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Effect of drying methods on the physicochemical properties of waterleaf (*Talinum triangulare*)

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ABSTRACT

This study investigated the effects of sun drying and oven drying at three different temperatures (60 ^{0}C, 70 ^{0}C and 80 ^{0}C) on the physicochemical and sensory properties of waterleaf (*Talinum triangulare*). About 2000 g of freshly harvested leaves were obtained, sorted, chopped into small pieces and sub-divided into five portions of 400 g each; with one portion used for initial analysis, while the remaining four portions were sundried and oven-dried at 60, 70 and 80 ^{0}C respectively. Panelists were assigned to assess the samples as well.

The results of the proximate composition of the samples showed that moisture content ranged from 6.14 to 92.53% (49.34); ash content, 1.03-21.9% (11.47); crude fat, 1.13-5.89% (3.51); crude fibre, 3.59-6.21% (4.9) and crude protein, 2.73-32.29% (17.51). The mineral content of the samples showed that phosphorus content ranged from 92.43-265.59 mg/100 g (179.08); iron content, 0.10-4.50 mg/100 g (2.30); calcium content, 9.26-89.76 mg/100 g (49.51); zinc content, 0.06-5.15 mg/100 g (2.61) and potassium content, 65.54-108.11 mg/ 100 g (86.83). Ascorbic acid content ranged from 13.70-24.90 mg/100 g (19.3). The result of the sensory evaluation showed that oven-dried samples at 60 ^{0}C was significantly preferred to others. It is therefore concluded that waterleaf could be best dried using oven drying method at 60 ^{0}C, in order to retain much of the nutritional and sensory properties.

Keywords: Panelists, Drying methods, Proximate, Nutritional and Sensory properties

INTRODUCTION

Vegetables are rich sources of vital ingredients in healthy and balanced human and animal diets without quantitative restriction (Aletor and Adeogun, 1995; Okoli et al., 1998; Osuagwe, 2008). They are important low cost foods containing low levels of fat and high levels of vitamins, minerals, fibre and some calorie intake and protein (Oguntona, 1998; Mepba et al., 2007; Bolaji et al., 2008). Leafy vegetables which are fed either as processed, semi processed or fresh to man but usually fresh to livestock are reported to be a good source of carotene, ascorbic acid, riboflavin, folic acid and minerals like calcium, iron and phosphorus which have several health benefits including therapeutic uses such as treatment of scurvy, prevention of cold, correction of hypertysosinomenia, malformation of bones and anemia in new born infants (Fasuyi, 2006). As a result of these, they are preciously valued and are also preserved for their economic importance in the advanced countries of the world.

Waterleaf (*Talinum triangulare*) is a common edible leafy vegetable, belonging to the family *Portulacaceae*. Different ethnic tribes in Nigeria referred to it as follows: Edos- *Adodoro,* Efik- *Mmongikong,* Igbo- *Nti oke or Ofebekee,* Tiv- *Ashwe,* Yoruba- *Gbure* and Yagbaland in Kogi State- *Adegbere.* Like other vegetables, it contains carotenoids such as *Lutein* and *Zeaxanthin* which act as a stimulant and in a way influencing the immune cells of the eyes (Shakuntala and Shadaksharaswamy, 1985). Fasuyi (2005) reported that consumption of vegetables helps toward off heart diseases, control blood pressure and cholesterol level, prevent some types of cancer, avoid a painful intestinal ailment called diverticulosis, and guard against cataract and muscular degeneration- two common causes of vision loss. Disu (2010) reported that waterleaf is eaten cooked as a pet-herb and in soups, as a condiment in sauces or raw in salad, besides, very rich in mineral salts and amino acids as well as having anti-scorbutic properties i.e. prevention against scurvy.

Oguntona (1998) reported that consumption of waterleaf has risen to about 360 g per day in the recent time. He indicated that one of the wonderful components of vegetables is the indigestible fibre which sops up water like a sponge and expands when it passes through the digestive system. This calms the irritable bowel by triggering regular bowel movements, decreasing pressure inside the intestinal tract and may help prevent diverticulosis (the development of tiny, easily irritated pouches inside the colon).

Rice et al. (1991) reported that since transpiration is normally at minimum during the hours of darkness and easily in the day, harvesting of vegetables should be done early in the morning to obtain optimum freshness. Drying of these leafy vegetables enhances its packaging and reduces post harvest losses for a considerable period of time. This process can be done either through sun-drying or oven-drying method, with considerable monitoring to avoid loss or contamination by any means.

