pre-drying treatments compared favourably in quality with frozen okra. According to Fellows [11] 1990] blanching at 88^0C stop all life process, inactivates enzymes, fixes green colour and removes certain harsh flavour common in vegetables. Cooking also causes significant changes in the nutritional properties of foods as well as gelatinization of starches and coagulation of proteins to improve their digestibility and sensory properties [11]. To the consumer, the most important attributes of a food are its sensory characteristics. These determine an individual's preference for specific products, and small difference between brands of similar products can have a substantial influence on acceptability.

Different processing and preservation methods can revealed the conditions for optimal nutritional quality and for an appreciable shelf life without any consideration for its sensory characteristics. Kays [12] 1999] indicated that the appearance and colour are the main criteria to be considered to assess. Onayemi and Badifu [13] 1987] proved that sun-dried vegetables had inferior colour, texture and acceptability compared to the vegetables dried in the cabinet dryer. The different methods of processing and preservation can therefore have an effect on the organoleptic properties of vegetables and the overall acceptability by the consumer. The outstanding preservative method practiced in many homes in Nigeria is sun-drying which may/or not combine with blanching and cooking of vegetables in soup preparation have considerable effects on the nutritive value and sensory acceptability of final products. This study is aimed at studying the effect of these preservation methods on the nutritive and sensory properties of Celosia argentea, Telfaria accidentalis and Talinum triangulare.

MATERIAL AND METHODS

Preparation of samples: The young shoots and fresh leaves of these vegetables species were harvested from an experimental farm in Okada and the rinsed in water to remove dust. They were then sorted and sliced. The drying was carried out by the method described by [14]. The leafy vegetable was weighed and divided into two parts for the drying process. A part was sun-dried for 12 hours while the remaining parts were dried at 45^0C to constant weight. In another experiment one kilogramme each of the vegetables were blanched following the methods described by [15]. Briefly, Ikg each of the vegetables were blanched in hot water at 100^0C for 5-6mins and rapidly cooled to 20^0C in a freezer. The minimum blanching time which is a function of enzyme inactivation was determined by testing for

peroxides activity after introducing the vegetables into hot water at 100^0C for periods of time up to six minute [5].

Chemical analysis: The recommended methods of the Association of Official Analytical Chemists [17] were adopted for the determination of proximate composition of ground samples of raw, blanched, cooked, sun-dried, and oven dried vegetables. The moisture content was determined by air-oven drying at 130^0C for 1 hr, and the crude protein contents by microKjeldah method (% protein = N x 6.25). The lipid content was determined using petroleum ether (b.p 60-80^0C) in a soxhlet extraction apparatus and crude fiber content by dilute acid and alkali hydrolysis. Carbohydrate content was calculated by difference of total contents from 100.Phosphorus was determined by the phosphomolybdate method of [18]. Sodium and potassium were determined by flame photometer (Jenway, PF 7, Essex UK) while calcium, magnesium, iron and zinc were determined by Atomic absorption spectrophotometer (Unicam Analytical system, Model 919, Cambridge, UK. Vitamin C was assayed by visual titration with 2, 6 dichlorophenol solution. Vitamin

Sensory evaluation: A twenty-five member sensory panel consisting of 15 male and 10 female students, who are regular consumers of vegetable soups and familiar with the attributes, investigated the sensory qualities of the prepared soups. The soup samples were coded with four digit letters and evaluated soup samples for colour, taste, flavour, texture and overall acceptability characteristics on a 9 point hedonic scale as proposed by [19].

Statistical analysis: All data obtained in triplicate were subjected to analysis of variance (ANOVA) using the SPSS statistical package (version 10.0), (2000 edition).

