# EFFECT OF PROCESSING METHODS ON THE NUTRITIONAL VALUE OF *AMARANTHUS HYBRIDUS L.*

***By***

**Oluwalana I.B.**

Department of Food Science and Technology, Federal University, Akure, P.M.B 704 Ondo State, Nigeria.

Correspondence author's E-mail Address and Telephone: iboluwalana@futa.edu.ng; ioluwalana2002@yahoo.com : GSM: +234-8033976209

## Abstract

*Leafy vegetables when freshly harvested are sliced and conventionally sun dried as a means of extending the shelf-life. Many reports have shown that such dried vegetables becomes dark brown (discoloured) and in many cases laden with dust and micro-organisms. Blanching as a means of inactivating enzymes and mechanical drying have been reported to minimise browning and contamination in many dried fruits and vegetables. This study therefore investigated the effects of blanching, sun drying and oven drying on proximate composition, mineral contents, vitamin C (ascorbic acid) and microbial load of Amaranthus hybridus. The vegetables were obtained from Bisi market in Ado–Ekiti, Nigeria. The vegetables were sorted, trimmed, washed, drained and divided into three portions of 500g, 1kg and 1.5kg respectively. The first portion (500g) was thinly spread on a 1.0 x 0.5 m² tray and sundried for 5 hours (hrs.); the second portion divided into two equal halves of 500g each and blanched at 80°C and 100°C for 5 minutes while the third portion was divided into three parts of 500g each and oven dried at 60°C, 70°C and 80°C in a hot air oven for 4 hrs. Each of the samples was analysed for proximate and mineral compositions using standard methods. Also, the vitamin C and the microbial load of the processed vegetable were determined using standard methods. The result showed a significant increase ($p<0.05$) in protein, carbohydrate and fat contents of oven dried and sundried samples comparatively with the fresh and blanched ones. Conversely the fresh and blanched samples were significantly ($p>0.05$) lower in ash content but high in moisture. The most abundant mineral in all the vegetable samples was potassium. The potassium content (mg/100g) range from 4.05 – 4.30 (i.e. 4.30, 4.25, 4.15 and 4.05) respectively. The fresh sample (A) had the highest vitamin C content (240mg/100g). The highest microbial load was found in sundried samples (D: $1.7x10^8$ cfu/g) and the least in the oven dried one (G: 0.7 x $10^8$ cfu/g). The overall result showed that heat processing had effects on nutritional values of Amaranthus hybridus. The oven dried samples tend to be freer from microbial load and retain more nutrients except vitamin C which decreased as it is heat labile.*

**Keywords**: *Amaranthus hybridus, blanching, sun-drying, oven drying and vitamin C (Ascorbic acid)*

**IJAFS 4, 2013, 15: 523- 529**
**Accepted for publication, September, 2013.**
***Cite as IJAFS 4 (1&2), Pp 523–529***

## Introduction

Vegetables are important as food both from economic and nutritional stand points. Their nutritive significance is their richness in minerals which is very essential in the maintenance of human health (Bolaji *et al*, 2008). They are noted to occupy an important place among the food crops as they provide adequate amount of vitamins and

minerals for human. Leafy vegetables are typically low in calories, low in fat, and high in protein per calories, high in dietary fibres. They are rich source of minerals (including Iron, Calcium, Potassium and Magnesium) and vitamins including vitamins K, C, E and many of the B vitamins. They are very high in phytochemicals such as Carotenoid, Lutein, and Folate. Vegetables are highly perishable, they loose their eating quality very rapidly after harvesting (Bolaji *et al*, 2008). Sugar content declines and the amount of cellulose increase, if allowed to stay long after harvest without proper processing or storage; they become witted and tough through lost of moisture. Likewise flavour is impaired due to enzymatic action and conversion of sugar to starch during wilting or loss of moisture (Ihekoronye and Ngoddy, 1985). Much of the ascorbic acid in leafy vegetables is reported to be lost through oxidation or leaching during heating or blanching processes
(Bolaji *et al*, 2008).