Lin and Durance (1998) reported that there is vitamin degradation during drying, especially vitamin C (Ascorbic acid) which is being affected by time, temperature and moisture content, as high temperature will oxidize it to L- dehydroxyl ascorbic acid. The thermal damage incurred by a product during drying is directly proportionally to temperature and time. Mohr (1994) and Okoli et al. (1998) reported that high temperature and long drying time associated with conventional dryers often cause heat damage and adversely affect the texture, colour, flavour and nutritive value of waterleaf.

Bright sun, moderate temperature and low humidity are essential for sun drying. This is the oldest and cheapest method of drying vegetable. Drying in the sun can take about 3-7 days with the temperature of about 37 ^{0}C. Though very cheap, but is highly dependent on climatic conditions which is impossible for man to adjust. Besides, it is time-consuming and offers no protection against rodent and insects. However, Ibrahim et al. (2011) in their study of the mineral and phytochemical content of waterleaf subjected to different processing methods found the sun dried sample to retain more of its mineral components compared to the steam blanched and combined treatment samples.

Meanwhile it is indicated that oven drying removes moisture as quickly as possible at a moderate temperatures conducive for flavour, texture and colour retention (Shittu and Ogunmoyela, 1999). In oven drying water leaf, there is need to rotate and shift trays every half an hour and occasionally turning it to ensure even drying i.e. it requires careful monitoring. Dipersio et al. (2004) reported that if the temperature of drying is too low at the beginning; microorganisms may survive and even grow before the leaf is adequately dried. Nevertheless, if temperature is too high and the humidity is low, case hardening may occur, which may result to inability of internal moisture to escape on time, thereby leading to its deterioration. Considering the potential benefits of the nutrients contained in waterleaf, there is need for intensive investigation into their sensitivity to the methods of processing them (Edeoga et al., 2006; Aja et al., 2010).

The specific objectives of this study were therefore:

(i) To investigate the effects of sun drying and oven drying at three different temperatures (60 ^{0}C, 70 ^{0}C and 80 ^{0}C) on the physicochemical and sensory properties of waterleaf (*Talinum triangulare*) by assessing its proximate, mineral and vitamin C composition as well as its sensory properties.

(ii) To obtain an appropriate heat treatment suitable for its preservation with maximum nutrient retention.

MATERIALS AND METHODS

Materials

Fresh water leaf (*Talinum triangulare*) from the Federal University of Technology, Akure (FUTA) environs, 10ml solution of concentrated hydrochloric acid (HCl), Dye solution (2-6 dichlorophenol indophenols), stock standard solution (Ascorbic acid in 4% oxalic acid solution), working standard solution, hot-air-oven, vanadomolybdate reagent and, Buck model 200A Flame Atomic Absorption Spectrophotometer were used in this study.

Methodology

The fresh leaves harvested from FUTA environs were sorted to remove those with bruises and other defects. The disease-free leaves were thoroughly washed with water to remove adhering dirt. The samples were re-sorted to remove the stalks. After washing with water, the green leaves were drained with plastic sieve and thereafter sliced. This was done to obtain slices about 1cm thickness, so as to ensure optimum dryness. The samples were then divided into four portions of about 400 g each. The first portion (A) was sundried for three days, while the remaining portions (B, C, and D) were oven dried under the three Oven temperatures i.e. 60, 70 and 80 ^{0}C until moisture content reached 6% by using conventional moisture determination method.

The proximate composition analysis was done using the methods described by Association of Official Analytical Chemists (AOAC, 1990). Ascorbic acid content was determined using titration method with 2-6 dichlorophenol indophenols (dye). Sensory evaluation was done using a panel of 12 semi-trained judges to evaluate the sensory qualities of the leaves. The mineral contents (Na, Mg, Fe, Ca, Zn and K) were determined using a Buck model 200A Atomic Absorption Spectrophotometer (AAS) while phosphorus was determined using vanadomolybdate reagent.

Statistical analysis

All determinations were performed in triplicate. The statistical analysis was conducted using ANOVA procedures. Duncan's multiple-range test (DMRT) was used to differentiate between the mean values. All the analyses were done with SPSS (11.0) software.