RESULTS AND DISCUSSION

Table 1 shows the effects of processing treatments on nutrient contents of the indigenous vegetables. The protein contents of fluted pumpkin ranged from 1.6–2.4mg/100g while the crude fiber contents ranged from 1.5-2.6mg/100g. The moisture contents of the sun-dried sample decreased significantly ($P \leq 0.05$) with corresponding increase in the contents of dry matter. Talinun triangulare and celosia argentea had protein contents ranging from 3.2–3.5 and 3.0-3.4mg/100g respectively. Generally, sun-dried vegetables had significantly ($P \leq 0.05$) lower moisture contents than raw and oven vegetables. Sun-drying resulted in a loss of 31.4% moisture but an increase of 0.6% protein and 1.1% crude fiber in fluted pumpkin leaves. Generally, the results (Table1) indicate that the vegetables were good sources of proteins, crude fiber and carbohydrates. Higher protein contents were recorded for celosia argentea, talinum triangulare and Telfairia occidentalis leaves. These results are in accordance with those in literature [20, 21, 22].

Our results also indicated that sun-drying at 30 ± 10^0C and RH 80-85% for 10hr resulted in a mean moisture contents of 30.7% with insignificant ($P>0.05$) crude fiber and total ash contents of treated vegetables. Similarly, Mandhyan [22] observed that sun-drying at 34-39^0C and RH 40-75% for 16hr caused significant reductions (60.5%) in moisture contents of spinach, cabbage, carrots and peas. Accordingly, reductions in moisture contents resulted in

corresponding increases in dry matter contents due to concentration of soluble solids with relatively chemically stable products. Ajayi and Onayemi [15] similarly observed that blanching had variable effects on dry matter composition with insignificant ($P>0.05$) reductions in lipid, crude fiber, total ash and carbohydrate contents but had no effect on the protein content of the vegetables. Heating is one of the most important methods developed to extend the shelf life of foods and increasing the availability of nutrients to consumers. The reduced protein contents of dried vegetables could be attributed to the severity of thermal process during drying [24] Lund, 1997].

The effects of processing treatments on mineral contents of test vegetables are given in Table 2. Sun-drying had variable effects on the mineral contents of the experimental vegetables. K, Mg and Ca were the predominant minerals analyzed while contents of Zn and P were low. The concentrations of minerals elements vary significantly ($P\leq0.05$) with treatments, with higher concentrations in the sun-dried samples. Celosia argentea and fluted pumpkin had the highest contents of Fe, Ca and Na respectively. Data on mineral analysis (Table 2) indicate that sun-drying caused significant ($P \leq0.05$) reductions in the K, Na, Ca, Zn and P contents of the vegetables. Oladunmoye [25] observed significant ($P\leq0.05$) reductions in K, Na, Ca, P, Fe and vitamin C contents of blanched and cooked tender and matured cassava leaves. Uzoekwe and Ukhun [26] also reported reductions in the Fe, and Zn contents of scent leaf (Ocimum gratissimum), gnectum vegetable, bitter leaf (Veronica amygdalina), bush okro and green pepper (Piper gunineense).

The result for mineral analysis of the vegetables suggests consumption of large quantities to meet the Recommended Daily Allowance Adult minimum K requirement for health set by the 1989 RDA is 2000mg daily. K is a primary electrolyte and major cation inside the cell and low blood K is a life – threatening problem [27]. Similarly, consumption of large amounts of fluted pumpkin, celosia argentea or talinun triangulare vegetable would be important to meeting the RDA for Na. A Na intake of less than 2g/day increases calcium loss in urine and high intakes can contribute to hypertension in some people [27]. Therefore the low level of Na in Talinum triangulare *leaves* make them suitable for use in Na restricted diets. Calcium is probably mainly associated with the pectic substance of the cell wall and could significantly influence texture. Its high content in fruit vegetables such as *tomatoes* was expected. Its low contents in leafy vegetables suggest a low intake by vegetarians that must seek alternative sources to meet their needs for calcium. This is important because the cells need calcium and more than 99% of calcium in the body is used as a structural component of bones and teeth. This represents about 40% of all the minerals present in the body [27].

Fluted pumpkin had the highest magnesium content while moderate concentrations were recorded in other leafy vegetables. Magnesium occurs abundantly in chloroplasts as a constituent of chlorophyll molecule. Its low concentrations in most of the vegetables could be attributed to age of plants and cultural practices. The levels obtained in this studies is low to meet the Recommended Daily Allowance (RDA) of 400mg/day for men 19-30 years old and 310mg/day for women 19-30 years old[28]. The levels of phosphorus obtained were similarly low. Phosphorus is a constituent of cytoplasm and nuclear protein, phospholipids and nucleic

acids, as well as taking important part in carbohydrate metabolism. Efficient absorption plus the wide availability in foods makes phosphorus a much less important mineral than calcium [28] in diet planning.