*Amaranthus hybridus* (Tete) is an herbaceous annual leafy vegetable that can be produced for fresh market in 4-6 weeks after planting (Mepba *et al*, 2007). It can be produced all the year round depending on the availability of water. It is readily accepted and has a good market value. This vegetable is one of the cheapest dark green leafy vegetables in tropical markets, possessing an excellent nutritional value because of its high contents of carotene, calcium, vitamin C, folic acid and other micronutrients. *Amaranthus hybridus* leaves combined with condiments are used to prepare soup (Mepba *et al*, 2007).
*Amaranthus hybridus,* along with other green leafy vegetables lose their eating quality and high nutrient contents very rapidly after harvest due to high rates of respiration at the high ambient temperature of between 28±2$^{o}$C in the tropics, mechanical damage during harvest, handling and transportation, resulting in quality deterioration.

The vegetable as with others are eaten raw or processed. Any methods selected for processing vegetables should be such that does not adversely affect the colour, texture, flavour and nutritional values especially the vitamins and minerals (Edeoga *et al,* 2006).
*Amaranthus hybridus* is highly perishable vegetable and therefore require special processing methods to prevent decomposition. These processing methods either change the nature and constituents of the vegetables. Previous works done on Amaranthus include evaluations of the mineral contents and proximate composition (Aletor and Adeogun, 1995), nutritional and chemical values of the vegetable (Akubugwo *et al*, 2007).

This study therefore is to determine the effects of processing methods such as blanching, sun-drying and oven-drying on the nutritional values of *Amaranthus hybridus.* The specific objectives being to determine the effects of processing methods (blanching, sun-drying and oven-drying) in minimizing browning, nutritional and microbial losses of *Amaranthus hybridus.*

## Materials And Methods

### Sample collection

The fresh *Amaranthus hybridus* were obtained from 'Bisi' market in Ado-Ekiti, Ekiti State which is a popular market for fruits and vegetables.

### Sample preparation

Leafy vegetables when freshly harvested are sliced and conventionally sun dried as a means of extending the shelf-life. However many reports have shown that such dried vegetables becomes dark brown (discoloured) and in many cases become laden with dust and micro-organisms. The vegetables were sorted to remove the unwholesome and extraneous materials in it in order to have a good quality sample, trimmed, washed with clean water, drained and divided into three portions of 500g, 1kg and 1.5kg respectively. The first portion (500g) was thinly spread on a 1.0 x 0.5 $m^2$ tray and sundried for 5 hours (hrs.) to simulate the conventional way of processing leafy vegetables; the second portion divided into two equal halves of 500g each and blanched at 80$^oC$ and 100$^oC$ for 5 minutes to inactivate the enzymes while the third portion was divided into three parts of 500g each and oven dried at 60$^oC$, 70$^oC$ and 80$^oC$ in a hot air oven for 4 hrs., to evaluate the effect of mechanical drying on the vegetable.

**Chemical analysis**

Each of the samples was analysed for proximate and mineral compositions using standard methods.The nutrient composition (crude fibre, ash, fat and protein) and Vit. C of the processed and unprocessed (Control) *Amaranthus hybridus* was determined using standard methods according to AOAC (2005). Sodium and potassium were determined using a flame photometer as described by AOAC (1984) Calcium, Iron and Magnesium with X-ray fluorescence (XRF).

**Microbial analysis**

The microbial load analysis of each samples of the vegetable was determined using pour plate count method as described by Onwuka (2005).

**Result and Discussion**

The result of the proximate composition of *Amaranthus hybridus* samples are shown in table 1. It shows that the moisture content (%) values obtained for the fresh and blanched samples (A,B and C) were significantly ($P < 0.05$) higher than that of the sun-dried and oven-dried. This shows that the rate of moisture migration from the sun dried and oven dried samples is higher than the fresh and the blanched samples. The latter samples (sun dried and oven dried) also contain more moisture than the former samples (fresh and blanched). The higher moisture contents observed in the fresh and blanched samples is an indication of high susceptibility to microbial spoilage. In order words, the sun-dried and oven-dried samples (i.e. D, E, F and G) which are characterized by lower moisture contents will keep longer than the latter. The moisture contents of the fresh (raw) and blanched samples were within the range (81.4-90.3%) of some Nigerian green leafy vegetables as reported by Olaiya and Adebisi (2010), Mepba *et al* 2007), Akubugwu *et al* ( 2007). The low moisture contents of the sun-dried (D) and oven-dried (E, F and D) samples were as a result of subjection to higher heat processing methods.