RESULTS

The result of the proximate composition of the samples subjected to sun drying and oven drying is presented in Table 1. From the result, the mean moisture content ranged from 6.14-92.53% (49.34); crude protein, 2.73-32.29% (17.51); ash content, 1.03-21.90% (11.47); crude fibre, 3.59-6.21% (4.9); crude fat, 1.13- 5.89% (3.51) and carbohydrate, 0.11-32.86% (16.49). The results of the effects of drying methods (sun drying and oven drying) on vitamin C content of *Talinum triangulare* is presented in Table 2. The values ranged from 13.70% to 24.90% (18.58) with sample E (control) having the highest value (24.90). The effect of sun drying and oven drying methods on the sensory properties of water leaf is presented in Table 3. From the table, it is observed that there is no significant difference between the samples being oven dried in terms of aroma, mouth feel, taste and their level of acceptability. Figures 2-8 showed the effect of drying methods on the mineral content of *T. triangulare*. From the figures, it is observed that as the temperature increases, the mineral content increases until it reaches 80 ^{0}C compared to the sun dried and fresh samples. In contrast, however, as the temperature increases, the Zn content decreases.

Table 1: Effect of drying on the proximate composition of waterleaf (%).

Samples	Moisture	Crude protein	Carbohydrate	Crude fat	Crude fibre	Ash
A	6.14d	32.35a	28.86d	5.03d	6.15b	21.47c
B	6.22c	30.09a	32.08c	5.26c	6.10c	20.25d
C	6.43b	27.42b	32.67b	5.48b	6.19ab	21.81b
D	6.40b	25.46b	34.14a	5.89a	6.21a	21.90a
E	91.41a	2.73c	0.11e	1.13e	3.59d	1.03d

Values with the same letters in the same column are not significantly different. A= Oven dried waterleaf at 60 ^{0}C, B= Oven dried waterleaf at 70 ^{0}C, C= Oven dried waterleaf at 80 ^{0}C, D= Sun dried waterleaf, E= Fresh waterleaf (Control).

Table 2: Effect of drying methods on the Ascorbic acid content of Water leaf (%).

Heat treatment	Oven drying	Ascorbic acid content
A	60 ^{0}C	18.63c
B	70 ^{0}C	15.50d
C	80 ^{0}C	13.70e
D	Sun drying	20.16b
E	Control	24.90a

Values with the same letters in the same column are not significantly different. A= Oven dried waterleaf at 60 ^{0}C, B= Oven dried waterleaf at 70 ^{0}C, C= Oven dried waterleaf at 80 ^{0}C, D= Sun dried waterleaf, E= Fresh waterleaf (Control).

Table 3: Effects of drying on the sensory qualities of waterleaf.

Samples	Colour	Aroma	Mouth feel	Taste	Overall acceptability
E	7.65a	6.00c	4.60c	7.91a	7.00ab
A	7.42b	7.00ab	7.00a	6.83ab	7.75a
B	7.00c	7.16ab	6.67ab	5.50ab	7.08ab
C	6.48d	7.58ab	6.75ab	6.58ab	6.41b
D	4.25e	6.83b	6.65b	6.50b	5.00c

Values with the same letters in the same column are not significantly different.A= Oven dried waterleaf at 60 ^{0}C, B= Oven dried waterleaf at 70 ^{0}C, C= Oven dried waterleaf at 80 ^{0}C, D= Sun dried waterleaf, E= Fresh waterleaf (Control).

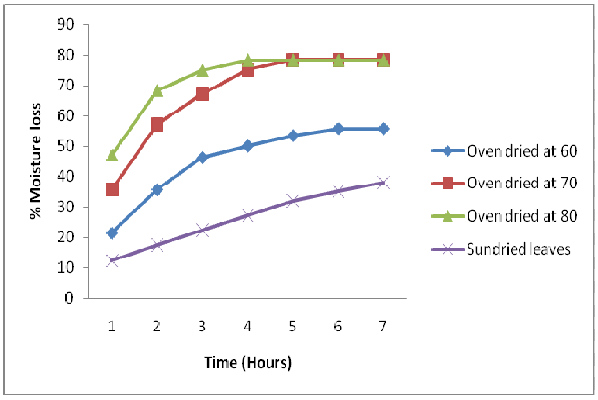

Figure 1: The graph of % moisture loss from waterleaf subjected to different heat treatments and drying methods.