Table 3 gives the Vitamin C contents of the three processed vegetables. The Vitamin C contents of raw vegetables ranged from 37.5 – 205.4mg/100g. The treatments (sun-drying and oven drying) caused significant ($P \leq 0.05$) losses of Vitamin C. Fluted pumpkin leaves had a significantly ($P \leq 0.05$) higher vitamin C content than all the tested samples while Talinum triangulare had the lowest vitamin C content. Sun-drying accounted for 26.5-62.5% losses. Vitamin C contents (mg/100g) up to 20.0, 21.3, 25.3, 59.7, 42.3, and 38.7 have been reported in cabbage, lettuce, endives, spinach, spinach beet, and spinach beet leaves respectively [29]. Values obtained in this study are in close agreement with the reports in literature [30, 31, 32, 33]. Addo [34] reported a low level loss of 21.3-36.5% of ascorbic acid in sun-dried vegetables than in cooked vegetables. He reported that losses varied with vegetable cultivars, as shown in fresh pepper losing 45% of its vitamin C content while baobab leaves retained 65% of its vitamin C contents. This observation shows that the thickness and size of vegetable pieces determine the effectiveness of drying.

The reported losses of ascorbic acid during drying may vary between 40 and 70% in some vegetables [31, 32, 35]. These values are in close agreement with the results obtained for this study. The high solubility of ascorbic acid in water and the relative ease with which it is oxidized makes this vitamin particularly susceptible to processing conditions. The rate of oxidation of ascorbic acid is influenced by several factors such as pH, trace metals, enzymes, presence of oxygen, time and temperature. Precooking preparation of vegetables may cause ascorbic acid oxidase to react with molecular oxygen and cause direct destruction of the vitamins. Atmospheric oxidation of ascorbic acid also occurs during cooking of soups which is catalyzed by natural copper, iron and anthocyanin which occur in the vegetables [36].

Table 4 shows the summary of scores for the sensory characteristics of soups prepared with fresh and dried vegetables by the panelists. The Panelists rated the vegetable soups significantly ($P \leq 0.05$) higher for their colour, taste, texture, flavour and overall acceptability. Soups prepared with fresh fluted pumpkin was rated significantly ($P \leq 0.05$) higher than other soups for colour and overall acceptability while soups prepared with dried celosia vegetable leaves had the least score. Similarly, fresh water leaf vegetable and fresh fluted pumpkin vegetable soups were rated significantly ($P \leq 0.05$) higher than other soups for taste and texture attributes. Fresh water leaf vegetable soups had the highest scores for flavour while dried celosia soup was lowest for these attribute. Dried celosia soup also had the least score for all the tested attributes while fresh fluted pumpkin vegetable soups had the highest score for colour, texture, and overall acceptability. Considering panel rating of the soups; fresh fluted pumpkin vegetable soups scored 81.0% while fresh water leaf soup had 77.0% of the total attribute scores and fresh celosia soup scored 69.0% of the total scores for the attributes studied. Generally, panelists preferred the fresh vegetable soups to the dried vegetable soups. Ajayi and Onayemi [15] have reported that sun-dried vegetables are generally of poor quality especially as their colour and taste are compromised.

CONCLUSION

Sun drying at 30^0C ± 10^0C and RH 80 -85% for 10hrs resulted in a mean moisture loss of 5.6% with insignificant (P >0.05) reductions in proteins, lipid, crude fiber and total ash contents of treated vegetables. Sun–dried had higher dry matter contents than raw and oven vegetables. Sun-drying caused significant (P ≤ 0.05) reductions in the K, Na, Ca, Zn, Fe and P contents of celosia argentea and fluted pumpkin, The mineral contents of the samples vary with processing treatments with significantly (P ≤ 0.05) higher concentrations in raw and sun–dried vegetables. Sun-drying accounted for 44.8-47.1% and 36.8 – 39.6% losses respectively. Generally, panelists preferred the fresh vegetable to dried vegetable soups.

