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# Nutrient Content of Amaranth (*Amaranthus cruentus* L.) Under Different Processing and Preservation Methods

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**Abstract:** Leafy vegetables are highly perishable food items and require special processing treatments to prevent post harvest losses. Indigenous vegetables like amaranth are not easily preserved by either canning or freezing and be kept for longer periods. So as to maintain acceptable quality there may be need for horticulturalists of these indigenous vegetable to blanch them. The study was carried out to assess the preservation methods that can maintain the nutritional value of amaranths so as to uphold its quality. Amaranth was planted and harvested at 3, 4, 5, 6, 7 and 8 weeks after emergence. The following preservation methods were used; sun-drying of samples without any pre-treatment, blanching and sun-drying and blanching then freezing. Fresh amaranth was used as the control. High levels of Ca and K content were observed in sun-drying of blanched and non-blanched Amaranth. Low levels of P, Na, Cu, Zn and protein were observed in the sun-drying of blanched and non-blanched amaranth. This work showed that blanching and then sun-drying of amaranth could be the best method of preserving it without compromising on its quality.

**Key words:** Blanching · Freezing preservation method · Protein · Sun-dry

## INTRODUCTION

Indigenous vegetable have received significantly less research attention. Vegetable amaranth has been rated equal to or superior in taste to spinach and is considerably higher in calcium, iron and phosphorous [1-3]. According to Pond and Lehman [4], amaranth used for human food should be heated for maximum nutritional benefit. To extend the shelf-life, different ways of preserving traditional vegetables such as amaranth have been developed. The two main methods are the sun-drying of fresh leaves and the sun-drying of blanched or cooked leaves. Electrification of the rural areas has introduced new preservation technology, including the blanching and freezing of leaves [5]. Amaranth production among small scale farmers in Zimbabwe is slowly taking shape and the most limiting factor is the preservation of the vegetable to uphold its quality for long periods. However ways of food preparation and preservation may affect significantly the concentration and availability of minerals, vitamins and other essential compounds in food. Losses of nutrients from vegetables during drying and cooking have been noted [6,7]. The main objective of this research was to assess the effects of different processing and preservation methods on the nutritional value of amaranths.

## MATERIALS AND METHODS

**Description of the Experimental Site:** The experiment was carried out at the Africa University farm in the 2008 and 2009 farming seasons. The farm lies in Natural Farming Region II of Zimbabwe, at 18° 53.595[1] S and 32° 36.173[1] E, with an altitude of 1104 m asl. Its mean annual rainfall is about 800-1000 mm. The soils are red sandy clay loam, Fersiallitic 5E soil under Zimbabwe soil classification system [8].

**Experimental Design:** The experiment was laid in Randomised Complete Block Design (RCBD) and was replicated three times. It was from this design that the foliar for analyses was sampled. The treatments comprised of six harvesting stages (3, 4, 5, 6, 7, 8 weaks after emergence (WAE).

**Processing and Preservation Methods Used**

**Blanching:** This involved the pre-heating of leaf samples for 2 min in hot water (100°C). The leaves were then removed from hot water and soaked in cold water for 30 seconds, then removed and squeezed to remove excess water. The blanched leaves were sun-dried for 2 days on clean perforated surface, with constant turning over to avert fungal growth.

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**Dried:** Fresh leaf samples when dried using natural sun light for 2 days.

**Frozen:** The harvested leaf samples were wrapped in plastic paper and frozen in a refrigerator for one month. The frozen samples were cut into small pieces using a sharp knife, while the sun-dried sample was ground into fine powder and sieved through a 2.0 mm mesh sieve to obtain samples for analysis.

**Fresh:** The fresh leaf samples were processed soon after harvesting as per protocol of the frozen method.

**Plant Sampling:** Twenty four plants were harvested from an area of $6m^2$ and then the younger leaves were collected from the stems. The leaf samples were collected from 3 February 2009 when the crop was 3 week old. Thereafter, the sampling was done by rows weekly for 6 weeks. The harvested plant foliar was analysed for phosphorus, potassium, calcium, sodium, zinc, copper and protein. The collected sample was thoroughly mixed and their stalks removed and were rinsed with distilled water.

**Foliar Nutrient Analyses:** The leaves were then analysed for N, P, K, Na, Ca, Zn and Cu following the protocols outlined by AOAC, [9].

**Statistical Analyses:** Statistical analysis of the data was performed using the STATISTICA software, version 8.02 program [10]. Means were separated using Bonferroni studentised range for testing least significant differences at the 5% level when ANOVA revealed significant ($P < 0.05$) differences among the treatments.