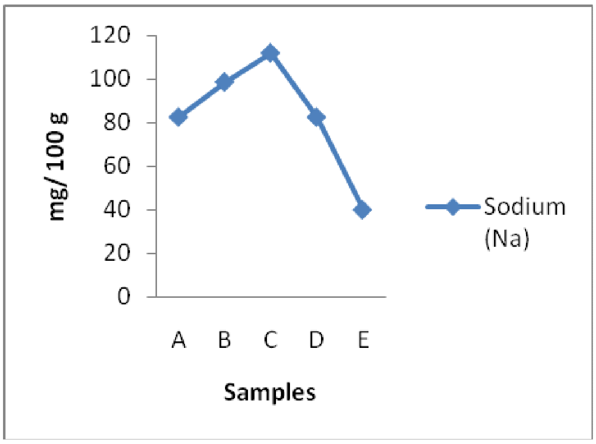

Figure 2: Effects of drying methods on the sodium content of waterleaf (in mg/100 g).

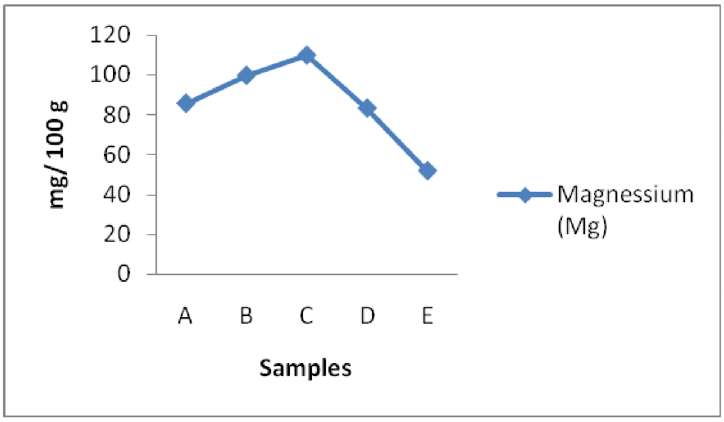

Figure 3: Effects of drying methods on the magnesium content of waterleaf (in mg/100 g).

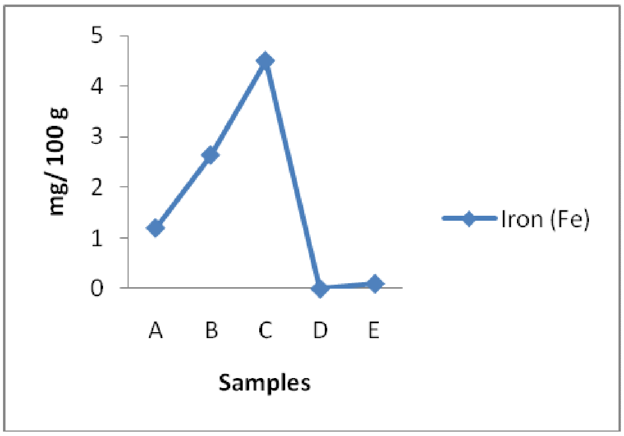

Figure 4: Effects of drying methods on the iron content of waterleaf (in mg/100 g).

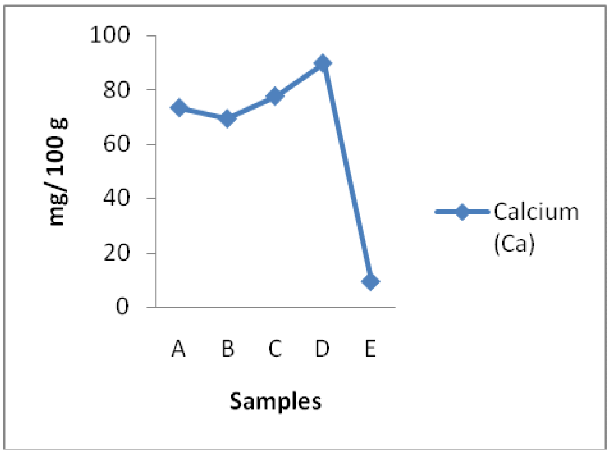

Figure 5: Effects of drying methods on the calcium content of waterleaf (in mg/100 g).