Conversely, the fresh and the blanched samples were significantly ($P > 0.05$) lower in ash content comparatively with the sun-dried and oven-dried ones. High ash content indicates inherent source of minerals in food. The total ash contents of fresh (raw) and blanched samples were similar to an earlier report by Olaiya and Adebisi (2010), Mepba (2007) while the values for the sun-dried and oven-dried were at variance with reports by Akubugwu *et al* (2007). Generally, the results are consistent with earlier reports by Ashaolu *et al* (2012). Appreciable significantly ($P<0.05$) increase in crude protein content was noticed in sun-dried (D) and oven-dried (E, F and G) vegetable samples. This could be due to concentration of protein as a result of moisture removal.

**Table 1: Effect of processing on the proximate composition (%) of *Amaranthus hybridus*.**

| Composition | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| Moisture | 87.50 ±0.50a | 86.50 ±0.50a | 86.50 ±0.50a | 9.50 ±0.5b | 9.00 ±0.50b | 8.50 ±0.50b | 8.00 ±0.50b |
| Ash | 3.00 ±0.50e | 2.60 ±0.10e | 2.60 ±0.10e | 15.50 ±0.50d | 18.50 ±0.20c | 22.50 ±0.50b | 25.50 ±0.50a |
| Protein | 4.30 ±0.10d | 4.20 ±0.10d | 4.10 ±0.10d | 18.50 ±0.50a | 17.50 ±0.50b | 17.00 ±0.20bc | 16.50 ±0.50c |
| Fat | 1.00 ±0.20d | 0.50 ±0.20e | 0.50 ±0.00e | 1.30 ±0.10c | 1.50 ±0.10ab | 1.70 ±0.20a | 1.80 ±0.30a |
| Crude fibre | 1.70 ±0.20c | 2.00 ±0.01b | 2.20 ±0.20b | 8.65 ±0.50a | 8.60 ±0.20a | 8.60 ±0.20a | 8.60 ±0.20a |
| Carbohydrates | 2.50 ±0.30f | 4.20 ±0.20e | 4.10 ±0.10e | 46.50 ±0.50a | 44.90 ±0.20b | 41.70 ±0.30c | 39.60 ±0.60d |

*Values are means of triplicate determinations. Values with different subscripts on the same row are significantly different at P≤0.05.*

***KEY:***
A = Fresh, B =Blanched at 80°C, C= Blanched at 100°C, D = Sun-dried, E= Oven-dried at 60°C, F = Oven-dried at 70°C, G= Oven-dried at 80°C

Plant food that provides more than 12% of its calorific value from protein is considered good source of protein (Pearson, 1976). Hence, Amaranthus can be considered as a good source of protein since it meet this requirement. The fat contents are generally low; however, the samples oven- dried at higher temperature (i.e. 70 and 80$^0$C) exhibited higher fat. The crude lipid range from 0.5-1.8, which is similar to an earlier report by Mepba *et al* (2007).

The fresh and blanched vegetable samples also had very low crude fibre compared with the sun-dried and oven-dried ones. Crude fibre is useful for maintaining bulk utility and increasing intestinal peristalsis by surface extension of the food in the intestinal tract (Mathenge, 1997). It is necessary for healthy condition, curing of nutritional disorders and for aiding food digestion. The carbohydrates of the fresh and blanched Amaranthus are extremely low compared with the sun-dried and oven-dried samples. Vegetables rich in carbohydrates are also rich in several antioxidants.

Table 2 shows the mineral composition of fresh, blanched, sun-dried and oven-dried *Amaranthus hybridus*. Generally, potassium was the most abundant mineral element, followed by sodium, iron, magnesium and calcium in all the samples. Except magnesium, other elements tend to decrease with heat treatment. The change in the mineral contents may be due to the breakdown of complex compounds into more simple forms. Magnesium is an important mineral element in connection with circulatory diseases such as heart diseases (Akubugwu *et al*, 2008), while iron is an essential trace element for hemoglobin formation, normal function for central nervous system and energy metabolism.