Table 1:Effect of treatment on proximate composition of selected leafy vegetables

Treatment	Moisture (%)	Crude Protein (%)	Lipid (%)	Crude Fiber (%)	Total Ash (%)	Carbohydrate (by difference) (%)
Fluted pumpkin						
Raw	90.1[c]	1.6[a]	0.9[a]	1.5[a]	2.1[a]	3.8[a]
Blanched	89.4[c]	1.5[a]	0.8	1.9[a]	2.9[a]	3.5
Cooked	67.0[b]	1.3[a]	0.5	2.5[a]	2.8[a]	25.9
Sun-dried	58.7[a]	2.2[a]	1.4[a]	2.6[a]	3.1[a]	32.0[b]
Oven-dried	59.2[b]	2.4a	1.5[a]	2.6[a]	3.3[a]	31.0[b]
Talinum triangulare						
Raw	88.4[c]	3.2[a]	0.5[a]	1.4[a]	2.4[a]	4.1[a]
Blanched	87.2[c]	3.1[a]	0.4[a]	2.3[a]	3.0[a]	4.0
Cooked	65.6[b]	3.0[a]	0.3[a]	2.5[a]	3.2[a]	25.4
Sun-dried	57.2[a]	3.4[a]	0.6[a]	2.7[a]	3.4[a]	32.7[b]
Oven-dried	58.3[a]	3.5[a]	0.7[a]	2.8[a]	3.6[a]	31.1[b]
Celosia argentea						
Raw	86.2[c]	3.0[a]	0.4[a]	1.4[a]	2.2[a]	6.8[a]
Blanched	85.6[c]	2.8[a]	0.3[a]	2.1[a]	2.4[a]	6.8
Cooked	64.8[b]	2.7[a]	0.2[a]	2.5[a]	2.6[a]	27.2
Sun-dried	56.2[a]	3[a]	0.9[a]	2.6[a]	3.1[a]	33.8[b]
Oven-dried	58.0[a]	3.4[a]	0.9[a]	2.5[a]	3.0[a]	32.2[b]

abc Means in the same columns not followed by the same superscripts are significantly different (P≤ 0.05)

Table 2: Effect of treatment on mineral composition of selected leafy vegetables

Treatments	Constituents in mg/100g					
P	K	Na	Ca	Mg	Zn	Fe
			Fluted pumpkin			
Raw	2.8a±0.3	3.5a±0.3	0.5a± 0.3	3.6a±0.3	1.3a±0.3	8.0a±0.3
0.4a±0.3						
Blanched	2.6±0.2	3.4±0.2	0.4 ± 0.2	3.5±0.2	1.2±0.2	7.9 ±0.2
0.4± 0.2						
Cooked	2.5±0.2	3.4 ±0.2	0.4 ± 0.2	3.2 ±0.2	1.0±0.2	7.7±0.2
0.3± 0.2						
Sun-dried	3.0b±0.3	3.6b±0.1	0.5a± 0.2	3.7b±0.2	1.3a ±0.2	8.1b±0.1
0.4a±0.1						
Oven-dried	3.3c±0.3	3.7c±0.1	0.6b± 0.2	3.8c±0.2	1.3a± 0.2	8.2c±0.1
0.4a± 0.1						
			Talinum triangulare (water leaf)			
Raw	2.4b ±0.4	0.5a±0.4	0.7a ±0.1	0.7a±0.1	0.6a±0.1	0.4a±0.4
0.7a±0.3						
Blanched	2.3 ±0.2	0.4 ±0.2	0.6 ±0.2	0.5±0.2	0.5 ±0.2	0.3±0.2
0.6±0.2						
Cooked	2.2 ±0.2	0.3 ±0.2	0.5 ±0.2	0.5±0.2	0.4± 0.2	0.3± 0.2
0.5±0.2						
Sun-dried	2.3a ±0.2	0.6b ±0.1	0.7a±0.3	0.6b±0.3	0.6a± 0.1	0.5b± 0.2
0.8b±0.1						
Oven-dried	2.4a ±0.2	0.6b ±0.1	0.8b± 0.3	0.6b± 0.3	0.7b± 0.1	0.6c± 0.2
0.8b±0.1						
			Celosia argentea			
Raw	4.5a±0.1	3.6a±0.1	0.2a±0.1	0.4a±0.1	0.8a±0.1	11.8a±0.3
0.6a±0.1						
Blanched	4.3 ±0.2	3.5±0.2	0.1 ±0.2	0.3 ±0.2	0.7±0.2	11.5 ±0.2
0.5±0.2						
Cooked	4.2 ±0.2	3.4 ±0.2	0.1±0.2	0.3±0.2	0.6±0.2	11.2 ±0.2
0.4±0.2						
Sun-dried	4.6b±0.3	3.7b± 0.2	0.3b± 0.1	0.5b±0.1	0.9b±0.3	12.1b±0.1
0.6a±0.2						
Oven-dried	4.6b±0.3	3.8c±0.2	0.3b±0.1	0.6c±0.1	0.9b±0.2	12.1b±0.1
0.7b±0.2						