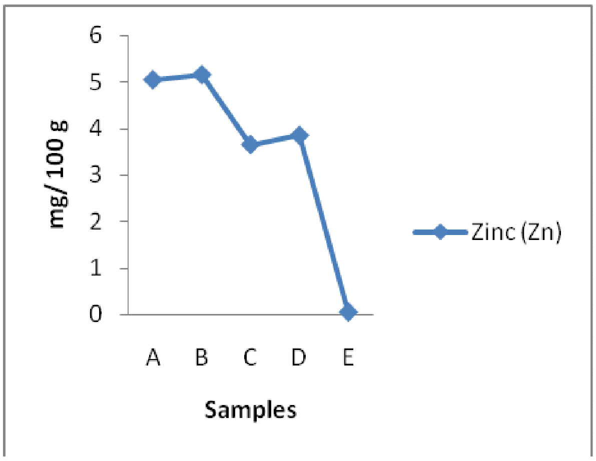

Figure 6: Effects of drying methods on the zinc content of waterleaf (in mg/100 g).

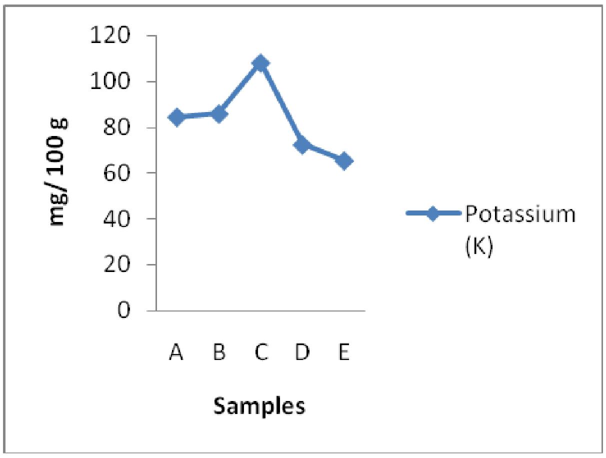

Figure 7: Effects of drying methods on the potassium content of waterleaf (in mg/100 g).

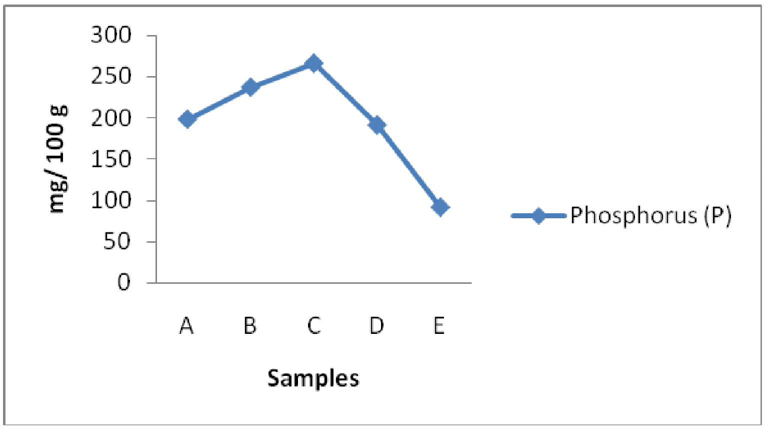

Figure 8: Effects of drying methods on the phosphorus content of waterleaf (in mg/100 g).
A = Oven dried waterleaf at 60 ^{0}C; B = Oven dried waterleaf at 70 ^{0}C; C = Oven dried waterleaf at 80 ^{0}C; D = Sun dried waterleaf; E = Fresh waterleaf (Control).

DISCUSSION

Effect of drying methods on the proximate composition of waterleaf

It could be observed from Table 1 that heat treatment significantly affected the proximate composition of the leaves; though the moisture content of the samples being sun dried and oven dried at 80 ^{0}C was not significantly different from each other.

The crude protein of oven dried leaves at 80 ^{0}C and sun dried samples were not significantly different (at $p \leq 0.05$) from each other; this is also applicable to samples dried at 60 ^{0}C and 70 ^{0}C. The protein content of the dried samples was found to be higher than the control and this might be due to concentration of protein content of the dried samples. These findings agree with those of Mepba et al. (2007).

Oven drying of the leaves at 80 ^{0}C (Figure 1) attained equilibrium moisture content at the fourth hour and showing no further increase in the percentage moisture removed. At 70 ^{0}C, the equilibrium moisture content was attained at the fifth hour, while it was attained at the sixth hour when subjected to heat at 60 ^{0}C. Sun drying took about three days to achieve this. This might be due to unstable weather conditions as being reported by Ngoddy and Ihekoronye (1985); that the lower the intensity of the sun for drying, the lower the rate of evaporation of water from the medium.