**Table 2: Mineral Composition of *Amaranthus hybridus* (mg/100g)**

| Mineral element | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| Calcium | 0.25[b] ±0.05 | 0.30[a] ±0.05 | 0.30[a] ±0.05 | 0.10[d] ±0.05 | 0.15[c] ±0.05 | 0.15[c] ±0.05 | 0.10[d] ±0.05 |
| Potassium | 4.30[a] ±0.14 | 4.25[b] ±0.35 | 4.25[b] ±0.35 | 4.15[c] ±0.07 | 4.25[b] ±0.35 | 4.25[b] ±0.35 | 4.05[d] ±0.07 |
| Sodium | 3.40[b] ±0.10 | 3.50[a] ±0.10 | 3.00[e] ±0.50 | 3.10[d] ±0.10 | 3.20[c] ±0.20 | 3.20[c] ±0.20 | 3.10[d] ±0.10 |
| Iron | 0.48[e] ±0.02 | 0.35[f] ±0.05 | 0.22[g] ±0.02 | 2.60[c] ±0.20 | 2.18[d] ±0.02 | 3.51[a] ±0.01 | 3.14[b] ±0.04 |
| Magnesium | 0.30[f] ±0.10 | 1.40[d] ±0.05 | 0.20[g] ±0.05 | 0.40[e] ±0.20 | 2.00[c] ±0.50 | 3.00[a] 0.20 | 2.20[b] ±0.20 |

*Values are means of triplicate determinations. Values with different subscripts on the same row are significantly different at P≤0.05.*

KEY:
A = Fresh, B =Blanched at 80°C, C= Blanched at 100°C, D = Sun-dried, E= Oven-dried at 60°C, F = Oven-dried at 70°C, G= Oven-dried at 80°C

Table 3 shows ascorbic acid content of *Amaranthus hybridus.* The results showed that the fresh sample was the richest in vitamin C, followed by sun-dried and oven-dried samples respectively. The decrease in vitamin C content may be due to the fact that vitamin C is heat labile in nature. In other words, the higher the temperature the more the likelihood of reduction in vitamin C. Similar observation was reported by Olaiya and Adebisi (2010).

**Table 3: Vitamin C Content (Ascorbic acid) *Amaranthus hybridus* (mg/100g)**

| Samples | Vitamin C content |
|---|---|
| Fresh | 240±0.50 |
| Blanched at 80°C | 200±0.50 |
| Blanched 100°C | 180±0.50 |
| Sun-dried | 200±0.50 |
| Oven-dried at 60°C | 160±0.50 |
| Oven-dried at 70°C | 120±0.50 |
| Oven-dried at 80°C | 80±0.50 |

*Values are means of triplicate determinations. Values with different subscripts on the same row are significantly different at P≤0.05.*
KEY:
A = Fresh, B =Blanched at 80$^o$C, C= Blanched at 100$^o$C, D = Sun-dried, E= Oven-dried at 60$^o$C, F = Oven-dried at 70$^o$C, G= Oven-dried at 80$^o$C

Table 4 showed the result obtained on microbial load analysis that was carried out on each samples of the vegetable *(Amaranthus hybridus).* It showed that sun-dried method had the highest microbial load (1.7 X $10^8$ Cfu/g) followed by the fresh sample which is (1.5 X $10^8$ Cfu/g). The sample that had the least microbial load was the oven-dried Sample G at 80$^0$C: (0.7 x $10^8$ cfu/g). The sample with the highest microbial load could be due to exposure to air and dust. The heat application with the exception of blanching must have reduced the moisture content which can aid the growth of microorganisms that can contribute to the microbial load.