owed by the same

Table 3: Vitamin C contents of processed vegetables (mg/100g)

Samples	Fluted pumpkin	Talinum triangulare	Celosia argentea
Raw	165.4b		75.2a
76.6a			
Blanched	88.1c		55.1b
47.1a			
Cooked	55.4c		36.2b
34.8a			
Sun dried	102.0c		62.11b
55.2a			
Oven dried	105.2c		64.4c
56.8a			

Values are means of three determinations. Means in the row not followed by the same superscripts differ significantly (P≤ 0.05).

Table 4: Sensory attributes for soups prepared with fresh and dried vegetables

Soups	Colour	Taste	Flavour	Texture	Overall acceptability
Fresh pumpkin	8.4d	7.4e	7.1d	7.6c	8.4d
Dried pumpkin	6.4b	6.2a	6.0c	6.7b	6.4b
Fresh water leaf	8.2d	7.6e	7.6d	7.1c	8.0d
Dried water leaf	6.0b	6.7a	6.5a	6.2b	6.3b
Fresh celosia	7.2c	6.6c	7.4d	7.0c	7.2c
Dried celosia	5.8a	5.9a	6.0c	5.5a	5.2a

Means in the columns not followed by the same superscripts differ significantly (P≤ 0.05).

REFERENCES

FAO.1988. Traditional Food Plants. Food and Nutrition Paper. FAO, Rome, Italy, 42:1.

Oke 1966.

Aletor, V. and O. Adeogun, 1995. Chemical analysis of the fruit of *Vitex doniana* (Verbenaceae). Food Chem., 53: 375-379.

Devadas, R.P. and S. Saroja, 1980. Availability of Fe and â-carotene from *amaranthus* to children. In: Emmaus P (Ed), Proceeding of the 2nd *Amaranthus* Conference, Rodala

Ifon, ET. and O. Basir,1979. Nutritive value of some Nigerian leafy vegetables Part 3. Food Chem., 5: 231-235

Oshodi, A.A., 1992. Comparison of proteins, minerals and vitamin C content of some dried leafy vegetables. Pak. J. Sci. Industrial Res., 35: 267-269.

Ejoh, A. R., Tchouanguep, M. F. and Fokou, E. 1996. Nutrient composition of the leaves and flowers of *Colocasia esculenta* and the fruits of *Solanum melongena*. Plant Food for Human Nutr. 49:107-112.

Echetama JK, Ngoddy PO and K Mclean 1977 Okra dehydration in a see-saw solar dryer. Nigerian Food Journal 1:72-82.

Fellows P.1990 Food Processing Technology: *Principles and Practice*.West Sussex, England. Ellis Harwood limited.

Kays, S.J., 1999. Preharvest conditions affecting apprearance. Postharvest Bio. and Tec.,15: 233-247.

Onayemi, O. and G.I.O Badifu, 1987. Badifu Effect of blanching and drying methods on the nutritional and sensory quality of leafy vegetables, Plant Foods for Human Nutrition. 37: 291-298.

Mepha, HD. Eboh, L. & Banigo, D. B. 2004. Effect of processing treatments on the nutritional composition & consumer acceptance of some Nigeria edible leafy vegetables. African journal of biotechnology 4 (3):157-159.