This therefore, suggested that the sun dried water leaf could be susceptible to microbial attack as a result of longer drying period. The faster moisture removal in oven dried leaves hinders susceptibility to microbial attack during drying and this invariably increases the shelf life of the dried vegetable and makes it available throughout the year (Ngoddy and Ihekoronye, 1985).

Effects of temperature on vitamin C content

It was observed that heating treatments significantly affected the samples at $p \leq 0.05$. It was noticed as well, that as the drying temperature increases, vitamin C composition decreases. More so, the sample dried with highest temperature had the lowest vitamin C content. This result is in accordance with the report of Fasuyi (2005); higher ascorbic acid content in fresh leaves is due to absence of heat treatment that does easily degrade this compound. This heat liability feature of ascorbic acid also agreed with the findings of Shittu and Ogunmoyela (1999), Solanke and Awonorin (2002), and Edeoga (2006) on dried vegetables.

Effect of drying methods on the sensory qualities of water leaf

The colour of fresh water leaf was more preferable to the others. This might be due to non-degradation of its chlorophyll. This was followed by samples dried at 60 ^{0}C, while the least preferred sample in terms of colour was sun dried sample. This is possibly because of its longer exposure to air which could cause non-enzymatic browning thereby changing the chlorophyll (green) to pheophorbide (brown olive). It was also observed that as the drying temperature increased, chlorophyll degradation also increased. This could also be due to the fact that chlorophyll is an unstable compound and difficult to retain during heat processing as reported by Ngoddy and Ihekoronye (1985).

Table 3 showed that there is no significant difference between the samples being oven dried in terms of aroma, mouth feel, taste and their level of acceptability. This might be due to the concentration of the essential oil present in the vegetable as the moisture content is greatly reduced. These samples were significantly rated better in comparison to fresh leaves.

In terms of mouth feel and taste, oven dried samples were rated best with those dried at 60 ^{0}C rated as best by the panelists.

Effect of drying methods on the mineral composition of water leaf

It can be seen from Figures 2-8 that the leaves were appreciably high in mineral content with the oven dried sample at 80 ^{0}C having the highest value. The sodium content ranged from 40.15 mg/100 g in the fresh sample to 111.96 mg/100 g in sample oven dried at 80 ^{0}C; magnesium, 51.62 mg/100 g in the fresh sample to 109.63 mg/100 g in sample oven dried at 80 ^{0}C; iron, 0.10 mg/100 g in the fresh sample to 4.50 mg/100 g in sample oven dried at 80 ^{0}C while it was not detected in sundried leaves; calcium, 9.26 mg/100 g in the fresh sample to 89.76 mg/100 g in sample being sun dried; zinc, 0.06 mg/100 g in the fresh sample to 5.15 mg/100 g in sample oven dried at 70 ^{0}C; potassium, 65.54 mg/100 g in the fresh sample to 108.11 mg/100 g in sample oven dried at 80 ^{0}C and phosphorus, 92.43 mg/100 g in the fresh sample to 265.59 mg/100 g in sample oven dried at 80 ^{0}C.

This result is in accordance to the findings of Aletor and Adeogun (1995) who reported that mineral elements could be made available in considerable amount by destroying the anti-nutritional factors which inhibit the mineral elements present in the foods, during drying, soaking and cooking processes. The oven dried samples at 80 ^{0}C had higher magnesium, phosphorus and calcium; which could support rigid structure building and proper formation of bones and teeth (Disu, 2010). However, the high content of sodium and potassium in some of the dried samples (oven dried at 80 ^{0}C and sun dried) which ranged between 80 to over 100 mg/100 g could result in cardiovascular and renal disorders since the recommended dietary intake for human beings is seldom over 50 mg/100 g for potassium and 15 mg/100 g for sodium (FNB, 2005). Besides, high dietary sodium is discouraged in subjects who suffer from hypertension.

No significant difference was observed for iron contents of the sundried and fresh samples. Similar observations were also made by Oladumoye et al. (2005) on the study of the effects of cooking on tender and matured cassava leaves.

Conclusion

This work has shown that considerable amount of vitamin C can be lost from water leaf (*T. triangulare*) when it passes through different processing methods. Also, it serves as a valuable source of minerals. Considering the effect of drying methods on the nutritional qualities of water leaf, such as chemical and sensory properties; vitamin C and mineral contents at different temperatures, it could be concluded that oven drying at 60 ^{0}C may be the best method of drying as it has lesser detrimental effects on the nutritional qualities and reduction in susceptibility to contamination.

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