**Table 4: Total Microbial count of *Amaranthus hybridus***

| Plates | Dilution | No of colonies | Average concentration (No of colonies(cfu/g) |
|---|---|---|---|
| A | 10-7 | 14 | 1.5 X $10^8$ |
| | $10^{-7}$ | 16 | |
| B | $10^{-7}$ | 14 | 1.4 X $10^8$ |
| | $10^{-7}$ | 14 | |
| C | $10^{-7}$ | 14 | 1.3 X $10^8$ |
| | $10^{-7}$ | 12 | |
| D | $10^{-7}$ | 18 | 1.7 X $10^8$ |
| | $10^{-7}$ | 16 | |
| E | $10^{-7}$ | 12 | 1.2 X $10^8$ |
| | $10^{-7}$ | 12 | |
| F | $10^{-7}$ | 10 | 0.9 X $10^8$ |
| | $10^{-7}$ | 8 | |
| G | $10^{-7}$ | 8 | 0.7 X $10^8$ |
| | $10^{-7}$ | 6 | |

KEY:
A = Fresh, B =Blanched at 80$^o$C, C= Blanched at 100$^o$C, D = Sun-dried, E= Oven-dried at 60$^o$C, F = Oven-dried at 70$^o$C, G= Oven-dried at 80$^o$C

**Conclusion**

Processing can be used to enhance the value of *Amaranthus hybridus*. These processing methods help to prolong the shelf life of the vegetable as well as enhance the nutritive properties of the vegetable. The increase in the ash and protein composition with respect to processing procedure could make the vegetable to serve as useful ingredients in the diet of pregnant women and lactating mothers. Results obtained in this study has been able to show that, the oven-drying method is the most effective treatment to minimize browning, reduce microbial load, contaminants and therefore prolong the storage life of the vegetable.

## References

Akuhugwo, I.E., Obasi N.A, Chinyere G.C. and Ugbogu A.E.: Nutritional and Chemical value of *Amaranthus hybridus* L. Leaves from Afikpo, Nigeria. *African Journal of Biotechnology, Vol 6 (24).* (2007) pp 2833-2839.

Aletor V.A. and Adeogun, O.A.: Nutrient and Anti nutrient component of some tropical leafy vegetables. *J. Food Chem. Vol. 53*: (1995) pp. 375-379.

Association of Official Analytical Chemists (AOAC):. Official methods of Analysis 14th Edition Washington D.C. 1984

Association of Official Analytical Chemists (AOAC):. Official methods of Analysis 20th edition Washington D.C. 2005

Asaolu, S.S, Adefemi, O.S. Oyakilome I.G. Ajibulu K.E. and Asaolu M.F. Proximate and Mineral Composition of Nigeria leafy vegetables. *Journal of Food Research, Vol 1.* (3). (2012), pp 15-23.

Bolaji P.T., Komolafe G.O. and Alli, E.): Drying Characteristics of Selected local vegetables. *Nigeria Food Journal, Vol 26,(1).* (2008 pp 138.

Edeoga H.O. Omosun G. and Ushe L.G.: Chemical Composition of Hyptiss Sauvelens and Ocimumm gratissimum hybrid from Nigeria. *Afri .J. biotechnol 5(10).* (2006), pp. 892-893.

Ihekoronye A.I. and Ngoddy P.O.: Integrated Food Science and Technology for the tropics, Macmilliam Publisher, London, (1985).pp 293-307.

Mathenge L.: Nutritional value and utilization of indigeneous vegetables in Kenya in Guarino (Ed) Traditional African vegetables in Africa Conservation and use ICRAF-HQ, Nairobi, Institute of plant Genetic and Crop Plant Research Rome, 1997, (1997).76-77.

Mepba H.D., Iboh L. and Banogo D.E.B.: Effects of processing treatments on the nutritional composition and consumer acceptance of some Nigeria edible leafy vegetables. *African Journal of Food Agriculture Nutrition and Development. Vol. 7*,(1) (2007), pp 35-41

Onwuka, G.I.: Food Analysis and Instrumentation Theory and Practice pp 124-125. (2005)

Olaiya, C. and Adebisi J.: Phytoevaluation of the nutritional value often green leafy vegetables in south- Western Nigeria. *The internet Journal of Nutrition and Wellness, Vol. 9*,(2) (2010), pp104-111

Pearson D.: Chemical analysis of foods (7th ed) Churchchill, Livingstone London (1976) pp. 218-336.