## RESULTS AND DISCUSSION

As indicated in Table 1, there were significant differences ($P<0.05$) in all the preservation methods, from 3 to 8 WAE. Freshly harvested *Amaranthus cruentus* was always highest, followed by frozen. From 7 to 8 WAE, the highest Ca level was observed in dried and blanched samples and the lowest was observed in frozen sample. Higher concentration of Ca in dry than in fresh at 7 to 8 WAE is in accordance with the findings by Mepba *et al*., [11] and Morris *et al.,* [12] who attributed this to heating. According to Oke and Ojofeitimi [13], a daily required intake (DRA) for humans of Ca (mg/day) is 500 to 800 for adult, 1200 to 1400 for pregnant or lactating mothers and 500 for children. This means that blanched and sun-dried and unbalanced and sun-dried *Amaranthus cruentus* can be useful to lactating mothers when harvested at 3 to 8 WAE.

A significant difference ($P<0.05$) was noted between fresh and frozen only in 6 and 7 WAE. On the other hand, freshly harvested and frozen had lower K than dry and blanched from 3 to 8 WAE (Table 2). Dry and blanched were significantly different ($P<0.05$) at the third, sixth and seventh WAE, where dry was higher than blanched. The higher concentration of K in dry and blanched when compared to fresh amaranth could be attributed to the effect of heating on the availability of some nutrients [12]. However, even with the lowest level of K in fresh and frozen *A. cruentus*, they can easily meet the adult minimum DRA for K. Only 2000mg is required for health as set by the 1989 RDA [11].

The results in Table 3 show that there were significant differences ($P <0.05$) amongst all the preservation methods at 3 WAE. Ca content in freshly harvested was 6, 61 and 75% more than the frozen, blanched and dried, respectively. At 4 WAE there was no significant difference ($P>0.05$) between fresh and frozen and fresh and dry. Frozen was highest and dry was lowest.

There was a significant difference ($P < 0.05$) in Ca concentration from 5 -6 WAE. Blanched was highest and frozen was lowest. From 7 to 8 WAE, there was no significant difference ($P>0.05$) between dry and Blanched. Dry and blanched were higher as compared to fresh and frozen.

The significant differences ($P <0.05$) in concentration of Na in *Amaranthus cruentus* from different preservation methods (freshly harvested, dried, blanched and frozen) is shown in Table 4. The highest Na level was observed in freshly harvested *Amaranthus cruentus*, followed by frozen and the lowest level of Na was observed in dried and blanched *Amaranthus cruentus* The lower level of Na in sun-dried and blanched when compared to freshly harvest and frozen in *Amaranthus cruentus,* is negligible. This is because the DRA of Na is approximately 2000 to 2400 mg /day, with a minimum requirement of 500mg [14]. Apart from relying on the minimum requirement (500mg), in most cases when vegetable amaranth is cooked salt is added. Since salt is 39% sodium by weight, 5 grams of salt (about a teaspoon) which equates to about 2 grams/2000mg of sodium is able to meet the DRA [15].

Table 5 shows that there were significant differences ($P<0.05$) between freshly harvested and frozen from 4 to 8 WAE. The highest Cu content was observed in freshly harvested and the lowest Cu content was observed in blanched. As for Cu, considering the DRA of 1.5 to 3.0mg/day [13,14], it might be difficult for the dried and blanched at 8 WAE to meet the DRA, even though Cu observed with these two methods at other ages can still easily meet the DRA.

Table 1: The concentration (mg $100g^{-1}$) P in different preservation methods of amaranths. Means in each row followed by the same letter are not significantly different at $p < 0.05$

| Age(wks) | Blanched | Dried | Fresh | Frozen |
|---|---|---|---|---|
| 3 | 24a | 22a | 90c | 46b |
| 4 | 52b | 50ab | 160c | 34a |
| 5 | 44a | 40a | 96b | 34a |
| 6 | 27a | 38ab | 54bc | 60c |
| 7 | 57c | 45bc | 32ab | 24a |
| 8 | 39a | 50ab | 62b | 60b |

Table 2: The concentration (mg $100g^{-1}$) of K in different preservation methods of amaranths. Means in each row followed by the same letter are not significantly different at $p < 0.05$

| Age (wks) | Blanched | Dried | Fresh | Frozen |
|---|---|---|---|---|
| 3 | 2886.9b | 3778.1c | 1766.7a | 1557.5a |
| 4 | 2664.6b | 2797.6b | 1432.9a | 1308.1a |
| 5 | 2741.5b | 2695.6b | 835.74a | 859.36a |
| 6 | 1966.3b | 2704.9d | 2394.1c | 1702.5a |
| 7 | 2304.8b | 2648.8c | 1380.1a | 2067.7b |
| 8 | 2314.6b | 2551.9b | 975.8a | 1117.7a |