Ajayi. JK and O Onayemi.1977. Effect of steam blanching and chemical treatments on the quality characteristics of some common leafy vegetables grown in Nigeria. Nigerian Food Journal,1: 68-71.

AOAC. 1987. Method of Analysis of the association of official chemist. Edited 2nd edition published by AVI publishing company Inc Westport Connecticut.

Yuen, SH and AO. Polland, 1995. The determination of phosphorus in plants and soils by molybdenum method. *Journal of the Science of Food and Agriculture* ; 6:223-225.

Larmond,E.1977. Laboratory Methods for Sensory Evaluation of Foods. Publication No.1637, Research branch, Department of Agriculture, Ottawa, Canada. pp. 33-37,57.

Shittu, TA., OA. Ogunmoyela and LO. Sanni, 1999. Nutrient retention and sensory es. *Proceedings:* 2 Technology. Abuja, pp 150-152.

Shittu TA and OA Ogunmoyela.2001. Water blanching treatment and nutrient retention in some Nigerian green leafy vegetables. *Proceedings:* 25th Annual Conference of the Nigerian Institute of Food Science and Technology, Lagos, 64-65.

Lyimo, MH, Nyagwegwe SN and AP Mnkeni 1991. Investigations of traditional food processing, preservation and storage on vegetable nutrients. *Plant Foods for Human Nutrition* 41: 53-57.

Mandhyan, BL, Abroal CM and HR Tijagi 1988 . Dehydration characteristics of winter vegetables. *Journal of Food Science and Technology*., 25 (1): 20-22.

Lund, DB. Effects of heat processing on nutrients.1977 In: *Nutritional Evaluation of Food Processing*, (R.Harris and E. Karmas, eds). The AVI Publishing Co. lnc. Westport, C.T. 205-230.

Oladunmoye OO, Ojeniyi S and AO Bankole. 2005. Mineral Composition of tender and matured cassava leaves after home cooking procedures. *Proceedings*: 29th Annual Conference of the Nigerian Inst. of Food Science and Technology. Eboyi State University, Abakaliki, 151-152.

Uzoekwe, NM and ME.Ukhun, 2005. Iron and Zinc contents of selected vegetable foods *proceeding*: 29th Annual Conference of the Nigerian Inst. of Food Science and Technology. Ebonyi State University, Abakaliki, p 137-139.

Wardlaw, GM and MW, Kessel, 2002. Minerals: Dietary needs, absorption, transport and excretion. In: *Perspectives in Nutrition* (5th edn), Mc Graw-Hil Companies Inc, 2002; pp418-464.

FNB. 1997 Food and Nutrition Board, Institute of medicine: Dietary Reference intakes for calcium, phosphorus, magnesium, vitamin D and Fluoride. Washington DC, National Academy Press.

Corazzi L, Azizzi A and A. Usai.1989 The content of ascorbic acid in vegetable products from cold green houses. Aliment (Pinerolo) 58:2127.

Solanke, OF and SO Awonorin. 2002. Kinetics of vitamin C degradation in some tropical green leafy vegetables during blanching. *Nigerian Food Journal.*20: 24-32.

Fafunso M and Bassir.O. 1987. Effect of cooking on vitamin C content of fresh leaves and wilted leaves. *Journal of Agriculture and Food Chemistry* 23: 9-17.

Oteng - Gyang K and JI Machu. 1987. Changes in the ascorbic acid content of some tropical leafy vegetable during traditional cooking and local *processing. Food Chemistry,* 23:

Mepba, H. D., Eboh, L. and Banigo, D.E.B. 2007. Effects of processing treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetables. Afr. J. Food Agric. Nutr. Dev.**7**(1):1-18.

Ado. AA.1983 Ascorbic acid contents of foods commonly consumed in the Northern states of Nigerian. Nigerian Food Journal, 1:129-133.

Bassir O and IR Umoh.1976 Nutrient changes in some Nigeria traditional foods during cooking. I. Vitamin changes. West African Journal of Biology and Applied Chemistry 9-13.

Ajayi SO, Oderinde SF and O Osibanjo. 1979. Vitamin losses in cooked fresh leafy vegetables. Food Chemistry*;* 5: 243-247.