Table 3: The concentration (mg $100g^{-1}$) of Ca in different preservation methods of amaranths. Means in each row followed by the same letter are not significantly different at $p < 0.05$

| Age (wks) | Blanched | Dried | Fresh | Frozen |
|---|---|---|---|---|
| 3 | 1040b | 681.43a | 2693.1d | 2515.1c |
| 4 | 559.6b | 386.13a | 603.04b | 1023.3c |
| 5 | 871.03c | 620.8b | 201.14a | 179.6a |
| 6 | 555.33ab | 634.33b | 950.02c | 456.3a |
| 7 | 644.8c | 741.23c | 375.45b | 44a |
| 8 | 625.56b | 694.8b | 291.3a | 269a |

Table 4: The concentration (mg $100g^{-1}$) of Na in different preservation methods of amaranths. Means in each row followed by the same letter are not significantly different at $p < 0.05$

| Age (wks) | Blanched | Dried | Fresh | Frozen |
|---|---|---|---|---|
| 3 | 828.16b | 527.5a | 1169.6c | 1446d |
| 4 | 623.47a | 600.83a | 934.97b | 892.69b |
| 5 | 601.96a | 592.16a | 1104c | 850.05b |
| 6 | 403.6a | 387.2a | 1673.2b | 1524.9b |
| 7 | 411.1ab | 302.96a | 1255.8c | 512.09b |
| 8 | 401a | 300.06a | 1010.4b | 998.56b |

Table 5: The concentration (mg $100g^{-1}$) of Cu in different preservation methods of amaranths. Means in each row followed by the same letter are not significantly different at $p < 0.05$

| Age (wks) | Blanched | Dried | Fresh | Frozen |
|---|---|---|---|---|
| 3 | 1.46a | 4.03b | 6.25c | 6.07c |
| 4 | 0.25a | 0.53a | 4.82b | 8.90c |
| 5 | 0.35a | 2.93b | 14.43d | 7c |
| 6 | 2.4a | 2.56a | 12.03c | 2.09a |
| 7 | 0.96a | 1.80a | 23.27c | 7.42b |
| 8 | 0.23a | 0.35a | 2.87b | 5.21c |

Table 6: The concentration (mg $100g^{-1}$) of Zn in different preservation methods of amaranths. Means in each row followed by the same letter are not significantly different at $p < 0.05$

| Age(wks) | Blanched | Dried | Fresh | Frozen |
|---|---|---|---|---|
| 3 | 5.92a | 21.76a | 678.9c | 588.62b |
| 4 | 14.80a | 24.06a | 111.81b | 84.93b |
| 5 | 26.23a | 28.6a | 79.55b | 66.53b |
| 6 | 14.96a | 18.36a | 151.23b | 119.83b |
| 7 | 22.83a | 8.23a | 109.41b | 37.68a |
| 8 | 22.83a | 7.83a | 95.29b | 83.34b |

Table 7: The concentration (%) of protein in different preservation methods of amaranths. Means in each row followed by the same letter are not significantly different at $p < 0.05$

| Age(wks) | Blanched | Dried | Fresh | Frozen |
|---|---|---|---|---|
| 3 | 29.1b | 26.1a | 50.8d | 43.1c |
| 4 | 30.6a | 31.9a | 48.8c | 42.1b |
| 5 | 26.7a | 24.4a | 47.2c | 44.3b |
| 6 | 24.9a | 25.8a | 43.7b | 42.9b |
| 7 | 21.8a | 19.7a | 43b | 41.9b |
| 8 | 22.3b | 19.3a | 43.3b | 43b |

As shown in Table 6, there were significant differences ($P<0.05$) of Zn under different methods but blanched and dried methods did not show significant differences from 3 to 8 WAE. Also the lowest Zn concentration observed in dried and blanched is negligible because according to [14], breast-feeding mothers have the highest Zn DRA of 19 mg/day which can be easily met by the Zn content observed in blanched and dried ( 17-18 mg $100g^{-1}$).

Significant differences ($P<0.05$) of amaranths protein content preserved under different methods were noted from 3 to 5 WAE (Table 7). Freshly harvested *A. cruentus* showed higher protein content as compared to dried and blanched samples. Protein DRA of 10 to 15% or 0.8g per kg of body weight per day will be met even when the amaranths is preserved under the two sun-drying methods where the loss was higher as compare to fresh [16]. Protein DRA of 10 to 15% per day will be met with *A.cruentus* preserved under the three preservation methods (sun-dry, blanched and frozen).

## CONCLUSION

Sun-drying after blanching or without blanching resulted in a significant decrease in P, Na, Cu, Zn and protein. From week 7 to 8, Sun-drying after blanching or without blanching resulted in a significant increase of Ca. From week 3 to 8, sun-drying resulted in a significant increase of K.

Regardless of the losses caused by blanching and drying, still the remaining nutrient levels meet the DRA. Sun drying after blanching has got most benefits to humans in terms of essential nutrients like Na. Blanching followed by sun-drying presents some advantages over the straight sun-drying which include enhancing the quality and safety of the dried vegetables and slowing down of enzyme activity that causes undesirable changes in flavor and texture during storage.

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